THIRD AMERICAN EDITION.

OF

Nicholson's

BRITISH ENCYCLOPEDIA

or Dictionary of

ARTS & SCIENCES

illustrated by upwards of 180 elegant Engravings.

PHILADELPHIA.

Published by Mitchell Ames & White.

W. Brown Printer.

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OF

ARTS AND SCIENCES,

COMPRISING

AN ACCURATE AND POPULAR VIEW

OF THE PRESENT

IMPROVED STATE OF HUMAN KNOWLEDGE.

BY WILLIAM NICHOLSON,

Author and Proprietor of the Philosophical Journal, and various other Chemical, Philosophical, and Mathematical Works.

ILLUSTRATED WITH

UPWARDS OF 180 ELEGANT ENGRAVINGS.

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BUBROMA, in botany, a genus of the Polyadelphia Decandria class and order. Nat. order Columniferæ. Malvaceæ, Jussieu. Essential character: calyx three-leaved; petals five, arched, semibifid; anthers on each filament three; stigma simple; capsule muricate, ending in a five-rayed star punched with holes, five-celled, valveless, not opening. There is but one species, *viz.* B. guazuma, elm-leaved bubroma or theobroma, or bastard cedar. This tree rises to the height of forty or fifty feet in the West Indies, having a trunk as large as the size of a man's body, covered with a dark brown bark, sending out many branches towards the top, which extend wide every way; leaves oblong, heart-shaped, alternate, nearly four inches long, and two broad near the base, ending in acute points; the branches have a nap scattered over them; they have no buds; the flowers are in corymbs. In Jamaica it is known by the name of bastard cedar, and is peculiar to the low lands there, forming an agreeable shade for the cattle, and supplying them with food in dry weather, when all the herbage is burned up or exhausted. The wood is light and so easily wrought, that it is generally used by coachmakers in all the side pieces; it is also cut into staves for casks

BUCCANEERS, those who dry and smoke flesh or fish after the manner of the Americans. This name is particularly given to the French inhabitants of the island of St. Domingo, whose whole employment is to hunt bulls or wild boars, in order to sell the hides of the former and the flesh of the latter.

The buccaneers are of two sorts; the buccaneers ox-hunters, or rather hunters of bulls and cows; and the buccaneers boar-hunters, who are simply called hunters: though it seems that such a name be less proper to them than to the former; since the latter smoke and dry the flesh of wild boars, which is properly called buccaneering, whereas the former prepare only the hides, which is done without buccaneering.

Buccaneering is a term taken from Buccan, the place where they smoke their flesh or fish, after the manner of the savages, on a grate or hurdle made of Brasil wood, placed in the smoke a considerable distance from the fire; this place is a hut of about twenty-five or thirty feet in circumference, all surrounded and covered with palmetto leaves.

BUCCINATOR, in anatomy; a muscle on each side of the face, common to the lips and cheeks. See ANATOMY.

BUCCINUM, in natural history, a genus of the Vermes Testacea. Animal a limax; shell univalve, spiral, gibbous; aperture ovate, terminating in a short canal leaning to the right, with a retuse beak or projection; pillar-lip, expanded. There are between two and three hundred species, separated into eight divisions; *viz.* A. inflated, rounded, thin, subdiaphonous, and brittle. B. with a short exserted beak; lip unarmed outwardly. C. lip prickly outwardly on the hind part; in other respects resembling division B. D. pillar-lip, dilated and thickened. E. pillar-lip appearing as if worn flat. F. smooth, and not among the former divisions. G. angular, and not included among the former divisions. H. tapering, subulate, smooth.

BUCCO, the *barbet*, in natural history, a genus of birds of the order Picæ. Generic character; bill sharp-edged, compressed on the sides, notched on each side near the apex, bent inwards, with a long slit beneath the eyes; nostrils covered with incumbent feathers; feet formed for climbing. These birds live chiefly in warm climates, and are very stupid; bill strong, straightish, almost covered with bristles; tail feathers usually ten, weak. There are nineteen species, of which we shall notice only B. jamatia, or spotted-bellied barbet. This bird is found in Brazil and Cayenne, is clumsy in its shape, and pensive and solitary in its manners. It is so lethargic in its disposition, that it will suffer itself to be shot at several times before it attempts to escape. Its food consists of insects, and particularly large beetles, and the feathers of its tail are much worn by friction, so as to indicate the probability of the tail being employed, agreeably to the known habit of woodpeckers, in propping or supporting the body.

BUCEROS, the *hornbill*, in natural history, a genus of birds of the order Picæ. Generic character; their bill is convex, curved, sharp-edged, large, outwardly serrate, with a horny protuberance near the base of the upper mandible; the nostrils are behind the base of the bill; the tongue is sharp-pointed, and short; the feet gressorial. There are sixteen species enumerated by Gmelin, though Latham reckons only four; of these the most curious is the B. abyssinicus, or Abyssinian hornbill. This is found in the country from which it takes its name, principally among fields of jaff, and nourishes itself by the green beetles which abound in them. Its young are numerous, sometimes amounting even to eighteen. Though capable of flying far, it chiefly runs. It builds its nest in large thick trees, near churches or other elevated buildings: this nest resembles a magpie's in being covered, but is several times larger than an eagle's; it is seldom much elevated above the ground, but almost always firm on the trunk, and the entrance to it is always from the east. This bird is, in some places, called the bird of destiny.

BUCIDA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Holoraceæ. Elæagni, Jussieu. Essential character; calyx five-toothed, superior; corolla none; berry one-seeded. There is but one species; *viz.* B. buceras, olive bark tree, is a tree growing from twenty to thirty feet in height; the branches and twigs are divaricate or flexuose, roundish, smooth, and even flowers, in racemes from the crowded leaves, simple, spreading, many-flowered; calyx hoary without, tomentose within; filaments twice as long as the calyx; anthers roundish, yellow; germ flatted, with ten streaks at the base. It is a native of the West Indies, flowering in spring.

BUCHNERA, in botany, so named in honour of A. C. Buchner, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ Pediculares, Juss. Essential character: calyx, obscurely five-toothed; corolla border five-cleft, equal; lobes cordate, capsule two-celled. There are eleven species, of which B. Americana, North American buchnera, has the stem scarcely branching; flowers in a spike remote from each other; two of the stamens in the jaws of the corolla, and two in the middle of the tube. The herb grows black in drying. It is a native of Virginia and Canada. B. cernua, drooping buchnera, is a shrub half a foot in height, branching regularly; a little jointed from the scars left by the leaves; purplish; flowers sessile, erect, with a linear, sharp bracte, shorter than the calyx, and two shorter lateral bristles; calyx tubular, oblong semiquinquefid, equal; corolla white, with a filiform tube, twice as long as the calyx, and bent back; border flat, five-parted; segments subovate; anthers within the jaws, two lower than the other two; stigma inclosed, reflex, thickish. Native of the Cape of Good Hope.

BUCK, in natural history, a male horned beast, whose female is denominated a doe. See Cervus.

BUCKET, a small portable vessel to hold water, often made of leather, for its lightness and easy use in cases of fire. It is also the vessel let down into a well, or the sides of ships, to fetch up water.

BUCKING, the first operation in the whitening of linen-yarn or cloth: it consists in pouring hot water upon a tubful of yarn, intermingled with several strata of fine ashes of the ash tree. See Bleaching.

BUCKLER, a piece of defensive armour used by the ancients. It was worn on the left arm, and composed of wickers woven together, or wood of the lightest sort, but most commonly of hides, fortified with plates of brass or other metal. The figure was sometimes round, sometimes oval, and sometimes almost square.

Most of the bucklers were curiously adorned with all sorts of figures of birds and beasts, as eagles, lions: nor of these only, but of the gods, of the celestial bodies, and all the works of nature; which custom was derived from the heroic times, and from them communicated to the Grecians, Romans, and Barbarians.

Bucklers, *votive*. Those consecrated to the gods, and hung up in their temples, either in commemoration of some hero, or as a thanksgiving for a victory obtained over an enemy; whose bucklers, taken in war, were offered as a trophy.

BUCKRAM, in commerce, a sort of coarse cloth, made of hemp, gummed, calendered, and dyed several colours. It is put into those places of the lining of a garment, which one would have stiff and to keep their forms. It is also used in the bodies of women's gowns; and it often serves to make wrappers to cover cloths, serges, and such other merchandises, in order to preserve them and keep them from the dust, and their colours from fading.

BUCOLIC, in ancient poetry, a kind of poem relating to shepherds and country affairs, which, according to the most generally received opinion, took its rise in Sicily. Bucolics, says Vossius, have some conformity with comedy. Like it, they are pictures and imitations of ordinary life; with this difference, however, that comedy represents the manners of the inhabitants of cities; and bucolics, the occupations of country people. Sometimes, continues he, this last poem is in form of a monologue, and sometimes of a dialogue. Sometimes there is action in it, and sometimes only narration; and sometimes it is composed both of action and narration. The hexameter verse is the most proper for bucolics in the Greek and Latin tongues. Moschus, Bion, Theocritus, and Virgil, are the most renowned of the ancient bucolic poets.

BUDDLEA, in botany, so named in honour of Adam Buddle, a genus of the Tetrandria Monogynia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx four cleft; corol four cleft; stamens from the divisions; capsules two furrowed, two-celled, many-seeded. There are eight species, of which B. americana, long spiked buddlea, is a shrub the height of a man; leaves ovate-lanceolate; flowers in long slender spikes, axillary, and terminating; composed of little, opposite, many-flowered, crowded racemes; corolla coriaceous, scarcely longer than the calyx. B. occidentalis; spear-leaved buddlea; this plant is much taller than the first, and divides into a greater number of slender branches, which are covered with a russet hairy bark, with long spear-shaped leaves, ending in sharp points; these grow opposite at every joint; at the end of the branches are produced spikes of white flowers, growing in whorls round the stalks. It grows in sheltered places in the West Indies, being too tender to resist the force of strong winds.

BUDDING, in gardening, is a method of propagation, practised for various sorts of trees, but particularly those of the fruit kinds. It is the only method which can be had recourse to, with certainty, for continuing and multiplying the approved varieties of many sorts of fruit and other trees; as, although their seeds readily grow, and become trees, not one out of a hundred, so raised, produces any thing like the original; and but very few that are good. But trees or stocks raised in this manner, or being budded with the proper sorts, the buds produce invariably the same kind of tree, fruit, flower, &c. continuing unalterably the same afterwards.

The stocks for this use are commonly raised from seed, as the kernels or stones of these different sorts of fruit, &c. sown in autumn or spring in beds, in the nursery, an inch or two deep, which, when a year or two old, should be transplanted into nursery rows, two feet asunder, and fifteen or eighteen inches distant in the rows, to stand for budding upon, keeping them to one stem, and suffering their tops to run up entire; when of two or three years growth, or about the size of the little finger at bottom, or a little more, they are of a due size for budding upon.

Stocks raised from suckers arising from the roots of the trees of these different sorts, layers, and cuttings of them, are also made use of, but they are not so good for the purpose. Budding may likewise be performed occasionally upon trees that already bear fruit, when intended to change the sorts, or have different sorts on the same tree, or to renew any particular branch of a tree; the operation being performed on the young shoots of the year, or of one or two year's growth only. The most proper height to bud stocks varies according to the intention, but from about three or four inches to six feet or more from the ground is practised. To have dwarf trees for walls, and espaliers, &c. they must be budded from within, about three to six inches from the bottom, that they may first furnish branches near the ground: for half standards, at the height of three or four feet; and for full standards, at from about five to six or seven feet high; the stocks being trained accordingly. The necessary implements and materials for this purpose are, a small budding knife for preparing the stocks and buds for insertion, having a flat thin haft to open the bark of the stocks in order to admit the buds; and a quantity of new bass strings well moistened, to tie them with. In performing the operation of budding, the head of the stock is not to be cut off, as in grafting, but the bud inserted into the side, the head remaining entire till the spring afterwards, and then cut off. A smooth part on the side of the stocks at the proper height, rather on the north side away from the sun, should be chosen; and then with the knife an horizontal cut made across the rind, and from the middle of that cut a slit downwards about two inches in length, in the form of the letter T, being careful lest the stalk be wounded. Then, having cut off the leaf from the bud, leaving the foot-stalk remaining, make a cross-cut about half an inch below the eye, and with the knife slit off the bud with part of the wood to it, somewhat in the form of an escutcheon, pulling off that part of the wood which was taken with the bud, being careful that the eye of the bud be left with it, as all those buds which lose their eyes in stripping should be thrown away as good for nothing: then having gently raised the bark of the stock, where the cross incision was made with the flat haft of the knife clear to the wood, thrust the bud in, placing it smoothly between the rind and the wood of the stock, cutting off any part of the rind, belonging to the bud, which may be too long for the slit; and after having exactly fitted the bud to the stock, tie them closely round with bass strings, beginning at the under part of the slit and proceed to the top, taking care not to bind round the eye of the bud, which should be left open and at liberty. When the buds have been inserted about three weeks or a month, examine which of them have taken; those which appear shrivelled and black being dead, but such as remain fresh and plump are joined; and at this time loosen the bandage, which, if not done in time, is apt to pinch the stock, and greatly injure, if not destroy, the bud. The March following, cut off the stock about three inches above the bud, sloping it, that the wet may pass off, and not enter into the stock. To the part of the stock which is left, some fasten the shoot which proceeds from the bud, to prevent the danger of its being blown out, but this must continue no longer than one year; after which it must be cut off close above the bud, that the stock may be covered by it.

BUFF, in commerce, a sort of leather prepared from the skin of the buffalo, which, dressed with oil, after the manner of shammy, makes what we call buff-skin. This makes a very considerable article in the French, English, and Dutch commerce at Constantinople, Smyrna, and all along the coast of Africa. The skins of elks, oxen, and other like animals, when prepared after the same manner as that of the buffalo, are likewise called buffs.

BUFFALO, in zoology, an animal of the ox kind, with very large, crooked, and resupinated horns. See Bos.

BUFFONIA, in botany, so named in honour of the Count de Buffon, a genus of the Tetrandria Dygynia class and order. Natural order of Caryophillei. Essential character: calyx four-leaved; corol four petalled; capsules one-celled, two-seeded. There is but one species, *viz.* B. tenuifolia; small buffonia, or bastard chickweed, has an annual root, the stem half a foot in height, upright, commonly branched at the base; leaves in pairs at each joint, resembling grass leaves, but when the plant is in flower, they are dry and shrivelled; stamens two, sometimes four; filaments very slender, shorter than the corolla, fastened to the receptacle; anthers saffron coloured: the capsule splits at top into two hearts; seeds blackish. It is a native of England, France, Italy, and Spain. It flowers in May and June.

BUFO, *toad.* See Rana.

BUG. See Cimex.

The housebug, or cimex lectuarius, so extremely troublesome about beds, is of a roundish figure, and of a dark cinnamon colour. One of the best methods for extirpating these insects from bedsteads is, by thoroughly washing all the parts where they are likely to lodge with a solution of muriated mercury, or, as it is called in the shops, corrosive sublimate. Great caution should be had in the use of this mixture, as it is one of the most deadly poisons known.

BUGINVILLÆA, in botany, a genus of the Octandria Monogynia class and order. Corolla inferior, tubular, four toothed; stamina inserted on the receptacle; fruit one-seeded. One species, B. spectabilis, found at the Brazils.

BUILDING, a fabric erected by art,

either for devotion, magnificence, or conveniency.

BUILDING is also used for constructing and raising an edifice; in which sense it comprehends as well the expenses, as the invention and execution of the design. There are three things chiefly to be considered in the art of building, *viz.* convenience, firmness, and delight. To accomplish which ends, Sir H. Wotton considers the subject under these two heads, the situation, and the work. As to the situation, either that of the whole is to be considered, or that of its parts. In the first, regard must be had to the quality, temperature, and salubrity of the air; to the quality of the soil; to the conveniency of water, fuel, carriage, &c. and to the agreeableness of the prospect. As to the situation of the parts, the chief rooms, studies, and libraries, should lie towards the east; those offices which require heat, as kitchens, brew-houses, bake-houses, and distillatories, towards the south; those which require a cool fresh air, as cellars, pantries, granaries, to the north; as also galleries for paintings, museums, &c. which require a steady light. The ancient Greeks and Romans generally situated the fronts of their houses towards the south; but the modern Italians vary much from this rule. And indeed, as to this matter, regard must still be had to the country, each being obliged to provide against its own inconveniences.

The situation being fixed on, the next thing to be considered is the work itself, under which come first the principal parts, and next the accessaries or ornaments. To the principals belong the materials, and the form or disposition.

Modern buildings are, in general, much more commodious and beautiful than those of former times. Compactness and uniformity are now so much attended to, that a house built after the new way will afford, on the same ground, double the conveniences which could be had in an old one.

In this article we shall give an account of the principal parts of a building, beginning with the foundation.

Foundation, is the trench or trenches excavated out of the ground, in order to rest the edifice firmly on its base. The trenches should be sunk till they come to an uniform firm texture of ground, or to the solid rock: but when there is no prospect of a firm and uniform bed of gravel, clay, or rock, then recourse must be had to an artificial foundation.

If the ground is tolerably firm, lay transverse pieces of oak, called sleepers, about two feet distant from each other, firmly on the ground; having their upper surface level with the bottom of the trench, and their length equal to its breadth, or about two feet longer than the width of the intended masonry at the bottom of the wall: over these lay planks in the length of the foundation to the breadth of the masonry, where it is to be in contact with the ground, and pin or spike them down.

But if the ground be very bad, provide piles of wood, of such length that they may be able to reach the sound ground, and of such thickness as to be about a twelfth part of their length, and drive these either close to each other, or with interstices, such as the soil may require, and fix planks to their heads or upper ends.

If the ground be generally sound, turn arches over the loose places. When narrow piers are to stand upon the foundation, inverted arches might be turned below the apertures, in order to present a greater surface of resistance to the ground. When the outer walls of a building are piled, the inner ones must be so likewise, that the whole may stand uniformly firm, without the possibility of one wall sinking from another.

If narrow piers are to support a great structure, planks should be placed below, in order to prevent the piers from penetrating the ground. If a building is founded upon an inclined plane, the trenches should be made like steps, having their upper surfaces level, and the risings perpendicular.

Forced earth is unfit for a foundation for a considerable time.

Foundation is also the substructure or bottom of a wall, consisting of one or more regular steps on each side of the wall, below the level of the under side of the floor of the lowest story of a house, in order to prevent it from sinking into the ground, by opposing a greater surface of resistance to it, and for preventing the wall from being overturned by a tempest or storm: each course of steps is called a footing.

The breadth of the substructure should be proportioned to the weight of the superstructure, and to the softness of the ground on which it rests; if the texture of the ground is supposed to be constant, and the materials of the same specific gravity, the breadth of the foundation will be as the area of the vertical section passing through the line on which the breadth is measured; thus, for example, suppose a wall 40 feet high, 2 feet thick; to have a sufficient foundation at 3 feet in breadth, what should be the breadth of a foundation of a wall 60 feet high, $2\frac{1}{2}$ feet thick: by proportion it will be $40\times2 : 3 :: 60\times2\frac{1}{2}$: the ans. $= 5\frac{5}{8}$ feet. This calculation will give the breadth of the foundation of the required wall equal to the breadth of the insisting wall itself; when the height of the required wall is equal to the ratio, which is the first term $40\times2 = 80$, divided by the second term 3, that is $\frac{80}{3} = 26\frac{2}{3}$. Thus a wall of $26\frac{2}{3}$ feet would have the breadth of its foundation equal to its thickness above the foundation, and less than $26\frac{2}{3}$ feet would have a thinner foundation than even the superstructure. But though the calculation in this case gives the foundation less breadth than the thickness of its superstructure, it must be considered, that it only calculates the true breadth of surface that should be opposed to the ground, in order to prevent the wall from penetration by its weight: though the rule gives all the breadth that is necessary, on account of the weight of the insisting wall, yet the breadth of the substructure should always be greater than that of the superstructure; as it will stand more firmly on its base when affected by lateral pressure, and be less liable to rock by the blowing of heavy winds. The least breadth that is commonly given to the substructure of stone walls is one foot thicker than the superstructure. In damp foundations, the superstructure should always be separated from the substructure by lead, tarred paper, or other means.

Stone Arch. Stone arch is a number of stones so arranged, that, in consequence of their pressure upon one another and upon their supports, they may be suspended over a hollow space; every interior stone being such, that, if a plummet be depended by a line from any point in that stone, the line will fall within the hollow space.

Stone arches are generally hollow below, and concave towards that hollow. The interior stones ought to be truncated wedges, and their faces, which form the intrados, of less dimensions than the upper opposite surfaces which form the extrados: so that when any stone endeavours to descend through the aperture which surrounds it, it will be prevented by the dimensions of the lower part of the aperture being less than those of the top of the stone which has to fall through it.

Wedge-like stones forming an arch are arch stones.

The joints between the arch stones are called sommerings.

The support or supports of an arch are called the reins of that arch.

When the support or supports of an arch are stone walls, the upper course or courses, on which the beds of the extreme arch stones rest, are called the imposts.

Spring course, or chaptrels of the arch, are called the butments or abutments, or spring beds, or skew backs of the arch.

When an arch is either recessed in any piece of masonry, or forms the head of an aperture through that piece of masonry, the arch stones, which are common to the intrados and to the face of the masonry, are called voussoirs, and the middle voussoir is called the key-stone.

Stone arches are used for a variety of purposes, in supporting different parts of a building, over apertures, when the apertures are too wide for lintelling, and over a wooden or stone lintel, to assist in supporting the superincumbent building.

Arches are also used to prop the sides of a building, and in soft foundations inverted arches are used, between narrow piers, to prevent the pier from penetrating, by opposing a greater surface of resistance to the ground.

Floors and roofs are frequently supported with arches, in order to render the building more secure from fire.

Arches employed for several of these purposes have been demoninated as follows: those over wooden lintels have been called occult discharging arches, or arches of discharge; those used to prop the sides of a building are called arch boutants, or flying buttresses; and those over apertures, the intrados of which are horizontal planes, have been absurdly called straight arches; it is only for the property of its radiating joints this last is called an arch.

Because the courses in every kind of masonry ought to be horizontal, or the nearest position to it that the nature of the arch will admit of, in stone arching, it follows, that when the intrados is a rotative figure, with a vertical axis, the coursing joints will be conic surfaces, and their intersections upon the intrados horizontal circles, and the transverse joints will be planes tending to the axis: when the axis is horizontal, the coursing joints will be planes tending to the axis, and the transverse joints will be either vertical circular rings, or conic surfaces, having the same common axis with the intrados.

Stone Walls. Stone walls are those built of stone, with or without cement in the joints; the bedding joints have most commonly a horizontal position in the face of the work; and this ought always to be the case, when the top of a wall terminates in a horizontal plane or line. In bridge building, and in the masonry of fence walls, upon inclined surfaces, the bedding joints on the face sometimes follow the direction of the top or terminating surface.

The footings of stone walls ought to be constructed of large stones, which, if not naturally near the square from the quarry, should be reduced by hammer dressing to that form, and to an equal thickness in the same course; for, if the beds of the stones of the foundation are suffered to taper, the superstructure will be apt to give way, by resting upon mere angles or points; or upon inclined surfaces the footings ought to be well bedded upon each other with mortar, and all the upright joints of an upper footing should break joint; that is, they should fall upon the solid of the stones below, and not upon the joint.

The following are methods practised in laying the footings of a stone foundation: when walls are thin, and stones can be got conveniently, that their length may reach across each footing from one side of the wall to the other, the setting of each course with whole stones in the thickness of the wall should be preferred. But when the walls are thicker, and bond stones in part can only be conveniently procured, then every other succeeding stone in the course may be a whole stone in the thickness of the wall; and every other interval may consist of two stones in the breadth of the footing; this is placing the header and stretcher alternately, like Flemish bond in nine-inch brickwork. But when bond stones cannot be had conveniently, every alternate stone should be in length two-thirds of the breadth of the footing upon the same side of the wall; then upon the other side of the wall a stone of one-third of the breadth of the footing should be placed opposite to one of two-thirds; and one of two-thirds opposite to one of one third; so that the stones may be placed in the same manner as those of the other side.

In broad foundations, where stones cannot be procured for a length equal to two-thirds of the foundation, then build them alternately, with the joints on the upper bed of each footing, so that the joint of every two stones may fall as nearly as possible in the middle of the length of the one, or each adjoining stone; observing to dispose the stones alike on each side of every footing. A wall, the superstructure of which is built of unhewn stone laid in mortar, is called a ruble wall. They are of two kinds, coursed and uncoursed. The most common kind of ruble is the uncoursed, of which the greater part of the stones is crude, as they came out of the quarry, and the rest hammer dressed. This kind of walling is very inconvenient for the building of bond timbers; but if they are to be preferred to plugging, the backing must be levelled in every height in which the bond timbers are disposed. The best kind of ruble is the coursed; the courses are all of accidental thicknesses, adjusted by a sizing rule, as the slating of a roof; the stones are either hammer dressed or axed. This kind of work is favourable for the disposition of bond timbers: but as all buildings, constructed either in whole or in part of timber, are liable to be burnt, strong well built walls should never be bound with timber, but should rather be plugged; for if such accident take place, the walls will be less liable to warp.

Walls faced with squared stones, hewn or rubbed, and backed with ruble stone or brick, are called ashler. The medium size of each ashler measures horizontally in the face of the wall about 28 or 30 inches, in the altitude one foot, and in the thickness 8 or 9 inches. The best figures of stones for an ashler facing are formed like truncated wedges; that is to say, they are thinner at one end than at the other in the thickness of the wall, so that when the stones of one course, or a part of a course, are shaped in this manner, and alike situated to each other, the back of the course will form an indention like the teeth of a joiner's saw, but more shallow, in proportion to the length of a tooth; the next course has its indentations formed the same way, and the stones so selected, that the upright joints break upon the solid of the stones below.

By these means, the facing and backing are toothed together, and unquestionably stronger than if the back of each ashler had been parallel to the front surface of the wall; as the stones are mostly raised in quarries of various thicknesses, in an ashler facing, it would greatly contribute suppose a wall 40 feet high, 2 feet thick; to have a sufficient foundation at 3 feet in breadth, what should be the breadth of a foundation of a wall 60 feet high, $2\frac{1}{2}$ feet thick: by proportion it will be $40\times2 : 3 :: 60\times2\frac{1}{2}$: the ans. $= 5\frac{5}{8}$ feet. This calculation will give the breadth of the foundation of the required wall equal to the breadth of the insisting wall itself; when the height of the required wall is equal to the ratio, which is the first term $40\times2 = 80$, divided by the second term 3, that is $\frac{80}{3} = 26\frac{2}{3}$. Thus a wall of $26\frac{2}{3}$ feet would have the breadth of its foundation equal to its thickness above the foundation, and less than $26\frac{2}{3}$ feet would have a thinner foundation than even the superstructure. But though the calculation in this case gives the foundation less breadth than the thickness of its superstructure, it must be considered, that it only calculates the true breadth of surface that should be opposed to the ground, in order to prevent the wall from penetration by its weight: though the rule gives all the breadth that is necessary, on account of the weight of the insisting wall, yet the breadth of the substructure should always be greater than that of the superstructure; as it will stand more firmly on its base when affected by lateral pressure, and be less liable to rock by the blowing of heavy winds. The least breadth that is commonly given to the substructure of stone walls is one foot thicker than the superstructure. In damp foundations, the superstructure should always be separated from the substructure by lead, tarred paper, or other means.

Stone Arch. Stone arch is a number of stones so arranged, that, in consequence of their pressure upon one another and upon their supports, they may be suspended over a hollow space; every interior stone being such, that, if a plummet be depended by a line from any point in that stone, the line will fall within the hollow space.

Stone arches are generally hollow below, and concave towards that hollow. The interior stones ought to be truncated wedges, and their faces, which form the intrados, of less dimensions than the upper opposite surfaces which form the extrados: so that when any stone endeavours to descend through the aperture which surrounds it, it will be prevented by the dimensions of the lower part of the aperture being less than those of the top of the stone which has to fall through it.

Wedge-like stones forming an arch are arch stones.

The joints between the arch stones are called sommerings.

The support or supports of an arch are called the reins of that arch.

When the support or supports of an arch are stone walls, the upper course or courses, on which the beds of the extreme arch stones rest, are called the imposts.

Spring course, or chaptrels of the arch, are called the butments or abutments, or spring beds, or skew backs of the arch.

When an arch is either recessed in any piece of masonry, or forms the head of an aperture through that piece of masonry, the arch stones, which are common to the intrados and to the face of the masonry, are called voussoirs, and the middle voussoir is called the key-stone.

Stone arches are used for a variety of purposes, in supporting different parts of a building, over apertures, when the apertures are too wide for lintelling, and over a wooden or stone lintel, to assist in supporting the superincumbent building.

Arches are also used to prop the sides of a building, and in soft foundations inverted arches are used, between narrow piers, to prevent the pier from penetrating, by opposing a greater surface of resistance to the ground.

Floors and roofs are frequently supported with arches, in order to render the building more secure from fire.

Arches employed for several of these purposes have been demoninated as follows: those over wooden lintels have been called occult discharging arches, or arches of discharge; those used to prop the sides of a building are called arch boutants, or flying buttresses; and those over apertures, the intrados of which are horizontal planes, have been absurdly called straight arches; it is only for the property of its radiating joints this last is called an arch.

Because the courses in every kind of masonry ought to be horizontal, or the nearest position to it that the nature of the arch will admit of, in stone arching, it follows, that when the intrados is a rotative figure, with a vertical axis, the coursing joints will be conic surfaces, and their intersections upon the intrados horizontal circles, and the transverse joints will be planes tending to the axis: when the axis is horizontal, the coursing joints will be planes tending to the axis, and the transverse joints will be either vertical circular rings, or conic surfaces, having the same common axis with the intrados.

Stone Walls. Stone walls are those built of stone, with or without cement in the joints; the bedding joints have most commonly a horizontal position in the face of the work; and this ought always to be the case, when the top of a wall terminates in a horizontal plane or line. In bridge building, and in the masonry of fence walls, upon inclined surfaces, the bedding joints on the face sometimes follow the direction of the top or terminating surface.

The footings of stone walls ought to be constructed of large stones, which, if not naturally near the square from the quarry, should be reduced by hammer dressing to that form, and to an equal thickness in the same course; for, if the beds of the stones of the foundation are suffered to taper, the superstructure will be apt to give way, by resting upon mere angles or points; or upon inclined surfaces the footings ought to be well bedded upon each other with mortar, and all the upright joints of an upper footing should break joint; that is, they should fall upon the solid of the stones below, and not upon the joint.

The following are methods practised in laying the footings of a stone foundation: when walls are thin, and stones can be got conveniently, that their length may reach across each footing from one side of the wall to the other, the setting of each course with whole stones in the thickness of the wall should be preferred. But when the walls are thicker, and bond stones in part can only be conveniently procured, then every other succeeding stone in the course may be a whole stone in the thickness of the wall; and every other interval may consist of two stones in the breadth of the footing; this is placing the header and stretcher alternately, like Flemish bond in nine-inch brickwork. But when bond stones cannot be had conveniently, every alternate stone should be in length two-thirds of the breadth of the footing upon the same side of the wall; then upon the other side of the wall a stone of one-third of the breadth of the footing should be placed opposite to one of two-thirds; and one of two-thirds opposite to one of one third; so that the stones may be placed in the same manner as those of the other side.

In broad foundations, where stones cannot be procured for a length equal to two-thirds of the foundation, then build them alternately, with the joints on the upper bed of each footing, so that the joint of every two stones may fall as nearly as possible in the middle of the length of the one, or each adjoining stone; observing to dispose the stones alike on each side of every footing. A wall, the superstructure of which is built of unhewn stone laid in mortar, is called a ruble wall. They are of two kinds, coursed and uncoursed. The most common kind of ruble is the uncoursed, of which the greater part of the stones is crude, as they came out of the quarry, and the rest hammer dressed. This kind of walling is very inconvenient for the building of bond timbers; but if they are to be preferred to plugging, the backing must be levelled in every height in which the bond timbers are disposed. The best kind of ruble is the coursed; the courses are all of accidental thicknesses, adjusted by a sizing rule, as the slating of a roof; the stones are either hammer dressed or axed. This kind of work is favourable for the disposition of bond timbers: but as all buildings, constructed either in whole or in part of timber, are liable to be burnt, strong well built walls should never be bound with timber, but should rather be plugged; for if such accident take place, the walls will be less liable to warp.

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By these means, the facing and backing are toothed together, and unquestionably stronger than if the back of each ashler had been parallel to the front surface of the wall; as the stones are mostly raised in quarries of various thicknesses, in an ashler facing, it would greatly contribute to the strength of the work to select the stones in each course, so that every alternate ashler may have broader beds than those of every ashler placed in each alternate interval. In every course of ashler facing bond stones should be introduced, and their number should be proportioned to the length of the course. This should be strictly attended to in long ranges of stones, both in walls without apertures, and in the courses that form wide piers; when they are wide, every bond stone of one course should fall in the middle of every two bond stones in the course below. In every pier where the jambs are coursed with the ashler, and also in every pier where the jambs are one entire height, every alternate stone next to the aperture in the former case, and every alternate stone next to the jambs in the latter case, should bond through the wall; and also every other stone should be placed lengthwise, in each return of an angle, not less than the average length of an ashler. Bond stones should have no taper in their beds; the end of every bond stone, as well as the end of every return stone, should never be less than a foot. There should be no such thing as a closer permitted, unless it bond through the wall. All the uprights, or joints, should be square, or at right angles to the front of the wall, and may recede about ¾ths of an inch from the face, from thence gradually widen to the back, and thereby make hollow, wedge-formed figures, which will give sufficient cavities for the reception of packing and mortar.

Both the upper and lower beds of every stone should be quite level, and not form acute angles, as is often the case; the joints from the face to about ¾ths of an inch within the wall should be either cemented with fine mortar, or with a mixture of oil, putty, and white lead: the former is the practice both in London and Edinburgh, and the latter in Glasgow. The putty cement will stand longer than most stones, and will be prominent when the face of the stones has been corroded with age. The whole of the ashler, except that mentioned of the joints toward the face of the wall, the ruble work, and the core, should be set and laid in the best mortar, and every stone laid on its natural bed.

All wall-plates should be placed upon a number of bond stones, and particularly those of the roof; by which means they may either be joggled upon the bonds, or fastened to them by iron and lead. In building walls or insulated pillars of very short horizontal dimensions, not exceeding a length of stones that can be easily procured, every stone should be quite level on the bed, without any degree of concavity, and should be one entire piece between every two horizontal joints. This should be particularly attended to on piers, where the insisting weight is great, otherwise the stones will be in danger of splintering and crushing to pieces, and perhaps occasion a total demolition of the fabric. Vitruvius has left us an account of the manner of the construction of the walls of the ancients, which were as follows: the reticulated is that wherein the joints run in parallel lines, making angles of 45° each with the horizon in contrary ways, and consequently the faces of the stones form squares, of which one diagonal is horizontal, and the other vertical. This kind of wall was much used by the Romans in his time. The incertain wall was formed of stones, of which the one direction of the joints was horizontal, and the other vertical; but the vertical joints of the alternate courses were not always arranged in the same straight line: all that they regarded was to make them break joint. This manner of walling was used by the Romans in times antecedent to the time of Vitruvius. Vitruvius directs, that in both the reticulated and incertain walls, instead of filling up the spaces between the sides with ruble promiscuously, they should be strengthened with abutments of hewn stone or bricks, or common flints, built in walls two feet high, and bound to the front with cramps of iron. The emplection consisted of two sides or shells of squared stone, with alternate joints, and a ruble core in the middle.

The walls of the Greeks were of three kinds, named isodomum, pseudosodomum, and emplection. The isodomum had the courses all of an equal thickness; but the pseudosodomum had them unequally thick; in both these walls, wherever the squared work was discontinued, the interval or core was filled up with common hard stones, laid in the manner of brick, with alternate joints. The emplection was constructed wholly of squared stones; in these bond stones were placed at regular intervals, and the stones in the intermediate distance were laid with alternate joints, in the same manner as those of the face; so that this manner of Greek walling must have been much stronger than the emplection of the Roman villagers. This is a most strong and durable manner of walling, and in modern times it may be practised with the utmost success; but in the common run of buildings it would be too expensive.

Stone Columns. Stone columns should be executed with as few joints as possible; if they can be procured in one piece, they will have a strong and grand effect. There should be no such thing as vertical joints; for they not only destroy the beauty of the column, but are inconsistent with the laws of strength. Before the number of pieces can be fixed, two important circumstances must be taken into consideration: first, to find out those quarries which will produce durable stones, of the size and colour wanted, and the nearer to the place of erection the better; next to inquire concerning the price of the carriage; if these come within the maximum limit of what the proprietor would chuse to fix, then the number of pieces is determined; but, if not, this number must be increased, in order to make it equal to, or less than, the proposed sum, observing to choose the nearest odd number. The circumstances being thus accommodated to each other, and the stones laid down at the place intended for building, draw a section of the column through its axis, to the full size; divide the height of this section, by lines parallel to the base, into heights equal in number to that of the stones; by these means, the diameters of each end of every stone in the altitude will be determined. The upper and lower bodies of each stone are first to be wrought exactly to parallel planes; and as one great beauty of columns is to make them appear, at a small distance, as if they were in one entire piece, they should be rubbed at first with a large coarse stone, in order to prevent the surface from being excavated, and then with a fine stone of the same size as the coarse one; with the utmost care observing to try the straight edge, or rule, as the rubbing goes on; in this the edge of the rule should always coincide with the surface, otherwise the two superficies which are to form the joint can never coincide. The two beds of a stone being thus formed, find the centre, and describe the circle at one end; divide the circumference into a convenient number of equal parts; (it is usual to divide it into six or eight;) draw lines from each point to the centre; find the centre of the circle on the other bed, so that the two centres may be in the straight line forming the axis of the column; that is, when the straight line joining their centres is perpendicular to each bed, through the centre of this last circle draw a straight line, parallel to any one of the lines drawn through the centre and circumference of the former; also from the point in the circumference of the last drawn circle, where the line drawn through the centre cuts this circle, divide the circumference into the same number of equal parts as that of the circle formerly drawn; then draw lines from the centre to each of the points so divided, and these lines will be respectively parallel to those of the former circle; the extremities of each pair of parallel lines, in each circumference, will regulate the chissel draught, which is to be wrought along the surface of the column. The corresponding draught being made from each pair of parallels, the spaces between will be more easily wrought down; then, if the number of pieces which compose the column exceed seven or nine, a straight edge may be applied, the side of which always being in a plane passing through the axis; but if fewer pieces are used, make a diminishing rule, that is, to the line of the column: on the side of the diminishing rule draw a straight line parallel to the axis; this rule will serve to plumb the stones in setting them, and to work the convex surface of each stone: prepare another rule, equal in length to that of a stone having its edge straight the same as the diminishing rule.

The cement used in setting each column stone is either oil-putty, or white lead, or white lead mixed with chalk-putty, or fine mortar, or milled lead rolled very thin. If the column be large, and rolled lead be used, it needs only to form a ring half an inch distant from the edge of the joint, and let the joint at the edge be filled with oil-putty.

Stone Stairs. When stairs are supported by a wall at both ends, nothing difficult can occur in the construction; in this the inner ends of the steps may either terminate into a solid newal, or be tailed into a wall surrounding an open newal. Where elegance is not required, and where the newal does not exceed two feet six inches, the ends of the steps may be conveniently supported by a solid pillar; but when the newal is thicker, a thin wall surrounding the newal would be cheaper. In the stairs of a sunk story, where there is a geometrical stair above, the steps next to the newal are generally supported upon a dwarf wall. Geometrical stairs have the outer end fixed in the wall, and one of the edges of every step supported by the edge of the step below, and constructed with sally-formed joints; so that they cannot descend in the inclined direction of the stair, not yet in a vertical direction; the upper sally of every step forms an interior obtuse angle, called a back rebate, and the lower, of course, an exterior one; and the joint formed of these sallies is called a joggle. The upper part of the joint may be level from the face of the risers, to about one inch within the joint.

This is the plane of the tread of each step, continued one inch within the surface of each riser; the lower part of the joint is a narrow surface, perpendicular to the rake of the stair, at the end next to the newal. In stairs constructed of most kinds of stone, the thickness of every step, at the thinnest place of the end next to the newal, has no occasion to exceed two inches, for steps of four feet in length, that is, by measuring from the interior angle of every step perpendicular to the rake.

The thickness of steps at the interior angle should be proportioned to the length of the step; but allowing that the thickness of the steps at each interior angle is sufficient at two inches, then will the thickness of the steps at the interior angles be half the number of inches that the length of the steps has in feet; thus a step five feet long would be two inches and a half at that place.

The stone platform of geometrical stairs, *viz.* the landing half spaces, and quarter spaces, are constructed of one, two, or several stones, according to the difficulty of procuring them. When the platform consists of two or more stones, the first platform stone is laid upon the last step that is set, and the one end wedged in the wall: the next platform stone is joggled, or rebated, into the one next set, and the end again fixed in the wall, as that and the preceding steps are, and every stone in succession, till the platform is completed. If there is occasion for another flight of steps, the last platform becomes a spring stone for the next step; the joint is to be joggled, as well as all the succeeding steps, in the same manner as the first flight. Geometrical stairs, executed in stone, depend on the following principle: that every body must at least be supported by three points, placed out of a straight line, and, consequently, if two edges of a body in different directions be secured to another, the two bodies will be immoveable in respect to each other. This last is the case in a geometrical stair; one end of a stair stone is always tailed into the wall, and one edge either rests on the ground itself, or on the edge of the preceding stair stone, whether the stair stone be a plat or step. The stones forming a platform are generally of the same thickness as those forming the steps.

Roofs. Roof is that part of a building raised upon the walls, and extending over all the parts of the interior, which consists not only of the covering or exterior part, but of all the necessary supports of that part, for protecting its contents from inclement seasons. There are many forms of roofs, the most simple of which is that which has only one plane, and is called a shed roof; but the form which has always been, and still continues to be, in most general use, wherever the nature of climate requires it to be raised, is that, the vertical section of which consists of two sloping sides, is consequently triangular, and called a span or pediment roof.

Here it will be proper to say something of the changes of inclination or pitch which have prevailed in this simple form, among different nations, from time to time, arising as well from the nature of the climate as the caprice of the people, and as transmitted down to the present age. The ancient Egyptians, Babylonians, and Persians, as well as other eastern nations, and also the present inhabitants of those climates where rain seldom appears, make their roofs quite flat. The ancient Greeks, perceiving the inconvenience of this, raised them in the middle, with a gentle inclination towards the sides; the height from the middle to the level of the walls not exceeding one-ninth or one-eight part of the span; as may be seen by many ancient temples still remaining in that country. The Romans made the height from one-fifth to two-ninth parts of the span. After the decline of the Roman empire, high pitched roofs began to be in general request all over Europe, and the vertical section of that which most generally prevailed seems to have been an equilateral triangle, which was considered as the standard. In Germany, this has been remarkable from very remote antiquity, as appears from Vitruvius: the equilateral pitch, and that of a higher one, appears to have continued as long as pointed architecture prevailed.

When Grecian and Roman architecture was first introduced into this country from Italy, roofs began to be made lower, and the rafters were three-fourths of the breadth of the building: this was called true pitch, and subsequently the square seems to have been considered as the true pitch. In these several gradations of changes, the material for the covering has been supposed to be impervious stone or slates; and the roofs themselves to be those which cover ordinary dwellings; for, after the Italian architecture began to prevail in the last century, platform roofs, and those of a pediment pitch, were introduced in many sumptuous mansions and public edifices; but the material employed for covering was lead. At the present day, when good slates are to be had in abundance, we can execute roofs to the Grecian declivity; but with regard to the general practice, the pitch of the roof depends on the style of architecture introduced in the buildings; the proportion of the pitch, in ordinary dwellings, is between one-third and one fourth part of the span; mansions and public buildings are executed in every style that has prevailed in different times and among different people; and the proportion of the roof, as well as other parts, are rigidly adhered to; this consequently produces a great diversity in the heights.

There are some advantages in high pitched roofs; they discharge the rain with greater rapidity; snow continues to lie a much shorter time on their surface, and they are less liable to be stripped by heavy winds.

Low roofs require large slates, and the utmost care in the execution; but they have, however, this advantage, that they are much cheaper, since they require shorter timbers, and consequently much smaller scantling; besides, they have less pressure on the walls. The roof is one of the principal ties to a building, when executed with judgment, as it binds the exterior walls together. There are a variety of forms in the vertical section of roofs, besides the simple and customary one above mentioned. The figure of the roof depends on two or more vertical and horizontal sections. A span, or pent roof, is that which stands upon walls of a quadrangular plan, and of which the transverse vertical section is every where a triangle throughout its length, and slopes from two opposite sides. A hipt, or Italian roof is that, the sides of which incline alike to the horizon, and terminate either in a point, line, or raised platform. Vitruvius calls a hipt roof, which rises from a rectangular plan, a testudinated roof, or simply a testudo. When the plan of a roof is a parallelogram, and when the vertical section across the two opposite walls, which have not a greater span than that across the other two walls, consists of four sloping sides on the outside, each two forming an exterior angle, the roof is called a curb or mansard roof, whether there are gables on the other two sides of the building, or the different sides of the roof, equally inclined, all around, upon each respective wall.

Figures of roofs which rise from square, rectangular, and polygonal plans, forming only exterior angles on the outside, and which terminate in a point over the centre of the plan, are denominated from the base on which they rise, and from a vertical section passing through the apex perpendicular to any one of the sides of the base and to the horizon; that is, a roof standing upon a square pentagonal, or octagonal plan, having a triangular vertical section, is called a square pentagonal or octagonal pyramidal roof; when such a roof is said to be polygonal, the epithet only applies to the figure of the base. An octangular roof is one whose base is an octagon, whatever be the form of the vertical section. All roofs, the horizontal sections of which are similar figures, either polygons as above described, or circles or ellipses, and the vertical sections of which are segments of convex curves, such as of circles, ellipses, parabolas, &c. are called domes; hence a square dome is one that rises from a square plan; an octangular dome, from an octangular plan; a circular dome from a circular plan; and an elliptic dome from an elliptical plan. Domes upon circular plans are called cupolas. A circular or elliptical roof, the vertical section of which consists of two similar and equal concave curves meeting in the apex, is called a trumpet mouthed roof. When the roof is circular or elliptical, and the vertical section an isosceles triangle, the apex of which is that of the roof, the roof is simply called a conical or conoidal roof. When the vertical section of a circular dome is a parabola, hyperbola, or ellipsis, the dome is then called a paraboloidal dome, a hyperboloidal dome, or ellipsoidal dome, these epithets comprehending both the base of the figure and vertical section. All figures of roofs, which insist on the foregoing bases, whatever be the form of their vertical sections, are called by the general name of pavilion roofs, as they only cover one simple building. From the intersections of two or more simple roofs of the same or of different kinds, a multitude of complex figures will be formed: the plans of some of these are denominated by letters of the alphabet, as an ell roof is one which rests upon a plan in the form of the letter L: a tee roof upon a plan in the form of the letter T; and an aitch roof upon a plan formed like the letter H; but when two common roofs, having their ridges parallel to each other, and a side of the one either joins one of the other, or these two sides intersect each other, and thereby leave a gutter above the roof; then the roof which is thus compounded of the two simple roofs is called an em roof, as the vertical section is in the form of the letter M: or rather an inverted W as M: this is an instance where the roof is denominated by the vertical section, and not by the plan. All roofs whatever are said to be truncated, whether they terminate in a plane or raised platform, or have a void at the top, bounded by a level curb.

When the side of a roof is a plane surface, except at the eaves, at which place it is concave, the roof is said to have a bell cast at that place.

The general names of the timbers are, straining pieces, tie pieces, and bearers; under straining pieces are included, principal rafters, camber beams, hip and valley rafters, collar beams, or straining beams, straining sills, struts, auxiliary rafters, or principal braces and studs.

Under the pieces are included, tie beams, diagonal ties, and truss posts; and under bearers are included. plates, purlins, common rafters, small rafters, ridge pieces, boarding and dragon beams.

The sloping sides of roofs are of two kinds, single and double, or plain and carcase: single roofs are those which have one row of rafters upon the same side; double or carcase roofs are those which have two ties of rafters; the lower tie supporting the upper by the intervention of transverse pieces called purlins.

Stone Bridges. A stone bridge is a thick wall built across a hollow, with one, two, three, or a series of apertures, formed into arcades, which either serve to lighten the masonry, or to give passage to a stream of water, or both.

When a stone bridge is resolved upon, the first consideration is its place: in this several particulars should be taken into consideration, and the advantages compared to the disadvantages. As the height of the bridge depends on the banks of the river, the expense will be increased according to their height: therefore a convenient situation should be chosen, where the banks will be adequate in height to that necessary for the bridge, though the expense will be increased by the length of the bridge. In most cases, where the river runs in a valley, a wide part of the stream must be preferred to a narrow part, as the water at this narrower part has not only a greater degree of velocity of itself, but the velocity would also be increased by the piers of the bridge; in times of heavy floods it would be liable to be thrown down, and in a navigable river the navigation would be impeded. As the expense depends on the bed of the river, it must also be taken into the account.

These being settled, the form and height of the arches come next under consideration; the height of the arches, which determine that of the bridge, depends on the rise of the water in time of floods; and whether there is to be a navigation, and what kind of vessels there are to pass.

Stone bridges ought to be constructed with as few arches as possible, which will not only give greater beauty, but will require fewer foundations, piers, and centerings, and also easier passage for craft. The piers ought to be so proportioned as to enable them to withstand the thrust of the adjacent arches, though the rest were thrown down. The number of arches ought to be odd, in order that one may stand in the middle, where the stream has its greatest velocity.

When the passage-way along the top of the bridge is a convex curve, the arches should diminish from the middle towards each extreme, so as to be similar to the middle one; this will allow a more free passage to the water, the velocity being greatest in the middle. With respect to the choice of arches, the elliptical, cycloidal, and equilibrated arches, are not only convenient, in allowing more room for the passage of ships at the hanches, but they require fewer materials than most other curves of the same dimensions.

When the extrados is convex, and the height of the arch small in proportion to the span, a segment of a circle may be used with success: in this case the arch should not exceed 60 degrees.

These particulars being fixed, the practice is as follows:—When the foundation of a stone bridge is to be laid in a river which is not very deep, a single or double inclosure of wood is formed, and the intervening space is rammed well with clay or chalk, to prevent the water from coming in. These inclosures are either made with piles driven closely together, and dovetailed at their jointings, or by piles driven at certain distances from one another, and grooved on the sides opposite each other, and the intervals are shut with boards let in between the grooves. This kind of fence against the water is called a batterdeaux, or coffer-dam. The batterdeaux, or coffer-dam, requires a good foundation of solid earth or clay. If the bed of the river be of a loose consistence, the water will ooze through it in too great abundance. The sides of the inclosure must be made very strong, and well braced within, to prevent the ambient water from forcing its way into the batterdeaux.

Where the water is deep, but having a sound bottom, a strong chest, called a caisson, must be formed, so that the sides may easily be disengaged from the bottom of the river, being bevelled where the pier is to be built, and the caisson properly placed over it, and kept in this situation by ropes: begin to build, and as the work advances it will sink gradually, and at the same time keep continually bracing the sides with timber, to prevent the ambient water from crushing it together, and thereby not only spoiling the work, but drowning the workmen. When the pier is of such height as to be deeper than the water, the sides may be disengaged, and the bottom of the caisson will remain under the pier, as a footing on which it is to rest: for this purpose the bottom of the caisson should be made very strong. Where the foundation is not firm, recourse must be had to piling, as in other such foundations.

With regard to the superstructure of a stone bridge, the arch stones sometimes terminate in a curve parallel to the intrados, and sometimes the joints of the arch stones are continued through the spandrils, observing to break joints sideways; at other times, the upper ends of the arch stones terminate so as to fit the beds and upright joints of every course of stone. The joints of the arch stones are sometimes joggled with plugs, in order to prevent them from passing each other. The piers are generally solid pieces of masonry from the foundation till they come to the spring, or above the spring of the arch; thence arches, or complete cylindrical vaults, are sometimes thrown, in order to lighten the bridge, and brace every two adjacent arches between which they are placed. When the abutments are deep, and extend considerably along the road-way at each end, walls on each side of the road-way should be built, similar to those used in aquatic piers, and either strengthened with counterforts, or vaulted under and across the road-way. When there is a heavy pressure of earth between the side of the abutments, these sides should be both concave in any vertical, and also in any horizontal sections.

In stone bridges, when the extrados is a curve, and when the work is coursed, the intersection of the bedding joint of every two courses on the face of the masonry ought to be parallel to the intersection of the extrados with this face, as this position of the joints is not only more beautiful, but is also more agreeable to the laws of strength, than those bedding joints which have their intersections in horizontal planes.

BULB, or Bulbous *root*, in the anatomy of plants, expresses a root of a round or roundish figure, and usually furnished with fibres at its base. See Botany.

BULBOCODIUM, in botany, a genus of the Hexandria Monogynia class and order. Liliaceous plants. Order Spathaceæ: Narcissi, Jussieu. Essential character: corolla funnel-form, hexapetalous, with a narrow claw bearing the stamens; capsule superior. There is but one species, *viz.* B. vernum, spring flowering bulbocodium, resembles the common colchicum in shape, though much smaller; it is covered with a dark brown skin. About the middle of February, according to the season, the flowers spring up, inclosed within three brownish green leaves, opening themselves as soon almost as they are out of the ground, and shew their buds for flowers within them very white, before they open far; though sometimes purplish at first appearing. There is frequently but one flower, and never more than two; they are smaller than those of colchicum. After the flowers are past, the leaves grow to the length of a finger, and in the middle of them rises up the seed vessel, which is smaller, shorter, and harder than that of colchicum, and contains many small brown seeds. It is a native of Spain and of Russia, in mountainous situations.

BULIMY, a disease in which the patient is affected with insatiable and perpetual desire of eating; and unless he is indulged, he often falls into fainting fits. It is also called *fames canina*, canine appetite.

In the third volume of the "Memoirs of the Medical Society of London" is inserted the history of a case of bulimy, accompanied with vomiting, wherein 379*lbs.* of meat and drink were swallowed in the space of six days; yet the patient lost flesh rapidly. A cure was effected by giving food boiled down to a jelly, frequently, and in small quantities. In this form the food was retained, and the body being duly supplied with nourishment, the stomach and rest of the system recovered their proper tone and energy. But the most extraordinary instance of bulimy, which perhaps ever occurred, is that recorded in the third volume of the "Medical and Physical Journal," communicated by Dr. Johnson, commissioner of sick and wounded seamen, to Dr. Blane, formerly physician to the navy. The subject was a Polish soldier, named Charles Domery, in the service of the French, on board of the Hoche frigate, which was captured by the squadron under the command of Sir John Borlase Warren, off Ireland, in 1799. He was 21 years of age, and stated that his father and brothers had been remarkable for their voracious appetites. He began when he was 13 years of age. He would devour raw and even live cats, rats, and dogs, besides bullock's liver, tallow candles, and the entrails of animals. One day (*viz.* September 7th, 1799) an experiment was made of how much this man could eat in one day. This experiment was made in the presence of the before-mentioned Dr. Johnson, Admiral Child, and Mr. Forster, agent for prisoners at Liverpool, and several other gentlemen. He had breakfasted at 4 o'clock in the morning on 4*lbs.* of raw cow's udder; at half past nine o'clock there were set before him 5*lbs.* of raw beef and 12 tallow candles of 1*lb.* weight, together with 1 bottle of porter; these he finished by half past ten o'clock; at one o'clock there were put before him 5*lbs.* more of beef, 1*lb.* of candles, and three bottles of porter; he was then locked up in the room, and centries were placed at the windows, to prevent his throwing away any of his provisions. At two o'clock he had nearly finished the whole of the candles and great part of the beef; but without having had any evacuations by vomiting, stool, or urine. His skin was cool, pulse regular, and spirits good. At a quarter past six he had devoured the whole, and declared he could eat more; but the prisoners on the outside having told him that experiments were making upon him, he began to be alarmed.

BULK *heads* are partitions made athwart the ship with boards, by which one part is divided from the other; as the great cabin, gun-room, bread-room, and several other divisions. The bulk head afore is the partition between the forecastle and gratings in the head.

Bulk *breaking.* See Breaking.

BULL. See Bos.

Bull *finch.* See Loxia.

Bull, among ecclesiastics, a written letter dispatched by order of the Pope, from the Roman chancery, and sealed with lead, being written on parchment, by which it is partly distinguished from a brief. See Brief.

Bull, *golden,* an edict or imperial constitution, made by the Emperor Charles IV. reputed to be the magna charta, or the fundamental law of the German empire.

It is called golden, because it has a golden seal, in the form of a pope's bull, tied with yellow and red cords of silk: upon one side is the Emperor represented sitting on his throne, and on the other the capital of Rome. It is also called Caroline, on Charles IV.'s account. Till the publication of the golden bull, the form and ceremony of the election of an emperor were dubious and undetermined, and the number of the electors not fixed.

This solemn edict regulated the functions, rights, privileges, and pre-eminences of the electors. The original, which is in Latin, on vellum, is preserved at Frankfort; this ordinance, containing thirty articles or chapters, was approved of by all the princes of the empire, and remains still in force.

BULLA, in natural history, a genus of insects of the Vermes Testacea. Animal a limax; shell univalve, convolute, unarmed with teeth; aperture a little straightened, oblong, longitudinal, very entire at the base; pillar oblique, smooth. There are nearly sixty species. B. lignaria is found on European coasts, and is about three inches long. The shell is thin, of a dirty colour, but within it is white. The inhabitants of this species, and, according to Gmelin, those of most of the genus, are furnished with an organ resembling the gizzard of a fowl, and which they appear to use for the purpose of masticating their food.

BULLET, an iron or leaden ball, or shot, wherewith fire-arms are loaded. Bullets are of various kinds; *viz.* red-hot bullets, made hot in a forge, intended to set fire to places where combustible matters are found. Hollow bullets, or shells made cylindrical, with an aperture and fuse at one end, which giving fire to the inside when in the ground, it bursts, and has the same effect with a mine. Chain-bullets, which consist of two balls, joined by a chain three or four feet apart. Branch-bullets, two balls joined by a bar of iron, five or six inches apart. Two-headed bullets, called also angles, two halves of a bullet, joined by a bar or chain.

The diameter of a leaden bullet, weighing one pound, is 1.69 inches, according to Sir Jonas Moore; or, by a table in Muller's "Treatise of Artillery," 1.672 inches: and the diameter of any other bullet is found by dividing 1.69 inches by the cube root of the number, which expresses how many of them make a pound; or by subtracting continually the third part of the logarithm of the number of bullets in the pound, from the logarithm .2278867 of 1.69, and the difference will be the logarithm of the diameter required. Thus the diameter of a bullet, of which 12 make a pound, will be found by subtracting .3597270, a third part of 1.0791812 the logarithm of 12, from the given logarithm .2278867; or because this logarithm is less than the former, an unit must be added, so as to have 1.2278867; and then the difference .8681597 will be the logarithm of the diameter sought, which is .738 inches, observing that the number found will be always a decimal, because the number subtracted is greater than the other. We may also deduce the diameter of any bullet from its given weight, provided that the specific gravity of lead is known; for, since a cubic foot of lead weighs 11325 ounces, and 678 is to 355 as the cube of a foot, or 12 inches, *i. e.* 1728 to the content of a sphere, which is therefore 5929.7 ounces: and since spheres are as the cubes of their diameters, the weight 5929.7 is to 16 ounces, or one pound, as the cube 1728 is to the cube of the diameter of a sphere, which weighs sixteen ounces, or one pound; which cube is 4.6663, and its root is 1.6706, the diameter sought.

By the rule above laid down is calculated the following table, shewing the diameters of leaden bullets, from 1 to 39 in the pound.

TABLE.

	0	1	2	3	4	5	6	7	8	9
0	0	1.69	1.341	1 172	1.064	0.988	0.930	0.883	0.845	0.812
1	0.784	0.760	0.738	0.719	0.701	0.685	0.671	0.657	0.645	0.633
2	0.623	0.612	0.603	0.594	0.586	0.578	0.570	0.563	0.556	0.550
3	0.544	0.537	0.532	.527	0.521	0.51[illegible]	.512	0.507	0.503	0.498

The upper horizontal column shews the number of bullets to a pound; the second their diameters; the third, the diameters of those of 10, 11, 12, &c. and the fourth those of 20, 21, 22, &c. and the last, those of 30, 31, 32, &c.

The government allows 11 bullets in the pound for the proof of muskets, and 14.5 in the pound, or 29 in two pounds, for service, 17 for the proof of carabines, and 20 for service; and 28 in the pound for proof of pistols, and 34 for service.

The diameter of musket bullets differs but $\frac{1}{50}$th part from that of the musket-barrel; for if the shot but just rolls into the barrel, it is sufficient. Cannon bullets or balls are of different diameters and weights, according to the nature of the piece.

BULLION, uncoined gold or silver in the mass.

Those metals are called so, either when smelted from the native ore, and not perfectly refined; or when they are perfectly refined, but melted down in bars or ingots, or in any unwrought body, of any degree of fineness.

When gold and silver are in their purity, they are so soft and flexible, that they cannot well be brought into any fashion for use, without being first reduced and hardened with an alloy of some other baser metal.

To prevent those abuses, which some might be tempted to commit in the making of such alloys, the legislators of civilized countries have ordained, that there shall be no more than a certain proportion of a baser metal to a particular quantity of pure gold or silver, in order to make them of the fineness of what is called the standard gold or silver of such a country.

According to the laws of England, all sorts of wrought plate in general ought to be made to the legal standard; and the price of our standard gold and silver is the common rule whereby to set a value on their bullion, whether the same be in ingots, bars, dust, or in foreign specie; whence it is easy to conceive, that the value of bullion cannot be exactly known, without being first assayed, that the exact quantity of pure metal therein contained may be determined, and consequently whether it be above or below the standard.

Silver and gold, whether coined or uncoined (though used for a common measure of other things) are no less a commodity than wine, tobacco, or cloth; and may, in many cases, be exported as much to the national advantage as any other commodity.

BUMALDA, in botany, a genus of the Pentandria Digynia. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: corolla five-petalled; styles villose; capsule two-celled, two-beaked. There is but one species; *viz.* B. trifolia, with a shrubby stem; branches close, in all parts smooth; branches obscurely angular, jointed, purple; leaves opposite, petioled, ternate, pale underneath, on very short capillary petioles, spreading very much, or reflex; flowers terminating the branches in racemes, or capillary peduncles. Native of Japan.

BUMELIA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: corolla five-cleft, with a five-leaved nectary; drupe one-seeded. There are seven species, all trees or shrubs, and natives of the West-Indies.

BUNIAS, in botany, a genus of the Tetradynamia Siliquosa. Natural order of Siliquosa. Cruciferæ, Jussieu. Essential character: silicle deciduous, four-sided, muricated with unequal acuminate angles. There are nine species, of which B. cornuta, horned bunias, is a very singular plant. It has silicle transversely oval, finishing on each side in a horn, or very long and strong spine, so that the silicle resembles a pair of horns; in the middle of the silicle are four small spines, directed different ways. It is a native of the Levant and Siberia. B. spinosa, thorny bunias, is an annual plant, and a native of the South of France, Switzerland, Austria, and Italy.

BUNIUM, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: cor. uniform; umbel crowded; fruits ovate. There is but one species, *viz.* B. bulbocastanum, earth nut, or pig nut, has a perennial, tuberous root on the outside, of a chesnut colour, within white, solid, putting forth slender fibres from the sides and bottom, of an agreeable sweetish taste, lying deep in the ground, commonly four or five inches deep, the stems from the surface tapering towards it, flexuose or bending to and from, and of a white colour; the universal involucre consists seldom of more than one, two, or three very slender leaves, but in most instances is altogether wanting; the partial umbel has sometimes twenty rays; the petals are lanceolate, entire, but rolled inwards, so as to appear as if they were emarginate; the filaments are longer than the petals; the pistils at first close, after divaricate, but never bend back. This description applies to the plant as usually found in Great Britain. That Brunium which is most common in many parts of the continent is somewhat different from ours; the segments of the leaf are not so fine, and nearer to parsly, whereas ours approach to fennel. The root is not so far within the ground, the leaves are larger and greener, and it sends forth leaves from the bulb itself. With us it grows on heaths, in pastures, woods, and among bushes, in a gravelly or sandy soil: it flowers in May and June.

BUNT, *of a sail*, the middle part of it; formed designedly into a bag or cavity, that the sail may gather more wind. It is used mostly in top sails, because courses are generally cut square, or with but small allowance for bunt or compass. The bunt holds much leeward wind, that is, it hangs much to leeward.

Bunt *lines* are small lines made fast to the bottom of the sails, in the middle part of the bolt rope, to a cringle, and so are reeved through a small block, seized to the yard. Their use is, to trice up the bunt of the sail, for the better furling it up.

BUNTING. See Emberiza.

BUOY, at sea, a short piece of wood, or a close-hooped barrel, fastened so as to float directly over the anchor, that the men who go in the boat to weigh the anchor may know where it lies.

Buoy is also a piece of wood, or cork, sometimes an empty cask, well closed, swimming on the surface of the water, and fastened by a chain or cord to a large stone, piece of broken cannon, or the like, serving to mark the dangerous places near a coast, as rocks, shoals, wrecks of vessels, anchors, &c.

There are sometimes, instead of buoys, pieces of wood placed in form of masts, in conspicuous places; and sometimes large trees are planted in a particular manner, in number two at least, to be taken in a right line, the one hiding the other, so as the two may appear to the eye no more than one.

To BUOY *up the cable*, is to fasten some pieces of wood, barrels, &c. to the cable, near the anchor, that the cable may not touch the ground, in case it be foul or rocky, lest it should be fretted and cut off.

BUPHAGA, the *African beaf-eater*, in natural history, a genus of birds of the order of Picæ. Generic character: its bill is straight, and somewhat square; its mandibles are gibbous, entire, more gibbous externally, and its legs well formed for walking. It is found not only in Senegal, but near Caffraria. Its manners much resemble those of the starling. It feeds on various kinds of insects, and alighting on the backs of antelopes, sheep, and oxen, and by pressure on the elevated part of the hide, which contains the larvæ of the oestrus, forcing this out, greatly relieves the animal, and procures itself an exquisite banquet.

BUPHTHALMUM, in botany, a genus of the Syngenesia Polygamia Superflua. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: stigma of the hermaphrodite floscules undivided: seeds have the sides, especially in the ray, edged; down an obscure edge; receptacle chaffy. There are twelve species, of which, B. frutescens, shrubby ox-eye, rises with several woody stems from the root, and grows to the height of eight or ten feet, furnished with leaves very unequal in size, some of which are narrow and long, others broad and obtuse. The foot-stalks of the larger leaves have, on their upper side, near their base, two sharp teeth standing upward, and a little higher there are generally two or three more growing on the edge of the leaves. The flowers are produced at the ends of the branches single: these are of a pale yellow colour, and have scaly calyxes. It grows naturally in America. B. arborescens, tree ox-eye, seldom grows higher than three feet, sending out many stalks from the root, which are succulent; it has spear-shaped leaves, placed opposite; the flowers are produced upon foot-stalks, which are two inches long. These flowers are larger than those of the first sort, of a bright yellow colour. They appear in July, August, and September. Some of these plants are shrubs, but most of them are herbs. The flowers are commonly terminating, and mostly of a yellow colour.

BUPLEURUM, in botany, a genus of the Pentandria Digynia. Natural order of Umbellatæ. Essential character: involucres of the umbellule larger, five-leaved; petals involuted; fruit roundish, compressed, striated. There are 19 species, of which B. rotundifolium, common thorough wax, so called from the singular circumstance of the stalk waxing or growing through the leaf; the root is annual, small and fibrous; the stem a foot high, upright, round, perfectly smooth, alternately branched; every part of the plant is remarkably hard and rigid, and has a slight aromatic smell. It is a native of most parts of Europe. B. stellatum, starry hare's ear, has a perennial root, with a stem about 18 inches high, with long grass-like root-leaves, some ending obtusely, others drawing to a point; scarcely any on the stem, except one embracing leaf under a branch. Universal involucre of one, two, or three leaves. Partial involucre, coloured, longer than the flowers, eight or nine-cleft at the edge, but united at bottom, so as to form a sort of basin, in which the flowers are lodged. It is a native of the Alps, of Switzerland, and Dauphine. Most of the Bupleurums are herbaceous plants, some of them are shrubby, and one is thorny; the leaves are mostly simple and entire. The little flowers are yellow, and but few in an umbel. The involucre is many-leaved and short, though it has sometimes only three or five leaves. They are almost all of them natives of Switzerland and the south of France.

BUPRESTIS, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ setaceous, of the length of the thorax; head half withdrawn beneath the thorax. This genus of insects is very conspicuous, on account of the superior brilliancy of its colours, with which many of the larger species shine with a metallic lustre It is a very numerous genus, consisting, according to Gmelin, of 156 species. Among these we shall notice the B gigantea, which is the largest hitherto discovered, measuring two inches and a half in length: the thorax is smooth, resembling the colour of polished bell-metal, and the wing-sheaths are of a gilded copper colour, with a cast of blue-green. It is a native of India, China, and many other parts of Asia, and is also found in South America. Its beauty is so very singular, that the Chinese attempt to imitate it on bronze, in which they have sometimes succeeded so well, that the copy has been mistaken for the reality. This insect proceeds from a large white larva, resembling that of the lucanus cervus, or great stag-chaffer. Of the European insects of this genus, the B. rustica is one of the largest, measuring about an inch and a half, and of a coppery colour, with several longitudinal furrows along the wing-shells; the thorax of a deep blue-green, with numerous impressed points: it is found in the woods. The European Buprestes fall far short of the Indian and American species, both in point of size and splendour, though among them may be numbered several elegant insects.

BURCARDIA, in botany, so named in honour of Henry Burckhard, a genus of the Pentandria Pentagynia class and order. Essential character: calyx five-leaved; corolla five-petalled; capsule angular, one-celled, three-valved; seven or eight seeded. There is but one species, *viz.* B. villosa, an annual plant, with a branched stem two feet high, hirsute, with reddish brown hairs. Flowers at the end of the stem and branches, axillary, solitary, on long hairy peduncles. The whole plant is covered with stiff hairs. It is found on the sandy coasts of Cayenne and Guiana.

BURDEN, or Burthen, in a general sense, implies a load or weight, supposed to be as much as a man, horse, &c. can well carry. A sound and healthy man can raise a weight equal to his own. An able horse can draw *350lb.* though for a length of time *300lb.* is sufficient. Hence calculations are formed by the artillery officers. One horse will draw as much as seven men.

Burden *of a ship* is its contents, or number of tons it will carry. The burden of a ship may be determined thus: multiply the length of the keel, taken within board, by the breadth of the ship within board, taken from the midship-beam, from plank to plank, and multiply the product by the depth of the hold, taken from the plank below the keelson to the under part of the upper deck plank, and divide the last product by 94, then the quotient is the content of the tonnage required.

BURGAGE, in law, a tenure proper to boroughs and towns, whereby the inhabitants hold their lands and tenements of the King, or other lord, at a certain yearly rate. This tenure is described by Glanvil, and is expressly said by Littleton to be but tenure in socage. It is indeed only a kind of town socage; as common socage, by which other lands are holden, is usually of a rural nature. A borough is usually distinguished from other towns by the right of sending members to parliament; and where the right of Election is by burgage tenure, that alone is a proof of the antiquity of the borough. Tenure in burgage, therefore, or burgage tenure, is where houses, or lands which were formerly the scite of houses, in an ancient borough, are held by some lord in common socage, by a certain establishment. The free socage in which these tenements are held, seems to be plainly a remnant of Saxon liberty; and this may account for the great variety of customs, affecting many of these tenements so held in ancient burgage; the principal and most remarkable of which is that called borough English; which see. There are also other special customs in different burgage tenures; as in some, that the wife shall be endowed of all her husband's tenements, and not of the third part only, as at the common law: and in others, that a man might dispose of his tenements by will, which in general was not permitted after the conquest till the reign of Henry VIII.; though in the Saxon times it was allowable. A pregnant proof, says Judge Blackstone, that these liberties of Socage tenure were fragments of Saxon liberty.

BURGESS, an inhabitant of a borough, or one who possesses a tenement therein. In other countries, burgess and citizen are confounded together; but with us they are distinguished: the word is also applied to the magistrates of some towns. Burgess is now ordinarily used for the representative of a borough-town in parliament.

BURGH-*bote* signifies a contribution towards the building or repairing of castles or walls, for the defence of a borough or city.

BURGLARY, in law, or nocturnal house-breaking, an unlawful entering into another man's dwelling, wherein some person is, or into a church, in the night-time, in order to commit some felony, or to kill some person, or to steal something thence, or do some other felonious act, whether the same be executed or not. This crime has been always regarded as very heinous; partly on account of the terror which it occasions, and partly because it is a forcible invasion and disturbance of that right of habitation, which every individual might require, even in a state of nature, and against which the laws of civil society have particularly guarded. Whilst they allow the possessor to kill the aggressor, who attempts to break into a house in the night time, they also protect and avenge him, in case the assailant should be too powerful. Such regard, indeed, has the law of England to the immunity of a man's house, that it stiles it his castle, and will never suffer it to be violated with impunity; for this reason no outward doors can in general be broken open to execute any civil process; though, in criminal cases, the public safety supersedes the private. Hence, also, in part, arises the animadversion of the law upon eves-droppers, nuisancers, and incendiaries; and to this principle it must be assigned, that a man may assemble people together lawfully (at least if they do not exceed eleven) without danger of raising a riot, rout, or unlawful assembly, in order to protect and defend his house; which he is not permitted to do in any other case. The definition of a burglar, as given by Sir Edward Coke, is, "he that by night breaketh and entereth into a mansion-house, with intent to commit a felony." In this definition, says Judge Blackstone, there are four things to be considered; the time, the place, the manner, and the intent. 1. The time must be by night, and not by day; for in the day-time there is no burglary. In considering what is reckoned night, the day was anciently accounted to begin at sun-rising, and to end immediately upon sun-set: but the better opinion seems to be, that if there be daylight or twilight sufficient begun or left for discerning a man's face, it is no burglary. But this does not extend to moon-light: for then many midnight burglaries would go unpunished; and besides, the malignity of the offence does not so properly arise from its being done in the dark, as at the dead of night, when the whole creation, except beasts of prey, is at rest; when sleep has disarmed the owner, and rendered his castle defenceless. 2. As to the place. It must be, by the definition, a mansion-house; and, therefore, in order to account for the reason why breaking open a church is burglary, as it undoubtedly is, Sir Edward Coke quaintly observes, that it is "domus mansionalis Dei." But it is not necessary that it should in all cases be a mansion-house; for it may be committed by breaking the gates or walls of a town in the night. 3. As to the manner of committing burglary; there must be both a breaking and an entry, to complete this offence. But they need not be done at once: for if a hole be broken one night, and the same breakers enter the next night through the same, they are burglars. There must in general be an actual breaking, so that it may be regarded as a substantial and forcible irruption. Such are, breaking or taking out the glass of, or otherwise opening a window, and taking out goods; picking a lock, or opening it with a key; and lifting up the latch of a door, or loosing any other fastenings which the owner has provided. But if a person leaves his doors or windows of his house open, and a man enters by them, or with a hook or by any other means draws out some of the goods of the owner, it is no burglary; but if, having entered, he afterwards unlocks an inner or chamber door, or if he comes down a chimney, he is deemed a burglar. If a person enters by the open door of a house, and breaks open a chest and steals goods, this is no burglary, by the common law, because the chest is no part of the house. 4. As to the intent: it is clear that such breaking and entry must be with a felonious intent, otherwise it is only a trespass. And it is the same, whether such intention be actually carried into execution, or only demonstrated by some attempt or overt act, of which the jury is to judge.

BURGOMASTER, the chief magistrate of the great towns in Flanders, Holland, and Germany. The power and jurisdiction of the burgomaster is not the same in all places, every town having its particular customs and regulations: at Amsterdam there are four, chosen by the voices of all those people in the Senate who have either been burgomasters or echevins. Their authority resembles that of the lord-mayor and aldermen; they dispose of all under offices that fall in their time, keep the key of the bank, and enjoy a salary but of 500 guilders, all feasts, public entertainments, &c. being defrayed out of the common treasury.

BURGUNDY *pitch*, in medicine, the juice of the pinus abies, boiled in water, and strained through a linen cloth. It is chiefly employed for external purposes in inveterate coughs, &c. Plasters of this resin, by acting as topical stimulants, are frequently found of considerable service.

BURIAL, the interment of a deceased person. The rites of burial make the greatest and most necessary care, being looked upon in all countries, and at all times, as a debt so sacred, that such as neglected to discharge it were thought accursed: hence the Romans called them *justa*, and the Greeks *νομιμα, δικαια, οσια*, &c. words implying the inviolable obligations which nature has laid upon the living, to take care of the obsequies of the dead. Nor are we to wonder that the ancient Greeks and Romans were extremely solicitous about the interment of their deceased friends, since they were strongly persuaded that their souls could not be admitted into the Elysian fields till their bodies were committed to the earth; and if it happened that they never obtained the rites of burial, they were excluded from the happy mansions for the term of an hundred years. For this reason it was considered as a duty incumbent upon all travellers, who should meet with a dead body in their way, to cast dust or mould upon it three times, and of these three handfuls one at least was cast upon the head. The ancients likewise considered it as a great misfortune, if they were not laid in the sepulchres of their fathers; for which reason, such as died in foreign countries had usually their ashes brought home, and interred with those of their ancestors. But, notwithstanding their great care in the burial of the dead, there were some persons whom they thought unworthy of that last office, and to whom therefore they refused it: such were, 1. Public or private enemies. 2. Such as betrayed or conspired against their country. 3. Tyrants, who were always looked upon as enemies to their country. 4. Villains guilty of sacrilege. 5. Such as died in debt, whose bodies belonged to their creditors. And 6. Some particular offenders, who suffered capital punishment.

Of those who were allowed the rites of burial, some were distinguished by particular circumstances of disgrace attending their interment: thus persons killed by lightning were buried apart by themselves, being thought odious to the gods; those who wasted their patrimony forfeited the right of being buried in the sepulchres of their fathers; and those who were guilty of self-murder were privately deposited in the ground, without the accustomed solemnities. Among the Jews, the privilege of burial was denied only to self-murderers, who were thrown out to rot upon the ground. In the Christian church, though good men always desired the privilege of interment, yet they were not, like the heathens, so concerned for their bodies, as to think it any detriment to them, if either the barbarity of an enemy, or some other accident, deprived them of this privilege. The primitive Christian church denied the more solemn rites of burial only to unbaptised persons, self-murderers, and excommunicated persons, who continued obstinate and impenitent, in a manifest contempt of the church's censures.

The place of burial among the Jews was never particularly determined. We find they had graves in the town and country, upon the highways, in gardens, and upon mountains. Among the Greeks, the temples were made repositories for the dead in the primitive ages, yet the general custom in later ages with them, as well as with the Romans and other heathen nations, was, to bury their dead without their cities, and chiefly by the highways. Among the primitive Christians, burying in cities was not allowed for the first three hundred years, nor in churches for many ages after, the dead bodies being first deposited in the atrium or church-yard, and porches and porticos of the church: hereditary burying-places were forbidden till the twelfth century.

Burials, in law, persons are to be buried in woollen, or their representatives shall forfeit 5*l.* and affidavit is to be made thereof before a justice, under a like penalty.

Burials, as practised by the military, differ in some respects according to the rank of the deceased. The funeral of a field-marshal is saluted with three rounds of fifteen pieces of cannon attended by six battalions and eight squadrons: that of a general with three rounds of eleven pieces of cannon, four battalions and six squadrons: and so on, decreasing in honour, till that of a private, which is attended by one serjeant, and thirteen rank and file, with three rounds of small arms. The pall is to be supported by officers of the same rank with that of the deceased. The order of march to be observed in military funerals is reversed with respect to rank. For instance, if an officer is buried in a garrison-town, or from a camp, it is customary for the officers belonging to the other corps to pay his remains the compliment of attendance, in which case the youngest ensign marches at the head, immediately after the pall, and the general, if there be one, in the rear of the commissioned officers, who take their posts in reversed order, according to seniority. The battalion, troop, or company, follow the same rule.

BURLESQUE, a jocose kind of poetry, chiefly used in the way of drollery and ridicule, to deride persons and things.

BURMANNIA, in botany, so named, in honour of John Burgmann; a genus of the Hexandria Monogynia class and order. Natural order of Liliaceous Flowers. Coronariæ, Linnæus. Bromeliæ, Jussieu. Essential character; calyx prismatic coloured, trifid; angles membranous; petals three; capsule three celled, straight; seeds minute. There are but two species; of which B. disticha has the root composed wholly of capillary fibres, very small. The plant has the appearance of an anthericum; root-leaves six, grass-like, or ensiform, two inches long, quite entire; stem upright, simple, a span and a half in height, having six or seven small alternate leaves an inch long; two equal divaricating spikes, each composed of about nine flowers, terminate the stem; the flowers are sessile, in a single row; they are blue, very elegant, and do not fall off. It is a native of Ceylon. B. biflora, has strong fibrous roots, with several oblong oval leaves arising from it, which are smooth and entire, four or five inches long; among these springs the flower stem, six or eight inches high, terminating by blue flowers, growing together in each sheath. It is a native of Virginia and Carolina.

BURN, in medicine and surgery, an injury received in any part of the body, in consequence of the application of too great heat. See SURGERY.

BURNING-*glass*, a convex or concave glass, commonly spherical, which, being exposed directly to the sun, collects all the rays falling thereon into a very small space, called the focus; where wood, or any other combustible matter, being put, will be set on fire. See OPTICS

We have some extraordinary instances and surprizing accounts of prodigious effects of burning-glasses. Those made of reflecting mirrours are more powerful than those made with lenses, because the rays from a mirrour are reflected all to one point nearly; whereas, by a lens, they are refracted to different points, and are therefore not so dense or ardent. The whiter also the metal or substance is, of which the mirrour is made, the stronger will be the effect.

The most remarkable burning-glasses, or rather mirrours, among the ancients, were those of Archimedes and Proclus; by the first of which the Roman ships, besieging Syracuse, according to the testimony of several writers, and by the other, the navy of Vitalian, besieging Byzantium, were reduced to ashes. Among the moderns, the burning mirrours of greatest eminence are, those of Villette and Tschirnhausen, and the new complex one of M. de Buffon.

That of M. de Villette was three feet eleven inches in diameter, and its focal distance was three feet two inches. Its substance is a composition of tin, copper, and tin-glass. Some of its effects, as found by Dr. Harris and Dr. Desaguliers, are, that a silver sixpence melted in 7½″; a King George's halfpenny melted in 16″, and ran in 34″, tin melted in 3″ and a diamond, weighing 4 grains, lost seven-eighths of its weight.

That of M. de Buffon is a polyhedron, six feet broad, and as many high, consisting of 168 small mirrours, or flat pieces of looking-glass, each six inches square; by means of which, with the faint rays of the sun in the month of March, he set on fire boards of beech wood at 150 feet distance. Besides, his machine has the conveniency of burning downwards, or horizontally, as one pleases, each speculum being moveable, so as, by the means of three screws, to be set to a proper inclination for directing the rays towards any given point: and it turns either in its greater focus, or in any nearer interval, which our common burning-glasses cannot do, their focus being fixed and determined. M. de Buffon, at another time, burnt wood at the distance of 200 feet. He also melted tin and lead at the distance of above 120 feet, and silver at 50.

Mr. Parker, of Fleet-street, London, was induced, at an expense of upwards of 700*l.* to contrive, and at length to complete a large transparent lens, that would serve the purpose of fusing and vitrifying such substances as resist the fires of ordinary furnaces, and more especially of applying heat in vacuo, and in other circumstances, in which it cannot be applied by any other means. After directing his attention for several years to this object, and performing a great variety of experiments in the prosecution of it, he at last succeeded in the construction of a lens, of flint-glass, three feet in diameter, which, when fixed in its frame, exposes a surface two feet 8¼ inches in the clear, without any other material imperfection besides a disfigurement of one of the edges by a piece of the scoria of the mould, which unfortunately found its way into its substance. This lens was double convex, both sides of which were a portion of a sphere of 18 feet radius. It is difficult to form an accurate estimate of the burning power of this lens; inasmuch as it is next to impossible to discover what should be deducted for the loss of power, in consequence of the impediments that the glass of which it was made must occasion, as well as the four reflections, and two more by way of diminution; but we will endeavour to appreciate it, after making a full allowance for these deductions, which must necessarily result from every means of concentrating the solar rays, and which must be considered to be as the friction of an engine, of which nature they really partake. The solar rays received on a circular surface of 2 feet 8½ inches, when concentrated within the diameter of an inch, will be 1056.25 times its intensity, or this number of times greater than the heat of the sun, as felt on the surface of the earth. We will suppose that, as the heat of the air, in ordinary summer weather, is 65°, and in sultry weather is 75°, the average of which is 70°, and that we take this degree as the average effect, the accumulated power of the lens, on the supposition of an equal effect over the whole surface of the focus, will be equal to 73938°.

It must be recollected by those who have had an opportunity of examining the effects of this lens, that the external part of the focal light was less intense than that part which was near the centre of it; or rather, that the effect was very much accumulated in the centre but as it is possible that the refraction of the light and of the caloric fluid may not take place in the same angles, we think it safest to consider it as of an uniform effect, and after deducting one-fourth part thereof as a compensation, there remains 55454°, as the expression of its power. As the application of the second lens reduced the diameter of the focus to half an inch, the effect, without allowing for the reduction of its power, would be equal to 221816°, but deducting one-fourth for the second transmission, there remains 166362°, as the expression of its power.

Mr. Parker farther informs us that a diamond, weighing 10 grains, exposed to this lens for 30 minutes, was reduced to 6 grains; during which operation it opened, and foliated like the leaves of a flower, and emitted whitish fumes, and when closed again it bore a polish, and retained its form. Gold remained in its metallic state without apparent diminution, notwithstanding an exposure at intervals of many hours: but what is remarkable, the rest, or cupel, which was composed of bone-ash, was tinctured with a beautiful pink colour.

The experiments on platina evince that the specimens were in different states of approach to a complete metallic form; several of them threw off their parts in sparks, which, in most instances, were metallic. Copper, after three minutes exposure, was not found to have lost in weight.

What is remarkable with regard to experiments on iron, is, that the lower part, *i. e.* that part in contact with the charcoal, was first melted, when that part which was exposed to the focus remained unfused: an evidence of the effect of flux on this metal.

Several of the semi-crystalline substances, exposed to the focal heat, exhibited symptoms of fusion: such as the agate, oriental flint, cornelian, and jasper; but as the probability is that these substances were not capable of complete vitrification, it is enough that they were rendered externally of a glassy form. Garnet completely fused on black-lead, in 120″ lost ⅓th of a grain, became darker in colour, and was attracted by the magnet. Ten cut garnets, taken from a bracelet, began to run the one into the other in a few seconds, and at last formed into one globular garnet. The clay used by Mr. Wedgwood to make his pyrometric test run in a few seconds into a white enamel. Seven other kinds of clay sent by Mr. Wedgwood were all vitrified. Several experiments were made on lime-stone, some of which were vitrified, but all of which were agglutinated; it is, however, suspected that some extraneous substance must have been intermixed. A globule produced from one of the specimens, on being put into the mouth, flew into a thousand pieces, occasioned, it is presumed, by the moisture.

Some experiments were made in the year 1802, with Mr. Parker's lens, with the view of ascertaining whether the moon communicated any heat to the earth, in common with the reflected light from which we derive so much advantage. This experiment was attended by Sir Joseph Banks, with several members of the Royal Society, together with Dr. Crawford, who provided the most sensible thermometers; but after applying them to the luminous focus, so far from a perceptible increase of heat, it was thought there was perceived rather a diminution thereof; but this suspicion did not lead them to a fair investigation of the fact. Since this period some experiments have been made, that evince the power of communicating cold by reflection; but as this fact has not yet been explained consistently with the present received theory, we shall content ourselves with taking notice of the experiment made by M. Pictet. Two concave mirrors being placed at the distance of 10½ feet from each other, a very delicate air thermometer was put into one of the foci, and a glass matrass full of snow in the other. The thermometer sunk several degrees, and rose again when the matrass was removed. When nitric acid was poured upon the snow (which increased the cold) the thermometer sunk 5° or 6° lower. Here cold seems to have been emitted by the snow, and reflected by the mirrors to the thermometer, which it is thought could not happen unless cold were a substance. It has been found, that upon an admixture of equal quantities of snow, which is always at 32°, and of water heated to 172°, the result is, that the compound only retains the lowest heat of 32°, so that 140° of heat or caloric disappears. Much has been said respecting the point or degree at which the thermometer should indicate the presence of heat. The experiments of Dr. Crawford seem to place it at 1268° below the present 0; Mr. Kirwan places it at 1048°; Messrs. Lavoisier and La Place at 2736°; and by a mixture of four parts of sulphuric acid with three pints of water, it seems that it should be placed at 5803° below 0. Experiments of this kind may be made *ad infinitum*, and in time it may possibly be ascertained that cold is a real substance; but for the purpose of getting an answer to the present question, we will accommodate the scale of Fahrenheit, by adding 108° thereto, so as to make the 0 correspond with the caloric imbibed by snow or ice before it can melt.

The superficies of spherical bodies are to each other as the squares of their respective diameters. The diameter of the moon is considered to be 2180 miles, and its mean distance from the earth 240,000; from which it follows, on the supposition that all the solar rays received by the moon were reflected back, and that the earth was absolutely without heat, that the effect of this reflection would be found to be .00367 of a degree (for $\overline{240,000 \times 2} : 178° :: \overline{2180°} : .00367$); which multiplied into 1056.25, and this sum increased four times for the increased power of the second lens, would give 15.51234° as the heat of the focus; 98.28766° below the present 0, or 124.28766° below the freezing point. This dissertation is interesting in another point of view, for this calculation ascertains that the light afforded by the moon, when compared with that by the sun, abstracting all impediments in both cases, is only as 1 to 48480.

A subscription was proposed for raising the sum of 700 guineas towards indemnifying the charges of the inventor, and retaining the very curious and useful machine above described in our own country; but from the failure of the subscription, and some other concurring circumstances, Mr. Parker was induced to dispose of it to Capt. Mackintosh, who accompanied Lord Macartney in the embassy to China; and it was left, much to the regret of philosophers in Europe, at Pekin; where it remains in the hands of persons, who most probably know neither its value nor use.

BURNING-*mountains*, the same with volcanoes. See VOLCANO.

BURNISHER, a round polished piece of steel, serving to smooth and give a lustre to metals.

Of these there are different kinds, of different figures, straight, crooked, &c. Half burnishers are used to solder silver, as well as to give a lustre.

BURNISHING, the art of smoothing or polishing a metalline body by a brisk rubbing of it with a burnisher.

Book-binders burnish the edges of their books by rubbing them with a dog's tooth. Gold and silver are burnished by rubbing them with a wolf's tooth, or by the bloody stone, or by tripoli, a piece of white wood, emery, and the like. Deer are said to burnish their heads by rubbing off a downy white skin from their horns against a tree.

BURR *pump*, or BILDGE *pump*, differs from the common pump in having a staff 6, 7, or 8 feet long, with a bar of wood, whereto the leather is nailed, and this serves instead of a box. So two men standing over the pump thrust down this staff, to the middle whereof is fastened a rope for 6, 8, or 10 to hale by, thus pulling it up and down.

BURSARIA, in natural history, a genus of worms of the order Infusoria. Worm very simple, membranaceous, hollow. There are three species, *viz.* the truncatella, hirundinella, and duplella, found in marshy water: the first has a white body, oval, with a large hollow descending to the base, with sometimes four or five eggs at the bottom: the second is a pellucid hollow membrane, moving forwards like a bird in flight; the third is found among duck-weed, without visible intestines.

BURSARS, in the Scotch universities, are youths chosen as exhibitioners, and maintained for the space of four years at the rate of 100*l.* per ann. Scots.

BURSE, in a commercial sense, a place for merchants to meet in and negociate their business publicly, with us called exchange.

BURSERA, in botany, so called in honour of Joachim Burser, a genus of the

Polygamia Dioecia. Essential character: Herm. calyx three-leaved; corolla three-petalled; capsule fleshy, three valved, one-seeded. Male, calyx five-toothed; corolla five-petalled; stamina ten. There is but one species, *viz* B gummifera, Jamaica birch tree, is very lofty, with an upright, round, smooth trunk, covered with a livid shining bark, peeling off in round pieces, like the European birch; branches terminating, smooth, horizontal; flowers small and white; capsule red, resembling a drupe. On the male trees the flowers are more copious, and crowded in the racemes, but are scarcely larger. This tree is common in all the sugar islands of the West Indies. The bark is very thick, and exudes a clear transparent resin, which soon hardens in the air. It flowers from May to July. With us it has not flowered, although it has been cultivated since the year 1690.

BUSH, *burning*, that bush wherein the Lord appeared to Moses at the foot of Mount Horeb, as he was feeding his father-in-law's flocks. As to the person that appeared it the bush, the scripture, in several places, calls him by the name of God: he says of himself, "that he is the Lord, the God who is the God of Abraham, Isaac, and Jacob, &c." And Moses, blessing Joseph, says, "let the blessing of him that dwelt in the bush come upon the head of Joseph." But the Hebrew and the Greek septuagint import that the angel of the Lord appeared to him. St. Stephen, and several others, read it in the same manner; and, moreover, some say that is was an angel that represented the Lord: yet there are persons who hold the Son of God to be the person that appeared in the bush.

The Mahometans believe that one of Moses's shoes, put off by him as he drew near the burning-bush, was placed in the ark of the covenant, in order to preserve the memory of this miracle.

BUSHEL, a measure of capacity for dry things, as grain, fruits, dry pulse, &c. containing four pecks, or eight gallons, or one-eighth of a quarter.

A bushel, by 12 Henry VII. c. 5, is to contain eight gallons of wheat; the gallon eight pounds of troy weight; the ounce twenty sterlings; and the sterling thirty-two grains, or corns of wheat growing in the midst of the ear. See MEASURE and WEIGHT.

BUSKIN, a kind of shoe, somewhat in manner of a boot, and adapted to either foot, and worn by either sex.

This part of dress, covering both the foot and mid-leg, was tied underneath the knee; it was very rich and fine, and principally used on the stage by actors in tragedy. It was of a quadrangular form, and the sole was so thick, as that by means thereof men of the ordinary stature might be raised to the pitch and elevation of the heroes they personated. The colour was generally purple on the stage: herein it was distinguished from the sock worn in comedy, that being only a low common shoe. The buskin seems to have been worn not only by actors, but by girls, to raise their height; travellers and hunters also made use of it, to defend themselves from the mire.

In classic authors we frequently find the buskin used to signify tragedy itself, because it was a mark of tragedy on the stage.

It is also sometimes understood for a lofty strain, or high style.

BUSS, in maritime affairs, a small sea vessel, used by us and the Dutch in the herring fishery, commonly from forty-eight to sixty tons burden, and sometimes more: a buss has two small sheds or cabins, one at the prow, and the other at the stern; that at the prow serves for a kitchen. Every buss has a master, an assistant, a mate, and seamen in proportion to the vessel's bigness; the master commands in chief, and without his express order the nets cannot be cast nor taken up; the assistant has the command after him; and the mate next; whose business is to see the seamen manage their rigging in a proper manner, to mind those who draw in their nets, and those who kill, gut, and cure the herrings, as they are taken out of the sea. The seamen generally engage for a whole voyage in the lump. The provisions which they take on board the busses consist, commonly, in biscuit, oatmeal, and dried or salt fish; the crew being content for the rest with what fresh fish they catch.

BUST, or BUSTO, in sculpture, &c. a term used for the figure or portrait of a person in relievo, shewing only the head, shoulders, and stomach, the arms being lopped off: it is usually placed on a pedestal or console. The burst is the same with what the Latins called *herma*, from the Greek *Hermes*, Mercury, the image of that god being frequently represented in that manner by the Athenians.

BUST, *communicative*. See ACCOUSTICS.

BUSTARD, in ornithology. See OTIS.

BUTCHER, a person who slaughters cattle for the use of the table, or who cuts up and retails the same. Among the ancient Romans there were three kinds of established butchers, whose office was, to furnish the city with the necessary cattle, and to take care of preparing and vending their flesh. The suarii provided hogs; the pecuarii, or boarii, other cattle, especially oxen; and under these was a subordinate class, whose office was to kill, called lanii, and carnifices.

To exercise the office of butcher among the Jews, with dexterity, was of more reputation than to understand the liberal arts and sciences. They have a book concerning shamble-constitution; and in case of any difficulty, they apply to some learned Rabbi for advice: nor was any allowed to practise this art without a licence in form; which gave the man, upon evidence of his abilities, a power to kill meat, and others to eat what he killed; provided he carefully read every week for one year, and every month the next year, and once a quarter during his life, the constitution above mentioned.

In London, the furnishing of butcher's meat is separated into different trades. We have carcass-butchers, who kill the meat in great quantities, and sell it to others, who retail it among their customers. Besides these there are salesmen, who attend the market at Smithfield, and who act between the carcass butcher and the breeder and feeder of cattle in the country. The butchers were incorporated into a company in the third year of James I.

Butcher *bird*, in ornithology. See Lanius.

Butcher's *broom*, in botany. See Ruscus.

BUTEA, in botany, a genus of the Diadelphia Decandria class and order. Calyx slightly two-lipped; corolla with a very long lanceolate banner: legume compressed, membranaceous; one-seeded at the tip. Two species; *viz.* Frondosa and Superba, found on the coast of Coromandel.

BUTLER, the name anciently given to an officer in the court of France, being the same as the grand echanson, or great cup-bearer of the present times.

Butler, in the common acceptation of the word, is an officer in the houses of princes and great men, whose principal business is to look after the wine, plate, &c.

BUTLERAGE *of wine*, is a duty of two shillings for every ton of wine imported by merchants strangers; being a composition in lieu of the liberties and freedoms granted to them by king John and Edward I. by a charter called charta mercatoria. Butlerage was originally the only custom that was payable upon the importation of wines, and was taken and received by virtue of the regal prerogative, for the proper use of the crown. But for many years past, there having been granted by parliament subsidies to the kings of England, and the duty of butlerage not repealed, but confirmed, they have been pleased to grant away to some nobleman, who, by virtue of such grant, is to enjoy the full benefit and advantage thereof, and may cause the same to be collected in the same manner that the kings themselves were formerly wont to do. The name was derived from the circumstance of the duty being formerly paid to the king's butler.

BUTMENTS, in architecture, a mass of stone or brick-work, on or against which the feet of arches rest.

BUTT, in commerce, a vessel or measure of wine, containing four hogsheads, or two hundred and fifty-two gallons.

Butt, or Butt-*ends*, in the sea-language, are the fore-ends of all planks under water, as they rise, and are joined one end to another. Butt-ends in great ships are most carefully bolted; for if any one of them should spring or give way, the leak would be very dangerous and difficult to stop.

BUTTER, a fat unctuous substance, prepared from milk, by heating or churning it. It was late before the Greeks appear to have had any notion of butter; their poets make no mention of it, and yet are frequently speaking of milk and cheese. The Romans used butter no otherwise than as a medicine, never as a food. The ancient Christians of Egypt burnt butter in their lamps instead of oil; and in the Roman churches it was anciently allowed during Christmas time, to burn butter instead of oil, on account of the great consumption of it otherways. See Milk.

Butter, is a name given in the old chemistry to several metallic muriates, on account of their texture when newly prepared. According to this system, there are the butters of antimony, arsenic, bismuth, and tin. They all agree in the following particulars: they are formed by sublimation; their texture is not unlike that of butter in warm weather; they are decomposable by being dropped into pure water, a precipitation of white oxide taking place. There are likewise vegetable butters, a term applied to those vegetable expressed oils, that require a greater heat than that of the atmosphere to keep them in a fluid state: of these, the palm oil is best known: a similar oil may be obtained from the cocoa nut; and the celebrated Parke found in Africa a tree, called by the natives shea, from the fruit of which a tolerably pure butter was obtained.

Butter-*milk*, a kind of serum that remains behind, after the butter is made.

BUTTERFLY, the English name of a numerous genus of insects, called by zoologists papilio. See Papilio.

BUTTERY, a room in the houses of noblemen and gentlemen belonging to the butler, where he deposits the utensils belonging to his office, as table linnen, napkins, pots, tankards, glasses, cruets, salvers, spoons, knives, forks, pepper, mustard, &c.

BUTTNERIA, in botany, so named from David Sigismunda Augustus Buttner: a genus of the Pentandria Monogynia class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: corolla five-petalled; filaments at the top connate with the petals; capsule five-grained, muricate. There are three species; *viz.* B. scabra, is a pernenial plant, from three to five feet high, with alternate, long, angular branches, armed with cartilaginous prickles; at the axils of the leaves, stem and branches, the flowers are produced singly on short peduncles: it is found at Cayenne. B. carthaginensis is a shrub, branching and spreading on every side, in manner of the common bramble; racemes short, aggregate, and axillary on the young branches; flowers without smell, white, and very numerous: native of Carthagena and St. Domingo; flowering in September and October: and B. microphylla differs but little from the foregoing, in having the trunk and branches larger and round, the peduncles one-flowered, and the corolla purple and white, variegated: it was found in the island of St. Domingo by Jacquin, and brought into Europe.

BUTTOCK *of a ship*, is that part of her which is her breadth right a-stern, from the tack upwards; and a ship is said to have a broad or a narrow buttock, according as she is built broad or narrow at the transum.

BUTTOMUS, in botany, a genus of the Enneandria Hexagynia. Natural order of Tripetaloideæ. Junci, Jussieu. One of the connecting links between lilies and rushes. Essential character: calyx none; petals six; capsule six, many-seeded. There is but one species; viz. B. umbellatus, flowering rush or gladiole, has a perennial root; leaves ensiform, long, triangular, smooth, quite entire, spongy, at bottom sheathing, at top flat and twisted; flowers to thirty, each on a single, round, smooth peduncle, from an inch to about a finger's length, forming an upright umbel, surrounded at bottom by an involucre of three withering membranous sheaths, besides a smaller stipule to each peduncle; corolla very handsome and large, of a bright flesh colour; filaments placed on a regular circle on the receptacle; the pollen is of a bright yellow colour, germ nearly triangular. This is the only plant of the class Enneandria which grows wild in Britain.

BUTTON, an article of dress, serving to fasten clothes tight about the body, made of metal, silk, mohair. &c. in various forms. Metal buttons are either cast in moulds, in the manner of other small works, or made of thin plates of gold, silver, or brass, whose structure is very ingenious.

Of the manufacture of metal buttons. These are originally formed in two different ways; the blanks are either pierced out of a large sheet of metal with a punch driven by a fly-press, or cast in a pair of flasks of moderate size, containing 10 or 12 dozen each. In this latter case, the shanks are previously fixed in the sand, exactly in the centre of the impression formed by each pattern, so as to have their extremities immersed in the melted metal when poured into the flask, by which means they are consequently firmly fixed in the button when cooled. The former process is generally used for yellow buttons, and the latter for those of white metal. We shall first give an instance of the former mode of procedure, as used in the manufacture of gilt buttons. The gilding metal is an alloy of copper and zinc, containing a smaller proportion of the latter than ordinary brass, and is made either by fusing together the copper and zinc, or by fusing brass with the requisite additional proportion of copper. This metal is first rolled into sheets of the intended thickness of the button, and the blanks are then pierced out as before mentioned. The blanks thus formed are, when intended for plain buttons, usually planished by a single stroke of a plain die driven by the same engine, the fly-press; when for ornamental buttons, the figure is also frequently struck in like manner by an appropriate die, though there are others which are ornamented by hand. The shanks, which are made with wonderful facility and expedition by means of a very curious engine, are then temporarily attached to the bottom of each button by a wire clamp like a pair of sugar tongs, and a small quantity of solder and resin applied to each. They are in this state exposed to heat on an iron plate, containing about a gross, till the solder runs, and the shank becomes fixed to the button, after which they are put singly in a lathe, and their edges turned off smoothly. The surface of the metal, which has become in a small degree oxydated by the action of the heat in soldering, is next to be cleaned, which in this, as in a great variety of other instances in the manufacture of metallic articles, is effected by the process of dipping or pickling; that is, some dozens of them are put into an earthen vessel, pierced full of holes like a cullender; the whole dipped into a vessel of diluted nitric acid, suffered to drain for a few seconds, again dipped successively into four or five other vessels of pure water, and then dried.

The next operation is the rough burnishing, which is performed by fixing the buttons in the lathe, and applying a burnisher of hard black stone from Derbyshire: the minute pores occasioned by the successive action of the heat and the acid are thus closed, and the subsequent process of gilding considerably improved, both with regard to economy and perfection. The first step towards the gilding of all the alloys of copper consists in covering the surface uniformly with a thin stratum of mercury, by which means the amalgam, which is afterwards applied, attaches itself to it much more readily than it would otherwise do. This part of the process is called quicking, and is effected by stirring the buttons about with a brush, in a vessel containing a quantity of nitric acid supersaturated with mercury, which latter is, of course, by the superior elective attraction of the copper for the acid, precipitated in its metallic state on the bottoms, whose surfaces become uniformly and brilliantly covered with it. The mercury, which hangs in loose drops on the buttons, is then shaken off, by jerking the whole violently, in a kind of earthen cullender made for the purpose, and they are then ready for receiving the amalgam. The amalgam is made by heating a quantity of grain gold with mercury in an iron ladle; by which means the former is soon dissolved, and the whole is then poured into a vessel of cold water. The superabundant mercury is strongly pressed out through a piece of chamois leather, and the remaining amalgam, which is of about the consistence of butter, is then fit for application. This is performed by stirring the buttons, whose surfaces are already thinly covered or wetted with mercury, in an earthen vessel, with the requisite proportion of amalgam and a small quantity of diluted nitric acid, by which means the amalgam also attaches itself to their surfaces with a considerable degree of equality. The necessary quantity of gold is about five grains to a gross of buttons of an inch in diameter.

The next process is the volatilization of the mercury by heat, which is usually called by the workmen drying off. This is formed by first heating the buttons in an iron pan, somewhat like a large frying-pan, till the amalgam with which they are covered becomes fluid, and seems disposed to run into drops, on which they are thrown into a large felt cap, called a gilding cap, made of coarse wool and goat's hair, and stirred about with a brush, to equalize the covering of the surface by the gold. After this they are again heated, again thrown into the gilding cap, and stirred, and these operations successively repeated till the whole of the mercury is volatilized. When the mercury is volatilized from the buttons, or, as the workmen denominate it, when the buttons are dried off, they are finally burnished, and are then finished and fit for carding.

The white metal buttons, which are composed of brass, alloyed with different proportions of tin, after having been cast as before mentioned, are polished, by turning them in a lathe, and applying successively several pieces of buffaloe skin glued on wood, charged with powdered grindstone and oil, rotten stone, and crocus martis. They are then white-boiled, that is, boiled with a quantity of grain tin in a solution of crude red tartar, or argol, and, lastly, finished with a buff with finely prepared crocus.

Glass buttons. These articles are also frequently wholly composed of glass of various colours, in imitation of the opal, lapis lazuli, and other stones. The glass is in this case kept in fusion, and the button nipped out of it whilst in its plastic state, by a pair of iron moulds like those used for casting pistol shot, adapted to the intended form of the button; the workmen previously inserting the shank into the mould, so that it may become imbedded in the glass when cold.

Mother of pearl buttons. This substance is also frequently used in the manufacture of buttons: in which case, the mode of fixing in the shank is somewhat ingenious. It is done by drilling a hole at the back, which is under-cut; that is, larger at the bottom than the top, like a mortise, and the shank being driven in by a steady stroke, its extremity expands on striking against the bottom of the hole, and it becomes firmly rivetted into the button. To these foil-stones are also frequently added, in which case, they are usually attached with isinglass-glue. Steel studs are also often rivetted into buttons of this and various other kinds.

The practice of wearing buttons consisting merely of a mould covered with the same kind of cloth as the garment itself being at present extremely general, it may, perhaps, be proper to remark, that this is prohibited on pain of pecuniary penalties, from 40*s*. to 5*l*. per dozen, by several statutes, which have been made at different times, for the promotion of this manufacture, and under which several convictions have taken place within a few years.

BUTTRESS, a kind of butment built archwise, or a mass of stone or brick, serving to support the sides of a building, wall, &c. on the outside, where it is either very high, or has any considerable load to sustain on the other side, as a bank of earth, &c.

BUXBAUMIA, in botany, a kind of moss, of which there are only two species. Both are to be found in the dissertation of the younger Linnæus on mosses

BUXUS, in botany, a genus of the Monoecia Tetrandria class and order, Natural order of Tricoccæ. Euphorbiæ. Jussieu. Essential character: male calyx three leaved; petals three; styles three; capsule three-beaked; three-celled; seeds two. There is but one species; *viz.* B. sempervirens, box-tree, is well known in its dwarf-state, and as a shrub about three feet in length. The wood is of a yellow colour, very hard and ponderous. It is the only one of the European woods which will sink in water. The leaves are ovate in the common sort, hard, smooth, glossy, evergreen, very dark green above, and pale green underneath, like those of myrtle, but blunt and emarginate at the end; from the axils of the leaves come out the small herbaceous flowers, in round bunches; a female flower occupying the middle of the bunch, being surrounded by several males.

The female flower is succeeded by a capsule of a globular form, very smooth, shining, tricoccous, and before it opens having three beaks, resembling a tripod; the cocculi or grains are of the consistence of paper, two-valved, and opening with an elastic spring; receptacle central, three-sided, and short; in each cell is a pair of seeds, ovate, growing more slender upwards; triangular-compressed, obliquely truncate at the end, of a blackish brown colour. The wood of the box-tree sells at a very high price, by weight, being very hard and smooth, and not apt to warp. It is a native of most parts of Europe, from Britain southwards.

BY-LAWS, or Bye-laws, private and peculiar laws for the good government of a city, court, or other community, made by the general consent of the members. All by-laws are to be reasonable, and for the common benefit, not private advantage of any particular persons, and must be agreeable to the public laws in being. If made by corporations, they are to be approved by the Lord Chancellor or Chief Justice, or justice of assize, on pain of 40*l*. if against the good of the public. But it is said a corporation cannot make by-laws without a custom for it, or the king's charter: nor may they make any by-law to bind strangers that live out of their corporation, or to restrain a person from working in or setting up his trade, though it may be for the order and regulating of trades; and notwithstanding such a by-law may inflict a reasonable penalty, which may be recovered by distress or action of debt, yet none can be imprisoned upon it, as it is contrary to Magna Charta.

BYRLAW, or Burlaw, *laws* in Scotland, are made and determined by neighbours elected by common consent in byrlaw courts. The men chosen as judges are called byrlaw or burlaw-men, and take cognizance of complaints between neighbour and neighbour.

BYRRHUS, in natural history, a genus of insects of the order Coleoptera: generic character: antennæ longer than the head, clavate, the club perfoliate; feelers equal, subclavate; jaw and lip bifid. There are about 12 species, found in different parts of Europe. The B. scrophularia is a small insect, of the size of the lady-bird; its colour is dark brown, clouded with broken or irregular white bands, and the edges, constituting the line of division between the wing sheaths, are red. This insect is found more frequently on the plant called scrophularia aquatica than elsewhere. B. pilula is a larger species, equalling or rather exceeding the size of the common lady-bird; it is of an extremely convex shape, and when disturbed contracts its limbs, and lies in an inert state, resembling the appearance of a seed or pill. It is found on various plants, and about garden grounds, &c. The antennæ in this species are longer than in others, and rather foliated than merely knobbed.

BYSSUS, in botany a genus of the Cryptogamia Algæ, and the last in the scale of vegetation in that class. They appear in the form of threads, on rotten wood, the bark of trees, rocks, and walls, especially in damp cellars; one sort is common on wine casks; at first is like flakes of snow, but turns yellow; in this state it has black grains at the base like gunpowder. The green paper byssus is a farina, concreting on the surface of the water, and forming a wide thin film. There are many species, but the number is doubtful.

BYSTROPOGON, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order, Verticillatæ. Labiatæ, Jussieu. Essential character: calyx five-subulate, bearded at the opening; corolla, upper lip bifid; covers trifid; stamens distant. There are seven species, of which B. pectinatum, balm-leaved bystropogon, has an herbaceous stem, generally five or six feet high, leaves petiolated, cordate, veined; spikes simple or manifold; scarcely leafy; composed of whorls; supported by several bristle-shaped bractes, the length of the flowers, which grow thick together, curiously disposed on the smaller slips of the branched tops; they are whitish, and all the parts very small; the neck of the calyx and filaments are commonly covered with down. The corolla is scarcely larger than the calyx; stamens the length of the corolla, and distant; style purplish; stigmas simple, seeds roundish, black and glossy. This plant is a native of Jamaica. It is found in all the low lands about Kingston and Spanish Town.

C.

C, the third letter, and second consonant of the alphabet, is formed by forcing the breath between the tongue, elevated near the palate (to make the voice somewhat sibilous) with the lips open. It has two sounds, hard and soft; hard, like k, before a, u, o, l, and r; as in call, cost, cup, clean, crop; and soft, like s before i, e, and y; as in city, cession, cyder: before h it has a peculiar sound, as in chance, chalk: in chord, chart, and some other words, it is hard like k: but in many French words, it is soft before h, like s, as in chase, chagrin.

As a numeral, C signifies 100, CC 200, &c.

C, in music, the highest part in the thorough bass; again, a simple C, or rather a semicircle, placed after the cliff, intimates that the music is in common time, which is either quick or slow, as it is joined with allegro or adagio: if alone, it is usually adagio.

If the C be crossed or turned, the first requires the air to be played quick, and the last very quick.

CAABA, or Caabah, properly signifies a square building; but is particularly applied by the Mahometans to the temple of Mecca, built, as they pretend, by Abraham, and Ishmael his son. It is towards this temple they always turn their faces when they pray, in whatever part of the world they happen to be.

This temple enjoys the privilege of an asylum for all sorts of criminals; but it is most remarkable for the pilgrimages made to it by the devout Musselmen, who pay so great a veneration to it, that they believe a single sight of its sacred walls, without any particular act of devotion, is as meritorious in the sight of God, as the most careful discharge of one's duty, for the space of a whole year, in any other temple.

CAB, an Hebrew dry measure, equal to two and five-sixths pints of our corn measure.

CABBAGE. See Brassica.

Cabbage *tree*. See Areca.

CABBAGING, among gardeners, a term used for the knitting of cabbages into round heads.

CABBALA, properly signifies tradition, and is the name of a mysterious kind of science, thought to have been delivered by revelation to the ancient Jews, and transmitted by oral tradition to those of our times; serving for the interpretation of the books both of nature and scripture.

The Cabbala is properly the oral law of the Jews, delivered down by word of mouth from father to son; and it is to these interpretations of the written law that our Saviour's censure is to be applied, when he reproves the Jews for making the commands of God of none effect, through their traditions.

CABBALISTS, the Jewish doctors, who profess the study of the cabbala. In the opinion of these men, there is not a word, letter, or accent in the law, without some mystery in it. The Jews are divided into two general sects; the Karaites, who refuse to receive either tradition or the talmud, or any thing but the pure text of scripture; and the rabbinists, or talmudits, who, besides this, receive the traditions of the ancients, and follow the talmud. The latter are again divided into two other sects; pure rabbinists, who explain the scripture, in its natural sense, by grammar, history, and tradition; and cabbalists, who, to discover hidden mystical senses, which they suppose God to have couched therein, make use of the cabbala, and the mystical methods above mentioned.

CABECA, or Cabesse, a name given to the finest silks in the East Indies.

CABIN, in the sea language, a small room or apartment, whereof there are a great many in several parts of a ship, particularly on the quarter-deck, and on each side of the steerage, for the officers of the ship to lie in. The great cabin is the chief of all, and that which properly belongs to the captain or chief commander.

CABINET, the most retired place in the finest part of a building, set apart for writing, studying, or preserving any thing that is precious. A complete apartment consists of a hall, anti-chamber, chamber, and cabinet, with a gallery on one side. Hence we say, a cabinet of paintings, curiosities, &c.

Cabinet, in natural history. This term is applied, with some latitude, to any small or select collection of natural curiosities, without regarding whether the articles it comprises be contained within a cabinet or not. Thus, for instance, it is not unfrequent with us to speak of cabinets of animals, cabinets of birds, of fishes, reptiles, and other similar articles, as a mode of expressing such an assemblage of natural history, as may not be of sufficient importance to deserve the epithet of a museum. The word cabinet, in its usual acceptation with the naturalist, is not therefore confined solely to the boxes, press, or chest of drawers, in which articles of curiosity are contained, but implies at once both the repository itself, and the articles arranged in it.

Cabinets of fossils, shells, and corals, have the drawers sometimes divided for this purpose into small compartments, by means of an inner frame work, that lets into the bottom of the drawer; but trays of various sizes, made either of card or pasteboard, have a much neater appearance, and are preferred by many, as being more commodious, and more easily shifted from one part of the drawer to another, as the addition of new acquisitions in any particular tribe or genus may require. Nothing can be more desirable than to have the cabinets well made, that the drawers may slide with perfect ease in their proper recesses in the press. The drawers should fit so close, when shut up, as to preclude the entrance of dust of any kind. The cabinet itself should be also placed in a dry situation, as there are few articles of natural history that are not affected in a greater or less degree by an excess of damp, or even heat. The drawers are uniformly made shallow, the bottom of each is lined with cork, and the top is covered with glass, through which the insect may be seen, without being exposed to the air, or accidents that would arise from their being touched by the incautious spectator.

Cabinets for insects are built of various sizes, from those which contain ten or a dozen drawers to others that include above a hundred. They are usually of mahogany, but it is immaterial whether they be made of mahogany or wainscot; some have them of cedar, but seldom of deal, or any other wood of a soft texture. The drawers may be from fifteen to thirty inches in length, the same, or nearly the same, in breadth, and about two or three inches in depth. The cork with which the bottoms are lined must be chosen as free from cracks and holes as possible; it should be also glued into the drawers, to prevent its warping, and be filed or cut very level; and after this the irregularities on the surface of the cork should be rubbed down with pumice-stone, till the whole is rendered perfectly smooth, before the paper is pasted over it. The paper should be of a fine smooth and even grain, but neither very stout nor highly stiffened with size, lest it should turn the points of the pins, when placing the insects in the drawers. The top of every drawer must be covered with a plate of glass, to prevent the admission of dust or air. This plate is usually fitted into a frame of the same size as the drawer, and is made either to slide in a groove, or let in on a rabbet; the latter contrivance is much the best, because, in sliding the grass along the groove, if any of the pins happen to stand so high as to touch the frame work, the insects will be injured by the jerk, or, as more frequently happens in this case, be broken to pieces. On the contrary, when the frame falls in upon a rabbet, it is of no consequence whether the edge of the frame sinks into the drawer below the level of the heads of the pins on which the insects are placed or not; it is only necessary to observe, that the glass does not press upon the pins, since it is the glass only that can come in contact with them.

CABLE, a thick, large, strong rope, commonly of hemp, which serves to keep a ship at anchor.

There is no merchant ship, however weak, but has, at least three cables; namely, the chief cable, or cable of the sheet-anchor, a common cable, and a smaller one.

Cable is also said of ropes which serve to raise heavy loads, by the help of cranes, pullies, and other engines. The name of cable is usually given to such as are, at least three inches in diameter; those that are less are only called ropes of different names, according to their use.

Every cable, of what thickness soever it be, is composed of three strands, every strand of three ropes, and every rope of three twists; the twist is made of more or less threads, according as the cable is to be thicker or thinner.

In the manufacture of cables, after the ropes are made, they use sticks, which they pass first between the ropes of which they make the strands, and afterwards between the strands of which they make the cable, to the end that they may all twist the better, and be more regularly wound together; and also to prevent them from twining or entangling, they hang at the end of each strand and of each rope a weight of lead or of stone.

The number of threads each cable is composed of is always proportioned to its length and thickness; and it is by this number of threads that its weight and value are ascertained; thus, a cable of three inches circumference, or one inch diameter, ought to consist of forty-eight ordinary threads, and weigh 192 pounds: and on this foundation is calculated the following table, very useful for all people engaged in marine commerce, who fit out merchantmen for their own account, or freight them for the account of others.

A table of the number of threads and weight of cables of different circumferences.

Circumf.	Threads.	Weight.
3 inches,	48	192 pounds.
4	77	308
5	121	484
6	174	696
7	238	952
8	311	1244
9	393	1572
10	485	1940
11	598	2392
12	699	2796
13	821	3284
14	952	3808
15	1093	4372
16	1244	4976
17	1404	5616
18	1574	6296
19	1754	7016
20	1943	7772

Cable, *sheet anchor*, is the greatest cable belonging to a ship.

Cable, *to splice a*, is to make two pieces fast together, by working the several threads of the rope, the one into the other.

Cable, *pay more*, is to let more out of the ship. *Pay cheap the cable*, is to hand it out apace. *Veer more cable*, is to let more out, &c.

CABLED, in heraldry, a term applied to a cross, formed of the two ends of a ship's cable: sometimes also to a cross covered over with rounds of rope, more properly called a cross corded.

CABOCHED, in heraldry, is when the heads of beasts are borne without any part of the neck full faced.

CACALIA, in botany, a genus of the Syngenesia Polygamia class and order. Natural order of Compositæ Discoideæ: Corymbiferæ, Jussieu. Essential character: calyx cylindric, oblong, at the base only subcalycled; down capillary; receptacle naked. There are thirty-three species, of which we shall only give a short description of two or three. C. capillaris, or rough stalked cacalia, has the foot stalk very strong and thick, and is set round on every side, being destitute of leaves, with three truncated foot stalks, and thus is the stem defended in a singular manner from external injuries. It is a native of the Cape of Good Hope, and is cultivated in England, but has never yet produced flowers. C. suaveolens, sweet-scented cacalia, has a perennial creeping root, sending out many stalks; these rise to the height of seven or eight feet, are streaked, quite simple, and terminated by corymbs of white flowers; the peduncles above the ramifications have bristle-shaped bractes scattered over them, which are smooth. It is a native of Virginia and Canada; flowering in August, and ripening its seeds in October. The roots which have been cast out of the Chelsea gardens have been carried by the tide to a great distance, and lodged on the banks of the rivers, and fastened themselves to the ground, where they have increased so much as almost to appear as if they were natives. C. articulata, jointed stalked cacalia, is an elegant plant, smooth and glaucous, of an unpleasant flavour: stems many, fleshy, round, upright, but weak, marked with scars from the fallen leaves, and painted with lines of a deep green; florets twenty-five, a little longer than the calyx, white, with border acute, and spreading much; anthers dark purple; stigma bifid, yellow; seeds linear, crowned with a white sessile egret. Found at the Cape of Good Hope. It flowers in November.

CACAO, the *chocolate tree*, in botany. See THEOBROMA.

CACHRYS, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: fruit subovate, angular, suberous, cortical. There are five species, of which C. libanotis, smooth-seeded cachrys, has a thick fleshy root like fennel which runs deep into the ground, sending out several narrow pinnate leaves, ending in many points; between these arises a smooth jointed stalk, about three feet high, which is terminated by large umbels of yellow flowers. Native of Sicily. C. tenuifolia, five-leaved cachrys: root perennial, fleshy, gratefully aromatic, with branches an inch thick, a cubit in length, covered with a smooth bark; umbels almost a span in diameter, consisting of from sixteen to twenty rays, about two inches in length; flowers yellow. Native of Montpellier, flowering in May.

CACTUS, in botany, a genus of the Icosandria Monogynia class and order. Natural order of Succulentæ. Cacti, Jussieu. Essential character: calyx one-leafed, superior, imbricate; corolla manifold; berry one-celled, many-seeded. There are twenty-seven species. This genus consists of succulent plants, permanent in duration, singular and various in structure; generally without leaves, having the stem or branches jointed; for the most part armed with spines in bundles, with which, in many species, bristles are intermixed. The bundles of spines are placed on the top of the tubercles in the C. mammillaris, smaller melon thistle, which is tubercled all over, and produces its flowers between the tubercles. In C. melocactus, great melon thistle, or turk's cap, the spines are ranged in a single row on the ridge of the ribs: when it is cut through the middle, the inside is found to be a soft, green, fleshy, substance, very full of moisture. The flowers and fruit are produced in circles round the upper part of the cap. C. pitajaya, torch thistle, or torch wood, is upright, and grows to the height of eight or ten feet. The flower is whitish, very handsome, but has scarcely any smell; it is half a foot in diameter, and blows in the night. The fruit is of the form and size of a hen's egg, of a shining scarlet colour on the outside; the pulp is white, fleshy, sweet, eatable, full of small black seeds. C. grandiflorus, great flowering creeping cereus; and C. flagelliformis, pink flowering creeping cereus, are the same with those already mentioned, except that the stems are weak, and cannot support themselves; they therefore seek assistance, and throw out roots from the stem like ivy. C. moniliformis, necklace Indian fig; the branches are jointed, and very much flatted; the bundles of apines or bristles are scattered over the surface, and the flowers are produced from the edge of the branches. C. phyllanthus, spleenwort-leaved Indian fig, has the branches much thinner, and may be fairly denominated leaves; they are indented along the edge, and the flowers come out singly from the indentures. The fruit in some of the sorts is small, like currants, but in most it is large, and shaped like a fig; whence their name of Indian fig. These singular plants are all natives of the continent of South America and the West Indian islands.

CADENCE, in music, according to the ancients, is a series of a certain number of notes, in a certain interval, which strike the ear agreeably, and especially at the end of the song, stanza, &c. It consists ordinarily of three notes. Cadence, in the modern music, may be defined, a certain conclusion of a song, or of the parts of a song, which divide it, as it were, into so many numbers or periods. It is when the parts terminate in a chord or note, the ear seeming naturally to expect it; and is much the same in a song, as the period that closes the sense in a paragraph of a discourse. See MUSIC.

CADENCE, in rhetoric and poetry, the running of verse or prose, otherwise called the numbers, and by the ancients ῥυθμος.

CADENCE, in dancing, is when the several steps and motions follow, or correspond, to the notes and measures of the music.

CADENCE is used as a military term, and implies a very regular and uniform method of marching, by the drum and music; it may not, says a good writer on this subject, be improperly called mathematical marching; for after the length of the step is determined, the time and distance may be found.

CADET is a military term, denoting a young gentleman who chooses to carry arms in a marching regiment as a private man. His views are, to acquire some knowledge of the art of war, and to obtain a commission in the army. Cadet differs from volunteer, as the former takes pay, whereas the latter serves without any pay. There is a company of gentlemen cadets maintained at Woolwich, at the King's expense, where they are taught all the sciences necessary to form a complete officer.

CADI, or CADHI, a judge of the civil affairs in the Turkish empire. It is generally taken for the judge of a town; judges of provinces being distinguished by the appellation of mollas.

CADIA, in botany, a genus of the Decandria Monogynia class and order. Essential character: calyx five-cleft; petals five, equal, obcordate, legume, many-seeded. There is but one species; *viz.* C. purpurea, purple flowered cadia, is a shrub rising to the height of three feet. The leaves are pinnate, coming out alternately; leaflets from 15 to 30 pairs, linear, retuse, the nerve ending in a little point. The corolla is rose coloured, or rather the colour of a peach blossom; legume somewhat less than a span in length, containing eight or ten seeds. It is a native of Arabia.

CADUCI, in botany, the name of a class of plants in Linnæus's Methodus Calycina, consisting of plants of which the calyx is a simple perianthium, supporting a single flower, or fructification, and falling off either before or with the petals. It stands opposed to the Persistentes, in the same method, and is exemplified in mustard, sinapi, and ranunculus. The term caducous is expressive of the shortest period of duration, and has different acceptations, according to the different parts of plants to which it is applied. A calyx is said to be caducous, which drops at the first opening of the petals, or even before, as in the poppy. Petals are caducous, which are scarcely unfolded before they fall off, as in the meadow rue; and such leaves have obtained this denomination as fall before the end of the summer.

CADUS, in antiquity, a wine vessel of a certain capacity, containing a 80 amphoræ, or firkins, each of which, according to the best accounts, held nine gallons.

CÆCUM, or CŒCUM, in anatomy, the blind gut, or first of the large intestines. See ANATOMY,

CÆNOPTERIS, in botany, a genus of the Cryptogamia Filices. Generic character: fructifications in submarginal lateral lines, covered with a membrane gaping on the outside. There is but one species; *viz.* C. rhizophylla, common peduncle or rachis, round, brown, and smooth, elongated at the tip, leafless; bulbiferous rooting; partial peduncles green, flatted, sometimes winged. Fructifications in short, solitary, lateral lines, beginning at the nerve towards the base of the pinnules, and covered with an entire scariose brown membrane. Native of the island of Dominica.

CÆSALPINA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx five parted, the lowest segment longer, and slightly arched; stamen woolly at the base; petals five; legume compressed. There are eight species, of which C. elata is a tree with bipinnate leaves of seven pairs; the leaflets fifteen pairs, quite entire, minute; flowers large, and of a yellow colour; filaments very dark purple, villose at the base. It is a native of India. C. pulcherrima, the Barbadoes flower fence, rises with a straight stalk ten or twelve feet high: it is covered with a smooth grey bark: it divides into several spreading branches at the top, arched at each joint with two short, strong, crooked spines. The branches are terminated by loose spikes of flowers, which are sometimes formed into a kind of pyramid, and at others they are disposed more in form of an umbel. The peduncle of each flower is nearly three inches long. The petals are roundish at the top: they spread open, and are beautifully variegated with a deep red or orange colour, yellow, and some spots of green, and have a very agreeable odour. This beautiful plant is a native of both Indies. It is planted in hedges to divide the lands in Barbadoes, whence it has the name of flower-fence.

CÆSAR, in Roman antiquity, a title borne by all the emperors, from Julius Cæsar to the destruction of the empire. It was also used as a title of distinction for the intended or presumptive heir of the empire, as king of the Romans is now used for that of the German empire. This title took its rise from the surname of the first emperor, C. Julius Cæsar, which, by a decree of the senate, all the succeeding emperors were to bear. Under his successor, the appellation of Augustus being appropriated to the emperors, in compliment to that prince, the title Cæsar was given to the second person in the empire, though still it continued to be given to the first; and hence the difference betwixt Cæsar used simply, and Cæsar with the addition of Imperator Augustus.

CÆSARIAN *section*, in midwifery, a chirurgical operation, by which the fœtus is delivered from the womb of its mother, when it cannot be done in the natural way See MIDWIFERY.

CÆSULIA, in botany, a genus of the Syngenesia Æqualis, Receptacle chaffy; seeds involved in the chaff; calyx three-leaved. Two species *viz.* C. axillaris, a native of the East Indies, and C. radicans, a native of Guinea.

CÆSURA, in the ancient poetry, is when, in the scanning of a verse, a word is divided, so as one part seems cut off, and goes to a different foot from the rest; as,

Menti|ri no|li nun|quam men|dacia | prosunt.

where the syllables *ri*, *li*, *quam*, and *men*, are cæsuras.

Cæsura more properly denotes a certain and agreeable division of the words between the feet of a verse, whereby the last syllable of a word becomes the first of a foot, as in

Arma virumque cano, Trojæ qui primus ab oris,

where the syllables *no* and *jæ* are cæsuras.

CÆSURA or CÆSURE, in the modern poetry, denotes a rest, or pause, towards the middle of an Alexandrine verse, by which the voice and pronunciation are aided, and the verse, as it were, divided into two hemistichs. In Alexandrine verses of twelve or thirteen syllables, the cæsure must always be on the sixth; in verses of ten, on the fourth; and in those of twelve, on the sixth; verses of eight syllables must not have any cæsure

CÆTERIS *paribus*, a Latin term, often used by mathematical and physical writers, the words literally signifying "the rest, or the other things, being alike, or equal." Thus we say, the heavier the bullet, "cæteris paribus," the greater the range: *i. e.* by how much the bullet is heavier, if the length and diameter of the piece, and the quantity and strength of the powder be the same, by so much will the utmost range or distance of a piece of ordnance be greater. Thus also, in a physical way, we say, the velocity and quantity of the blood circulating, in a given time, through any section of an artery, will, "cæteris paribus," be according to its diameter, and nearness to or distance from the heart.

CAILLE (NICHOAAS LEWIS DE LA,) in biography, an eminent French mathematician and astronomer, was born in the diocese of Rheims in 1713. His father having quitted the army, in which he had served, amused himself in his retirement with studying mathematics and mechanics, in which he proved the happy author of several inventions of considerable use to the public. From this example of his father, our author, almost in his infancy, took a fancy to mechaincs, which proved of signal service to him in his maturer years. At school he discovered early tokens of genius. He next came to Paris in 1729, where he studied the classics, philosophy, and mathematics. He afterwards studied divinity in the College de Navarre, with the view embracing the ecclesiastical life, but never entered into priest's orders. His turn for astronomy soon connected him with the celebrated Cassini, who procured him an apartment in the observatory: where, assisted by the councils of this master, he soon acquired a name among the astronomers. In 1739 he was joined with M. Cassini de Thury, son to M. Cassini, in verifying the meridian through the whole extent of France; and in the same year he was named professor of mathematics in the College of Mazarine. In 1741 he was admitted into the Academy of Sciences, and had many excellent papers inserted in their memoirs; besides which, he published several useful treatises, *viz.* Elements of Geometry, Astronomy, Mechanics, and Optics. He also carefuly computed all the eclipses of the sun and moon that had happened since the christian æra, which were printed in the work, entitled "L'Art de verifier les Dates," &c. Paris, 1750, in 4to. He also compiled a volume of astronomical ephemerides for the years 1745 to 1755; another for the years 1755 to 1765; and a third for the years 1765 to 1775; as also the most correct solar tables of any; and an excellent work, entitled "Astronomiæ Fundamenta novissimis Solis et Stellarum Observationibus stabilita."

Having gone through a seven year's series of astronomical observations in his own observatory in the Mazarine College, he formed the project of going to observe the southern stars at the Cape of Good Hope; being countenanced by the court, he set out upon this expedition in 1750, and in the space of two years he observed there the places of about 10,000 stars in the southern hemisphere, that are not visible in our latitudes, as well as many other important elements, *viz.* the parallaxes of the sun, moon, and some of the planets, the obliquity of the ecliptic, the refractions, &c. Having thus executed the purpose of his voyage, and no present opportunity offering for his return, he thought of employing the vacant time in another arduous attempt; no less than that of taking the measure of the earth, as he had already done that of the heavens, whence he discovered, that the radii of the parallels in south latitude are not the same length as those of the corresponding parallels in north latitude. About the 23d degree of south latitude he found a degree on the meridian to contain 342222 Paris feet. The court of Versailles also sent him an order to go and fix the situation of the isles of France and of Bourbon.

M. de la Caille returned to France in the autumn of 1754, after an absence of about four years; loaded, not indeed with the spoils of the East, but with those of the southern heavens, before then almost unknown to astronomers. Upon his return, he first drew up a reply to some strictures which the celebrated Euler had published relative to the meridian; after which he settled the results of the comparison of his observations for the parallaxes, with those of other astronomers: that of the sun he fixed at $9\frac{1}{2}''$; of the moon at $56' 56''$; of Mars in his opposition, $36''$; of Venus $38''$. He also settled the laws by which astronomical refractions are varied by the different density or rarity of the air, by heat or cold, and by dryness or moisture. And, lastly, he shewed an easy and practicable method of finding the longitude at sea by means of the moon. His fame being now celebrated every where, M. de la Caille was soon elected a member of most of the academies and Societies of Europe, as London, Bologna, Petersburgh, Berlin, Stockholm, and Gottingen. He died in 1762, aged 49.

CAISSON, in the military art, a wooden chest, into which several bombs are put, and sometimes only filled with gunpowder; this is buried under some work, whereof the enemy intend to possess themselves, and when they are masters of it, is fired, in order to blow them up.

CAISSON is also used for a wooden frame, or chest, used in laying the foundations of the piers of a bridge.

The practice in building in caissons is a method sometimes adopted in laying the foundation of bridges in very deep or rapid rivers. There are large hollow vessels, framed of strong timbers, and made water tight, which being launched and floated to a proper position in the river, where the ground has been previously excavated and levelled, are there sunk. The piers of the bridge are then built within them, and carried up above, or nearly to the level of the water, when the sides of the caisson are detached from the bottom, and removed; the bottom, composed of a strong grating of timber, remaining and serving for a foundation to the pier. The most considerable work, where caissons have been used, was in the building of Westminster-bridge; of these, therefore, a particular account may be acceptable. Each of the caissons contained 150 loads of fir timber, and was of more tonnage than a man of war of 40 guns; their size was nearly 80 feet from point to point, and 30 feet in breadth; the sides, which were 10 feet in height, were formed of timbers laid horizontally over one another, pinned with oak trunnels, and framed together at all the corners, except the salient angles, where they were secured by proper iron-work, which, being unscrewed, would permit the sides of the caisson, had it been found necessary, to divide into two parts. These sides were planked across the timbers, inside and outside, with 3-inch planks, in a vertical position. The thickness of the sides was 18 inches at bottom, and 15 inches at top; and in order to strengthen them the more, every angle, except the two points, had three oaken knee timbers, properly bolted and secured. These sides, when finished, were fastened to the bottom, or grating, by 28 pieces of timber on the outside, and 18 within, called straps, about 8 inches broad, and about 3 inches thick, reaching and lapping over the tops of the sides; the lower part of these straps were dove-tailed to the outer curb of the grating, and kept in their places by iron wedges. The purpose of these straps and wedges was, that when the pier was built up sufficiently high above low-water mark, to render the caisson no longer necessary for the masons to work in, the wedges being drawn up gave liberty to clear the straps from the mortices, in consequence of which the sides rose by their own buoyancy, leaving the grating under the foundation of the pier. The pressure of the water upon the sides of the caisson was resisted by means of a ground timber or ribbon, 14 inches wide and 7 inches thick, pinned upon the upper row of timbers of the grating; and the top of the sides was secured by a sufficient number of beams laid across, which also served to support a floor, on which the labourers stood to hoist the stones out of the lighters, and to lower them into the caisson. The caisson was also provided with a sluice, to admit the water. The method of working was as follows: A pit being dug, and levelled in the proper situation for the pier of the same shape of the caisson, and about five feet wider all round, the caisson was brought to its position, a few of the lower courses of the pier built in it, and sunk once or twice, to prove the level of the foundation; then, being finally fixed, the masons worked in the usual methods of tide-work. About two hours before low water, the sluice of the caisson, kept open till then, lest the water, flowing to the height of many more feet on the outside than the inside, should float the caisson and all the stonework out of its true place, was shut down, and the water pumped low enough, without waiting for the lowest ebb of the tide, for the masons to set and cramp the stonework of the succeeding courses. Then, when the tide had risen to a considerable height, the sluice was opened again, and the water admitted; and as the caisson was purposely built but 16 feet high, to save useless expence, the high tides flowed some feet above the sides, but without any damage or inconvenience to the works. In this manner the work proceeded till the pier rose to the surface of the caisson, when the sides were floated away, to serve the same purpose at another pier.

CAKILE, in botany, *sea-rocket*, a genus of the Tetrandria Siliculosa class and order. Silicle lanceolate, somewhat four-sided, consisting of two deciduous joints, without valves, and each containing a single seed: the lower joint with a tooth on each side at the tip. There are two species, *viz.* C. maritima, found on the sea-coast of England; C. Ægyptiaca, a native of Italy and Egypt.

CALAGUALA *root*, brought from America for medicinal purposes, and has acquired considerable reputation on the continent. It is supposed to be obtained from a species of polypodium. Its colour is brown, and partly covered with scales, like the roots of fern, and is hard and difficult to reduce to powder. It is asserted by Vauquelin that it contains

Woody fibre	Colouring matter
Gum	Malic acid
Resin	Muriate of potash
Sugar	Lime
Starch	Silica.

The mode of analysis may be thus described. Alcohol dissolves the resin and sugar. By evaporating the solution to dryness, and treating the residue with water, the sugar is separated, and the resin left. Water dissolved the gum and the muriate of potash, which were obtained by evaporation. Diluted nitric acid dissolved the starch and colouring matter, and let fall the former, when mixed with four times its bulk of alcohol. The woody fibre remained, which, when incinerated, left carbonate of lime, muriate of potash, and a little silica. As the decoction reddened vegetable blues, it is possible that the lime was in combination with malic acid.

CALAMANCO, a sort of woollen stuff manufactured in England and in Brabant. It has a fine gloss, and is chequered in the warp, whence the checks appear only on the right side. Some calamancoes are quite plain, others have broad stripes adorned with flowers; some with plain broad stripes, some with narrow stripes, and others watered.

CALAMARIÆ, in botany, the name of a third order in Linnæus's "Fragments of a Natural Method." This order will be easily distinguished from the family of grasses, by recollecting, 1. That the base of the leaf, which embraces the stalk like a glove, has no longitudinal aperture in plants of this order, but is perfectly entire: 2. The stalk is generally triangular, and without knots or joints: 3. The flowers have no petals.

CALAMINARIS, or *lapis calaminaris*, a mineral containing zinc, united with iron and other substances It is heavy, hard, and brittle, or of a consistence between stone and earth. The colour is whitish or grey, sometimes inclining to yellow, and sometimes to black. It is found in great plenty in many parts of Europe; but the best is obtained in this country. It seldom lies deep, and in many parts it is found mixed with lead ores. Calamine is the only true ore from which zinc is obtained by calcination. See Zinc.

CALAMUS, in botany, a genus of the Hexandria Monogynia class and order. Natural order Tripetaloideæ. Palmæ, Jussieu. Essential character: calyx six-leaved; corolla none; berry dried, one-seeded, imbricate backwards. According to Martyn, there is but one species, though Loureiro has discriminated six; *viz.* C. rotang, rattan, has a perennial stem, quite simple or unbranched, without any tendrils: leaves alternate, sub-lanceolate, quite entire, scarcely a foot long: flowers commonly hermaphrodite, almost terminating on one spadix or more. The rattan seems to form the connecting link between the palms and the gramineous plants, having the flower of the former, but the habit of the latter. The palm called raphia has the embryo placed in the same manner, namely, on a lateral cavity of the horny albumen; in the fruit and spadix it agrees nearly with this in form, only they are much larger: the flowers differ but little, except that they are monoecous, as the flowers of the rattan probably are.

CALCAR, *corollæ*, in botany, the spur of the corolla. The nectarium, so called, which terminates the corolla behind, like a cock's spur, in valerian, orchis, violet, balsam, larkspur, &c.

CALCEOLARIA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Corydales. Scrophulariæ, Jussieu. Essential character: corolla ringent, inflated; capsule two-celled, two-valved; calyx four-parted, equal. There are seven species, of which C. pinnata, pinnated slipper-wort, has an annual root; stem erect, two feet high, round, brittle, with a thick down, and from sixteen to twenty joints; flowers from each top and stalk double; corollas yellow; upper-lip subglobular, inflated, emarginate in front, with a cleft for the prominent anthers; capsule thin, from a swelling base, diminishing to a pyramidal top; seeds very small, almost cylindric, sreaked: native of Peru, in moist places.

CALCINATION, in chemistry. A substance is said to be calcined, when it has been exposed to heat of a sufficient intensity to drive off every thing volatile, but short of that by which it might be fused: a calyx, therefore, was formerly understood to be a pulverulent substance, no longer combustible, or capable of further alteration by fire than that of vitrification. As most metals were found to be reducible to such a form by the continuance of the melting heat, the term "calces of metals" was long appropriated to them, and is still partially retained, though it has been chiefly supplanted by the more characteristic appellation of oxide, which expresses the peculiar change that occurs in metallic bodies by the absorption of oxygen. Calcination expresses the mode, by which, in metals, this change is produced, and oxydation the circumstance of change. It is, however, improper to consider the term calcination as synonymous with oxydation, even in speaking of metals, since the former term implies the agency of fire; whereas oxydation may be produced as well by the action of acids, as by heat and air.

CALCITRAPA, in botany, a genus of the Tetrandria Monogynia class and order; calyx four-cleft; corolla four-cleft; berry four-seeded. There are twelve species, found in both Indies, Cochin-China, and Japan.

CALCULATION, the act of computing several sums, by adding, substracting, multiplying, or dividing. See Arithmetic.

An error in calculation is never protected or secured by any sentence, decree, &c. for in stating accounts it is always understood that errors of calculation are excepted.

Calculation is more particularly used to signify the computations in astronomy and geometry, for making tables of logarithms, ephemerides, finding the time of eclipses, &c.

Calculation, in music: many eminent mathematicians suppose that a good ear, and strong hand on instruments, where the tone depends on the performer, are the musician's best guide, without having recourse to calculation. On this subject the celebrated D'Alembert says, "It is an achievement of no small importance, to have deduced the principal facts to a system from one experiment, *viz.* the harmonies of a single string. Calculation may, indeed, facilitate the intelligence of certain points of theory, such as the relation between the tones of the gamut and temperament; but the calculation necessary for treating these two points is so simple and trifling, that it merits no display. Let us not, therefore, imitate those musicians, who believe themselves geometricians, or those geometricians, who fancy themselves musicians, and in their writings heap figures on figures, imagining, perhaps, that this display is necessary to the art." See D'ALEMBERT.

CALCULI, *biliary*, in chemistry, are small stones found in the gall-bladder, and probably formed by the changes produced on the bile while it remains in that organ. These are not uniform in their appearance, but vary in colour, texture, and hardness. The most common are of a lamellated structure, resembling spermaceti, disposed in crystalline laminæ, which have a close resemblance in their properties to ADIPOCIRE, which see. Biliary calculi are soluble in oil of turpentine; but more completely in the fixed alkalies, by which they are reduced to a saponaceous state. Ammonia, unless in the boiling state, has little effect upon them. Nitric acid dissolves them, forming a liquid similar to the oil of camphor, which becomes concrete, and without any crystalline structure, and is more soluble in ether, and the alkalies, than the original matter. This substance is contained, in a greater or less degree, in nearly all the human biliary calculi: hence they partake of its properties: are fusible, inflammable, and more or less soluble in the re-agents which dissolve it. Other calculi are occasionally found in the gall-bladders of quadrupeds, which have been supposed to consist of inspissated bile; they are irregular, and of various forms. Gall-stones in general are distinguished for their lightness and inflammability, few of them being so heavy as to sink in water, and when put to a lighted candle they usually melt like wax, and kindle with a bright flame, attended with an ammoniacal smell.

CALCULI, *urinary*, concretions formed in the kidney or bladder, and composed, in greater or smaller proportions, of the following substances, *viz.* uric acid, urate of ammonia, phosphate of lime, phosphate of ammonia and magnesia, oxalate of lime, silex, and animal albumen. These principles being more or less common, and in different proportions, give rise to numerous varieties.

The calculi most common are those composed of uric acid; they are generally of a brown or yellowish colour, smooth on the surface, and with a texture compact or radiated; they are perfectly soluble in alkaline solutions, and give a red colour when treated with nitric acid. Dr. Wollaston has arranged the urinary calculi under four species, *viz.* 1. The uric acid concretion: 2. The fusible calculus, or phosphate of ammonia and magnesia: 3 The mulberry calculus, or oxalate and phosphate of lime: And, 4. the bony earthy calculus, composed of phosphate of lime, which forms the basis of bone. Fourcroy and Vauquelin have given a different arrangement; they affirm that in all calculi there exists a quantity of animal matter, which appears to connect their particles; but independently of this, which is common to the whole, they compose three genera; the first contains three species, each formed of one ingredient; the second comprises seven species, formed of two ingredients each: and in the third there are two species, consisting of three or four ingredients; this system is exhibited in the following table:

Genus I.	Species 1. Calculus of	uric acid.
	. . 2.	urate of ammonia.
	. . 3.	oxalate of lime
Genus II.	. . 4.	uric acid and earthy phosphates, in distinct layers
	. . 5.	uric acid and earthy phosphates, intimately mixed
	. . 6.	urate of ammonia and phosphates, in distinct layers.
	. . 7.	urate of ammonia and phosphates, intimately mixed.
	. . 8.	earthy phosphates, either mixed intimately or in fine layers
	. . 9.	oxalate of lime and uric acid, in distinct layers.
	. . 10.	oxalate of lime and earthy phosphates, in distinct layers.

Genus III.	. . . . . 11 . .	uric acid, or urate of ammonia, earthy phosphates, and oxalate of lime.
	. . . . . 12 . .	uric acid, urate of ammonia, earthy phosphates, and silex.

It becomes a question of great importance and interest to mankind, how far the solution of calculi in the bladder may be practicable. From what has been said, it is evident, that, being of very different chemical composition, the same solvent cannot be applicable to all of them. Long experience has sufficiently established the advantage of alkaline remedies; and as the calculi composed of uric acid are unquestionably the most abundant, it is no doubt from the chemical action they exert upon it that the benefit is derived. Lime, under the form of lime-water, has been employed as a solvent: and from some experiments of Dr. Egan, it should seem that lime-water acts with more energy than an alkaline solution of similar strength, in destroying the aggregation of urinary concretion. Mr. Murray bears his testimony to the same fact: "I observed," says he, "this effect strikingly displayed in a comparative trial which these experiments led me to make. In a dilute solution of pure potassa, a calculus of the uric acid kind was in part dissolved, the liquor, after a short time, giving a copious white precipitate with muriatic acid; but the remaining calculus preserved its aggregation, apparently without much alteration, the external layer having been merely removed; while a calculus of a similar kind, and discharged from the person, immersed in lime-water, became in a few days white and spongy: it appeared at length to be entirely penetrated; its cohesion was subverted; it presented a kind of loose scaly appearance, and the least touch made it fall down. The lime probably operates more upon the albumen or animal matter, which appears to serve as the cement or connecting substance, than upon the uric acid; and in endeavouring to discover solvents for these concrections, our views ought perhaps rather to be directed to this operation than to the effect on the saline matter. If lime, when received into the stomach under the form of lime water, can be secreted by the kidneys, as the alkalies unquestionably are, it would appear from these observations to be superior to them as a solvent."

CALCULUS denotes a method of computation, so called from the calculi, or counters, anciently used for this purpose.

CALCULUS *specialis*, or *literalis*. See ALGEBRA.

CALCULUS, *differentialis*, is a method of differencing quantities, that is, of finding an infinitely small quantity, which, being taken an infinitive number of times, shall be equal to a given quantity. An infinitely small quantity, or infinitesimal, is a portion of a quantity less than any assignable one; it is therefore accounted as nothing; and hence two quantities, only differing by an infinitesimal, are reputed equal. The word infinitesimal is merely respective, and implies a relation to another quantity; for example, in astronomy the diameter of the earth is an infinitesimal in respect to the distance of the fixed stars. Infinitesimals are likewise called differentials, or differential quantities, when they are considered as the difference of two quantities. Sir Isaac Newton calls them moments, considering them as momentary increments of quantities; for instance, of a line generated by the flux of a point, of a surface by the flux of a line, or of a solid by the flux of a surface. The calculus differentialis, therefore, and the doctrine of fluxions, are the same thing, under different names, the latter given by Sir Iaac Newton, and the former by Mr. Leibnitz, who disputes with Sir Isaac the honour of the discovery. There is, however, one difference between them, which consists in the manner of expressing the differentials of quantities: Mr. Leibnitz, and most foreigners, express them by the same letters as variable ones, prefixing only the letter d: thus the differential of x is called $d\,x$, and the differential of y, $d\,y$: and $d\,x$ is a positive quantity, if x continually increase; and a negative quantity, if x decrease. We, on the other hand, following Sir Isaac Newton, instead of $d\,x$ write x, (with a dot over it,) and instead of $d\,y$, y. But foreigners reckon this method not so commodious as the former, because, if differentials were to be differenced again, the dots would occasion great confusion; not to mention, that printers are more apt to overlook a point than a letter. See FLUXIONS.

CALCULUS *exponentialis*, among mathematicians, a method of differencing exponential quantities, and summing up the differentials of exponential quantities. By an exponential quantity is meant, a power, the exponent of which is variable, as x^x, a^x. In order to difference an exponential quantity, nothing else is required than to reduce the exponential quantities to logarithmic ones, upon which the differencing is managed as in logarithmic ones.

By the same method may be found the differential of an exponential quantity of any power. This calculus was invented by Mr. John Bournoulli, and is used in investigating the properties of exponential curves.

CALCULUS *integralis*, is a method of summing up differential quantities; that is, from a differential quantity given, to find the quantity from whose differencing the given differential results.

It is the inverse of the calculus differentialis; whence the English, who usually call the differential method fluxions, give this calculus, which ascends from the fluxions to the flowing quantities; or, as Wolfius and other foreigners express it, from the differences to the sums, the name of the inverse method of fluxions. See FLUXION.

CALEA, in botany, a genus of the Syngynesia Polygamia Æqualis. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate; down hairy, or none; receptacle chaffy. There are seven species, of which C. Jamaicensis has a shrubby stem, six or seven feet high; leaves hairy, rugged, three-nerved; flowers terminating, frequently three together; the pedicles of the same length with the flowers; calyx coloured; the pappus, or down, is rugged, and as long as the flower. Native of Jamaica, chiefly in the woods and inland parts of the island.

CALENDAR, a distribution of time, accommodated to the various uses of life, but more especially such as regard civil and ecclessiatical polity; in which sense it differs nothing from the modern almanacs.

The first calendar was made by Romulus, who divided the year into 10 months only, beginning on the first day of March, and containing 304 days, in which time he imagined the sun performed his course through all the seasons.

This calendar was reformed by Numa Pompilius, who added two months more, *viz.* January and February, placing them before March: his year began on the first of January, and consisted of 355 days. This was afterwards improved by Julius Cæsar, and was by him called the Julian account, which reduced the year to 365 days 6 hours; and was retained in most protestant countries, and in our nation till the year 1752. This year is disposed into quadrennial periods, of which the three first years, which were called common, consisted of 365 days, and the fourth, bissextile, of 366. See BISSEXTILE.

The Julian account was afterwards corrected by Pope Gregory XIII., which on that account obtained the name of the Gregorian calendar, or new style, the Julian being called the old style: and though the Gregorian calendar be preferable to the Julian, yet it is not without its defects: perhaps, as Tycho Brahe and Cassini imagine, it is impossible ever to bring the year to a perfect justness.

CALENDAR, *Julian Christian*, that wherein the days of the week are determined by the letters A, B, C, D, E, F, G, by means of the solor cycle; and the new and full moons, especially the paschal full moon, with the feast of Easter, and the other moveable feasts depending thereon, by means of golden numbers, rightly disposed through the Julian year. See CYCLE, DOMINICAL LETTER, and GOLDEN NUMBER.

CALENDAR, *Gregorian*, that which, by means of epacts, rightly disposed through the several months, determines the new and full moons, and the time of Easter, with the moveable feasts depending thereon, in the Gregorian year. Therefore, the Gregorian calendar differs from the Julian, both in the form of the year, and in that epacts are substituted instead of golden numbers. See EPACT.

Dr. Playfair, in his "System of Chronology," observes, that the method of intercalation used in the Gregorian Calendar is not the most accurate. Ninety-seven days, or 100—3, are inserted in the space of four centuries. This supposes the tropical year to consist of $365^d, 5^h, 49', 12''$. On this supposition the interpolation would be exact, and the error would scarcely exceed one day in 268,000 years. But the reformers of the calendar made use of the Copernican year of $365^d, 5^h. 49', 20''$. Instead, therefore, of inserting 97 days in 400 years, they ought to have added, at proper intervals, 41 days in 169 years, or 90 days in 371 years, or 131 in 540 years, &c. Recent observations have determined the quantity of the tropical year to be $365^d, 5^h, 48', 45\frac{1}{2}''$. Admitting this to be the true quantity of it, the intercalations ought to be made as follows:

$$+\frac{4}{1},\ -\frac{17}{4},\ +\frac{33}{8},\ -\frac{128}{31},\ +\frac{545}{132},\ +\frac{673}{163},\ +\frac{801}{199},\ +\frac{929}{225},\ +\frac{1057}{256},\ +\frac{1185}{287},$$

$$\overset{+}{\frac{1813}{318}},\ \overset{-}{\frac{1441}{349}},\ \overset{-}{\frac{2754}{667}},\ \overset{-}{\frac{4067}{985}},\ \overset{+}{\frac{9447}{2288}},\ \overset{-}{\frac{51302}{12425}},\ \overset{+}{\frac{60749}{14713}},\ \overset{-}{\frac{172800}{41851}};$$

that is, one day ought to be intercalated in the space of 4 years, or rather 4 days in 17 years, or 8 days in 33 years, &c. If 41,851 days were intercalated in 172,800 years, there would be no error. The signs + and — indicate that the number of intercalary days above which they are placed is too great or too small. Every succeeding number is more accurate than that which goes before. As this method of interpolation is different from that now in use, it is obvious that the Gregorian calendar must be corrected after a certain period of years. The correction, however, will be inconsiderable for many ages, as it will amount only to a day and a half, which is to be suppressed in the space of 5000 years.

CALENDAR, *reformed* or *corrected*, that which, setting aside golden numbers, epacts, and dominical letters, determines the equinox, with the paschal full moon, and the moveable feasts depending thereon, by astronomical computations, according to the Rudolphine table. This calendar was introduced among the Protestant States of Germany in the year 1700, when 11 days were, at once, thrown out of the month of February, by which means the corrected style agrees with the Gregorian.

CALENDAR, *French*, *new*, is a quite new form of calendar, that commenced in France, on the 22d of September, 1792.

The year, in this calendar, commences at midnight, the beginning of that day in which falls the true autumnal equinox for the observatory of Paris. The year is divided into 12 equal months, of 30 days each; after which 5 supplementary days are added, to complete the 365 days of the ordinary year; these 5 days do not belong to any month. Each month is divided into three decades of 10 days each; distinguished by 1st, 2d, and 3d decade. All these are named according to the order of the natural numbers, *viz.* the 1st, 2d, 3d, &c. month, or day of the decade, or of the supplementary days. The years which receive an intercalary day, when the position of the equinox requires it, which we call embolismic or bissextile, they call olympic; and the period of four years, ending with an olympic year, is called an olympiade; the intercalary day being placed after the ordinary five supplementary days, and making the last day of the olympic year. Each day, from midnignt to midnight, is divided into 10 parts, each part into 10 others, and so on to the least measurable portion of time.

In this calendar too the months and days of them have new names. The first three months of the year, of which the autumn is composed, take their etymology; the first from the vintage, which takes place from September to October, and is called Vendemaire; the second, Brumaire, from the mists and low fogs, which show, as it were, the transudation of nature from October to November; the third, Frimaire, from the cold, sometimes dry and sometimes moist, which is felt from November to December. The three winter months take their etymology; the first, Nivose, from the snow which whitens the earth from December to January; the second, Pluviose, from the rains which usually fall in greater abundance from January to February; the third, Ventose, from the wind which dries the earth from February to March. The three spring months take their etymology; the first, Germinal, from the fermentation and developement of the sap from March to April; the second, Floreal, from the blowing of the flowers from April to May; the third, Prairial, from the smiling fecundity of the meadow crops from May to June. Lastly, the three summer months take their etymology; the first, Messidor, from the appearance of the waving ears of corn and the golden harvests which cover the fields from June to July; the second, Thermidor, from the heat, at once solar and terrestrial, which inflames the air from July to August; the third, Fructidor, from the fruits gilt and ripened by the sun from August to September. Thus, the whole twelve months are,

AUTUMN.	SPRING.
Vendemaire	Germinal
Brumaire	Floreal
Frimaire	Prarial
WINTER.	**SUMMER.**
Nivose	Messidor
Pluviose	Thermidor
Ventose	Fructidor.

From these denominations it follows, that by the mere pronunciation of the name of the month, every one readily perceives three things, and all their relations, *viz.* the kind of season, the temperature, and the state of vegetation: for instance, in the word Germinal, his imagination will easily conceive, by the termination of the word, that the spring commences; by the construction of the word, that the elementary agents are busied; and by the signification of the word, that the buds unfold themselves.

As to the names of the days of the week, or decade of ten days each, which they have adopted instead of seven, as these bear the stamp of judicial astrology and heathen mythology, they are simply called from the first ten numbers: thus,

Primi	Sextidi
Duodi	Septidi
Tridi	Octidi
Quartidi	Nonidi
Quintidi	Decadi

In the almanac, or annual calendar, instead of the multitude of saints, one for each day in the year, as in the Popish calendars, they annex to every day the name of some animal, or utensil, or work, or fruit, or flower, or vegetable, &c. appropriate and most proper to the times.

Calendar, *astronomical*, an instrument engraved upon copper-plates, printed on paper, and pasted on board, with a brass slider which carries a hair, and shows by inspection, the sun's meridian altitude, right ascension, declination, rising, setting, amplitude, &c. to a greater exactness than our common globes will shew.

Calendar *of prisoners*, a list of the names of the prisoners in the custody of the respective sheriffs of counties.

CALENDARIUM *floræ*, among botanists, a calendar, containing an exact register of the respective times, in which the plants of any given province, or climate, germinate, expand, and shed their leaves and flowers, and ripen and disperse seeds.

CALENDER, a machine used in manufactories, to press certain woollen and silken stuffs and linens, to make them even, smooth and glossy, or to give them waves, or water them, as may be seen in mohairs and tabbies. This instrument is composed of two thick cylinders, or rollers, of very hard and polished wood, round which the stuffs to be calendered are wound: these rollers are placed crossways between two very thick boards, the lower serving as a fixed base, and the upper moveable, by means of a thick screw, with a rope fastened to a spindle, which makes its axis: the uppermost board is loaded with large stones cemented together, weighing 20,000*lbs.* or more. It is this weight that gives the polish, and makes the waves on the stuffs about the rollers, by means of a shallow indenture or engraving cut in it.

CALENDS, a Roman chronology, the first day of each month, so called from the Greek *καλειν*, to proclaim; it being customary on those days to proclaim the number of holy-days in each month. The calends were reckoned backwards, or in a retrograde order: thus the first of May begins the calends of May; the 30th of April was the second of the calends of May; the 29th, the 3d, &c. to the 13th, where the ides commence; which are also numbered in a retrograde order to the 5th, where the nones begin; and these are numbered after the same manner to the first of the month, which is the calends of April.

CALENDULA, in botany, the *marigold*, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ. Corymbiferæ, Jussieu: receptacle naked, flat; calyx many-leaved, nearly equal; seeds of the disk membranaceous. According to Martyn there are fourteen species, but Gmelin enumerates twenty-five. The flowers are commonly solitary and terminating. Many of the species are herbaceous, and natives of the Cape of Good Hope. Of the garden marigold there are the following varieties, *viz.* The single. The common double flowering. The largest very double flowering. The double lemon-coloured, and the greater and smaller childing marigold.

CALENTES, in logic, a sort of syllogism in the fourth, commonly called galenical, figure, wherein the major proposition is universal and affirmative; and the second or minor, as well as the conclusion, universal and negative.

This is intimated by the letters it is composed of, where the A signifies an universal affirmative, and the two E's as many universal negatives. *Ex. gr.*

CA. Every affliction in this world is only for a time.
lEn. No affliction, which is only for a time, ought to disturb us.
tEs. No affliction ought to disturb us, which happens in this world.

The Aristotelians, not allowing the fourth figure of syllogisms, turn this word into CElAntEs, and make it only an indirect mood of the first figure.

CALENTURE, in medicine, a feverish disorder incident to sailors in hot climates; the principal symptom of which is, their imagining the sea to be green fields: hence, attempting to walk abroad in these imaginary places of delight, they are frequently lost.

CALIBER, or CALIPER, properly denotes the diameter of any body; thus we say, two columns of the same caliber, the caliber of the bore of a gun, the caliber of a bullet, &c.

CALIBER, *compasses*, the name of an instrument, made either of wood, iron, steel, or brass: that used for measuring bullets consists of two branches bending inwards, with a tongue fixed to one of them, and the other graduated in such a manner, that if the bullet be compressed by the ends of the two branches, and the tongue be applied to the graduated branch, it will shew the weight of the bullet.

On these rulers are a variety of scales, tables, proportions, &c. which are reckoned very useful to gunners. On the best caliber compasses we have the measure of convex and concave diameters in inches. 2. The weight of iron shot from given diameters. 3. The weight of iron shot from given gun bores. 4. The degrees of a semi-circle. 5. The proportion of troy and avoirdupois weight. 6. The proportion of English and French feet and pounds. 7. Factors used in circular and spherical figures. 8. Tables of the specific gravities and weights of bodies. 9. Tables of the quantity of powder necessary for proof and service of brass and iron guns. 10. Rules for computing the number of shot or shells in a finished pile. 11. Rules concerning the fall of heavy bodies. 12. Rules for raising water and for firing artillery and mortars. 13. A line of inches. 14. Logarithmic scales of numbers, sines, versed sines, and tangents. 15. A sectoral line of equal parts, or the line of lines. 16. A sectoral line of planes and superficies. 17. A sectoral line of solids.

CALIBER also signifies an instrument used by carpenters, joiners, and bricklayers, to see whether their work be well squared.

CALICO, a species of cloth of cotton thread, manufactured formerly in the East Indies; but now we have in this country established manufactories which equal those in the East. It is said that in this business, and in the printing of calicoes, there are 150,000 persons employed. Cotton, in its raw state, is imported into this country, but calicoes are prohibited under the severest penalties.

CALICO-*printing*: the art of cloth-printing or calico-printing: in other words, of dyeing in certain colours particular spots of the cloth, or figures impressed on it, while the ground shall be of a different colour or entirely white, affords perhaps the most direct and obvious illustration of the application of these principles. The mordant which is principally used in this process is the acetate of argil. It is prepared by dissolving 3*lbs.* of alum and 1*lb.* of acetate of lead in 8*lbs.* of warm water. An exchange of the principles of these salts takes place: the sulphuric acid of the alum combines with the oxide of lead, and the compound thus formed being insoluble is precipitated, the acetic acid remains united with the argil of the alum in solution. There are added at the same time two ounces of the potash of commerce, and two ounces of chalk; the principal use of which appears to be, to neutralize the excess of acid that might act on the colouring matter, and alter its shade.

The superiority of this acetate of argil as a mordant to the cheaper sulphate of argil of alum arises principally from two circumstances,—from the affinity between its principles being weaker, in consequence of which the argil more easily separates from the acid, and unites with the cloth and the colouring matter: and 2dly, from the acetic acid disengaged in the process not acting with the same force on the colouring matter as the sulphuric acid would do. The acetate being also very soluble, and having little tendency to crystallize, can be more equally mixed and applied. The discovery of this mordant, so essential in the art of calico-printing, was altogether accidental, or rather empirical. The recipes of the calico-printers were at one time very complicated: different articles were from time to time omitted or changed, until at length the simple mixture of alum and acetate of lead was found to answer as a mordant, equally with compositions more complicated; and even after its discovery, its operation for a time was far from being understood by the artist. The mordant thus prepared is thickened with gum or starch; or in this country, within these few years, with the mucilage prepared from lichens scalded and boiled with a little potash. It is applied by wooden blocks, or stamps, to the parts of the cloth on which the figures cut in the stamp are designed to be impressed, or by a pencil, if more delicate lines are to be traced. The cloth is afterwards dried thoroughly, is washed in warm water to remove the mucilage and the superfluous mordant, and is then dipped in the dye colour, supposed to be an infusion of madder; the whole is dyed, but the parts which have been impregnated with the mordant receive a brighter colour than the part which has not: the colour too of the former is permanent, while that of the latter is fugitive. It is discharged by subsequent boiling with substances having a weak attraction to the colouring matter, principally with bran, and by exposure on the field, repeating these alternately. The ground of the cloth is thus at length rendered white, while the colours of the parts on which the mordant has been impressed, representing of course the design on the stamp, remain with little or no alteration.

Sometimes, after the whole cloth has been permanently dyed, by having been impregnated with the mordant, the colour is discharged from certain parts, by stamping these with a weak acid liquor: after being washed, these are again stamped, either with the same or with a different mordant, and dyed with different materials; and thus the most difficult kind of cloth printing is effected, where the ground is coloured, and at the same time impressed with a design in different colours. By combining these methods too, and by dexterously applying to different parts of the cloth different mordants, by stamps adapted to each other, so as to form a regular design, different colours are impressed, either on a white or coloured ground.

CALK, a genus of minerals, which is divided into twenty species. 1. Rock-milk, denominated, by Werner, berg-milch. 2. Chalk, denominated kreide, or creta alba: external characters: colour white: occurs massive disseminated, and as a crust covering flint; fragments indeterminately angular, blunt edged; opaque; soils; writes; easily frangible; specific gravity according to Kirwan 2.3, but bishop Watson takes it at 2.6; various specimens will no doubt account for this and other differences of the same kind. It effervesces strongly with acids, and is found to consist almost entirely of lime and carbonic acid. It constitutes a peculiar kind of formation; contains numerous flinty petrifactions; and is even remarkable for being the most general repository of flint. It is found chiefly on sea-coasts, as at Calais and Dover, and several of the Danish islands in the Baltic, as Rugen and Zealand: it occurs also in Poland; and several great tracts of country in the south of England are composed of it. In some parts of Kent a chalk pit is no contemptible estate, producing from one to five hundred per annum and upwards. In the manufactures it is used for polishing and cleansing metals, glass, &c. and when burnt into lime, it is of great importance in building. 3. Lime-stone; denominated kalkstein, which is divided into four subspecies, *viz.* compact-limestone; foliated lime-stone; fibrous limestone; peastone. The first is of a greyish colour, composed chiefly of lime and carbonic acid, with small portions of iron, alumina, and inflammable matter; and is found in the sandstone and coal formations of Saxony, Bohemia, Bavaria, Sweden, France, England, Scotland, &c. It is used as mortar, when deprived of its carbonic acid, and in this state also it is employed in the manufacture of soap, in tanning, and other processes. It is likewise used as a flux, in the reduction of such ores as are difficultly fusible, by means of its silica and alumina. The Florentine arborescent marble, a variety of this species, is, according to Jameson, very valuable for the purposes of ornament; and the limestone of Pappenheim serves for paving, grave-stones, and sometimes for polishing plate-glass. Of the foliated limestone, the granular is the most important variety: this is purer than common limestone, is found peculiarly beautiful at Carrava in Italy, where it is quarried, and from thence distributed over Europe, for the purposes of statuary. The white marble of Paros has been long celebrated for its fitness for sculpture, and other useful purposes. Calc-spar is another variety, of which many of its most beautiful and rare crystallizations are found in Derbyshire, in Ireland, and many parts of the continent. The fibrous limestone occurs only in small veins: the satin spar of Derbyshire belongs to this kind. The calc-sinter is a variety of the fibrous limestone, of which there is a striking instance in the grotto of Anteparos: when it occurs in large masses, it is used by the statuary for many of the purposes of marble. The alabaster of the ancients is calk-sinter. It was brought from Arabia in considerable quantities, and used principally for the drapery of marble statues. Peastone is found in great masses in the vicinity of the hot springs at Carlesbad in Bohemia. Particles of sand appear to be raised in the water by means of air-bubbles, and become covered with calcareous earth, which is deposited around them in lamellar concretions of the size of a pea; hence the name. 4. Schaum earth, or foaming earth, found in the neighbourhood of Gera, in the forest of Thuringia; also in the north of Ireland: it is called by Werner Schaumerde, and is thought by him to be nearly allied to slate spar, which is another species, composed almost entirely of carbonate of lime. The remaining species we pass over as of less interest.

CALKING, any kind of military drawing upon paper, &c. It is performed by covering the backside of the drawing with a black or red colour, and fixing the side so covered upon a piece of paper, waxed plate, &c. This being done, every line in the drawing is to be traced over with a point, by which means all the outlines will be transferred to the paper or plate, &c.

CALL, among fowlers, means the noise or cry of a bird, especially to its young, or its mate in coupling time.

The call of a bird, says the honourable Daines Barrington, is that sound which it is able to make when about a month old: it is, he says, in most instances, a repetition of one and the same note, is retained by the bird as long as it lives, and is common, generally, both to the cock and hen. One method of catching partridges is, by the natural call of a hen trained for the purpose, which drawing the cocks to her, gives opportunity for entangling them in a net.

Calls are also a sort of artificial pipes, made to catch several sorts of birds, by imitating their notes. Different birds require different sorts of artificial calls; but they are most of them composed of a pipe or reed, with a little leathern bag or purse, somewhat in form of a bellows, which, by the motion given thereto, yields a noise like that of the species of bird to be taken. The call for partridges is formed like a boat, bored through, and fitted with a pipe or swan's quill, &c. to be blown with the mouth, to make the noise of the cock partridge, which is very different from the call of the hen. Calls for quails, &c. are made of a leathern purse, in shape like a pear, stuffed with horse hair, and fitted at the end with the bone of a cat's, hare's, or coney's leg, formed like a flageolet: they are played by squeezing the purse in the palm of the hand, at the same time striking on the flageolet part with the thumb, to counterfeit the call of the hen quail.

Call, in sea-language, a sort of whistle or pipe, of silver or brass, used by the boatswain and his mates to summon the sailors to their duty, and direct them in their several employments. It is sounded to various strains, adapted to the different exercises, as hoisting, heaving, &c. and the piping of it serves the same purposes among sailors as the beat of the drum among soldiers.

Call *of the house*, in a parliamentary sense, has been sometimes practised, to discover whether there be any in the house not returned by the clerk of the crown; but more frequently to discover what members are absent without leave of the house, or just cause. In the former case, the names of the members being called over, every person answers to his name, and departs out of the house, in the order wherein he is called. In the latter, each person stands up uncovered at the mention of his name.

CALLA, in botany, a genus of the Gynandria Polyandria class and order. Natural order of Piperitæ. Aroideæ, Jussieu. Essential character: spathe flat; spadix covered with floscules; calyx and petals none; berries many-seeded. There are four species, of which C. æthiopica, Ethiopian calla, is a plant which grows naturally at the Cape, but has long been an inhabitant in the English gardens.

CALLICARPA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Dumosæ. Vitices, Jussieu. Essential character: calyx four cleft; corolla four cleft; berry four seeded. There are seven species, of which C. Americana, American callicarpa, is a shrub from four to six feet in height; calyx cylindric; corolla funnel form; germ superior. Native of North America; also of Cochinchina, which shows the impropriety of the trivial name.

CALLIGONUM, in botany, a genus of the Dodecandria Tetragynia class and order. Natural order of Holoraceæ. Polygoneæ, Jussieu. Essential character: calyx five-parted; corolla none; filaments about sixteen, slightly united at the base; germ superior, four-sided; nut one-celled, with a crust that has several wings, or many bristles. There are three species. The first is a native of America, the second of Egypt and Barbary, and the third of Cochinchina.

CALLIONYMUS, in natural history, dragonet, a genus of fishes of the order

Jugulares. Generic character: eyes vertical, approximated; gill-covers shut, with a small aperture on each side the neck: gill-membrane six-rayed; body naked; ventral fins very remote. There are seven species, of which we shall notice C. lyra, or gemmeous dragonet, so called from the peculiar form of its first dorsal fin, the shape of which bears a fancied resemblance to that of an ancient lyre or harp. It is a native of the Mediterranean and Northern Seas, and measures about 12 inches in length. Like most other fishes, the dragonet varies slightly in colour in different individuals, and at different seasons of the year. Mr. Pennant describes the pupils of the eyes to be of a rich sapphirine blue; the irides fine fiery carbuncle; the pectoral fins light brown; the side-line straight; the colours of the fish yellow, blue, and white, making a beautiful appearance when fresh taken. The blue is of inexpressible splendor; the richest cærulean, glowing with a gemmeous brilliancy; the throat black. C. dracunculus, or sordid dragonet, is nearly allied to the preceding; a native of the Mediterranean and Northern Seas; both are numbered with the edible fishes, and are supposed to live principally on worms and sea-insects.

CALLISIA, in botany, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Junci, Jussieu. Essential character: calyx three-leaved; petals three; anthers double; capsule two-celled. There is but one species, *viz.* C. repens, creeping callisia. It is a native of the West Indies, in low, moist, shady places. Here it flowers in June and July.

CALLITRICHE, in botany, a genus of the Monandria Digynia. Natural order of Holoraceæ. Naiades, Jussieu. Essential character: calyx none; petals two; capsule two celled, four-seeded. There are two species, *viz.* C. verna, vernal star-wort, or star-headed water-chickweed; and C. autumnalis, autumnal star-wort. These are very common in ditches and standing water, and are sometimes so thickly matted together, that one may walk upon them without sinking.

CALLUS, or Callosity, in a general sense, any cutaneous, corneous, or osseous hardness, whether natural or preternatural: but most frequently it means the callus generated about the edges of a fracture, provided by nature to preserve the fractured bones, or divided parts, in the situation in which they are replaced by the surgeon.

CALM, in sea-language, is when there is no wind stirring.

That tract of sea to the northward of the equator, between 4° and 10° of latitude, lying between the meridians of Cape Verd and of the easternmost island of that name, seems to be a place condemned to perpetual calms, the winds that do exist being only some sudden uncertain gusts, of very small continuance, and less extent. The Atlantic Ocean, near the equator, is very much subject, nay, always attended with these calms.

A long calm is often more fatal to a ship than the severest tempest, for, if tight and in good condition, she may sustain the latter without much injury, whereas, in a long calm, the provision and water may be entirely consumed, without any opportunity of obtaining a fresh supply. Calms are never so great on the ocean as on the Mediterranean, because the flowing and ebbing of the former keep the water in continual agitation, even where there is no wind; whereas, there being no tides in the latter, the calm is sometimes so dead, that the surface of the water is as clear as a loooking-glass; but such calms are generally the presages of an approaching storm. On the coast about Smyrna, a long calm is said to be prognostic of an earthquake.

CALODENDRUM, in botany, a genus of the Pentandria Monogynia class and order. Essential character: corolla spreading, five-petalled; nectary five-leaved; capsule five-celled. There is but one species, *viz.* C. capense, which is an evergreen. Flowers in terminating panicles, or opposite one flowered peduncles. Native of the Cape.

CALOMEL, in the materia medica, a name given to mercurius dulcis. See Mercury.

CALOPHYLLUM, in botany, a genus of the Polyandria Monogynia class and order. Essential character: calyx four-leaved, coloured; corolla four-petalled; drupe globular. There are two species; *viz.* C. inophyllum and C. calaba, both natives of the East and West Indies. They are both lofty trees, ninety feet in height, and twelve in thickness: leaves like those of the water lily. In Java they plant these trees about their houses, for the elegance of the shade and the sweetness of the flowers.

CALOPUS, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ filiform; four feelers, the fore ones clavate, the hind ones filiform; thorax gibbous; shells linear. There are three species; *viz.* the serraticornis, hispicornis, and pygmæus.

CALORIC, in chemistry, a word used to signify that substance or property, by which the phenomena of heat are produced. Concerning the nature of caloric there are two opinions, which have divided philosophers ever since they turned their attention to the subject. Some suppose, that caloric, like gravity, is merely a property of matter, and that it consists in a peculiar vibration of its particles; others, on the contrary, think that it is a distinct substance. Each of these opinions has been supported by the greatest philosophers; and till lately the obscurity of the subject has been such, that both sides have been able to produce exceedingly plausible and forcible arguments. The recent improvements, however, in this branch of chemistry, have gradually rendered the latter opinion much more probable than the former: and a recent discovery made by Dr. Herschell, has at last nearly put an end to the dispute, by demonstrating that caloric is not a property, but a peculiar substance; or at least that we have the same reason for considering it to be a substance, as we have for believing that light is material. Dr. Herschell had been employed in making observations on the sun, by means of telescopes. To prevent the inconvenience arising from the heat, be used coloured glasses: but these glasses, when they were deep enough coloured to intercept the light, very soon cracked, and broke in pieces. This circumstance induced him to examine the heating power of the different coloured rays. He made each of them in its turn fall upon the bulb of a thermometer, near which two other thermometers were placed, to serve as a standard. The number of degrees which the thermometer exposed to the coloured ray rose above the other two thermometers indicated the heating power of that ray. He found that the most refrangible rays have the least heating power, and that the heating power gradually increases as the refrangibility diminishes. The violet ray therefore has the smallest heating power, and the red ray the greatest. Dr. Herschel found, that the heating power of the violet, green, and red rays, are to each other as the following numbers:

Violet . . . . = 16
Green . . . . = 22.4
Red . . . . . = 55.

It struck Dr. Herschel as remarkable, that the illuminating power and the heating power of the rays follow such different laws. The first exists in greatest perfection in the middle of the spectrum, and diminishes as we approach either extremity; but the second increases constantly from the violet end, and is greatest at the red end. This led him to suspect, that perhaps the heating power does not stop at the end of the visible spectrum, but is continued beyond it. He placed the thermometer completely beyond the boundary of the red ray, but still in the line of the spectrum, and it rose still higher than it had done when exposed to the red ray. On shifting the thermometer still farther, it continued to rise, and the rise did not reach its maximum till the thermometer was half an inch beyond the utmost extremity of the red ray. When shifted still farther, it sunk a little, but the power of heating was sensible at the distance of 1½ inch from the red ray. These important experiments have been lately repeated and fully confirmed by Sir Henry Englefield, in the presence of some very good judges.

From these it follows, that there are rays emitted from the sun which produce heat, but have not the power of illuminating; and that these are the rays which produce the greatest quantity of heat. Consequently caloric is emitted from the sun in rays, and the rays of caloric are not the same with the rays of light. On examining the other extremity of the spectrum, Dr. Herschel ascertained that no rays of caloric can be traced beyond the violet ray. He had found, however, that all the coloured rays of the spectrum have the power of heating; it may be questioned, therefore, whether there be any rays which do not warm. The coloured rays must either have the property of exciting heat as rays of light, or they must derive that property from a mixture of rays of caloric. If the first of these suppositions were true, light ought to excite heat in all cases; but it has been long known to philosophers, that the light of the moon does not produce the least sensible heat, even when concentrated so strongly as to surpass in point of illumination the brightest candles or lamps, and yet these produce a very sensible heat. Here then are rays of light which do not produce heat: rays, too, composed of all the seven prismatic coloured rays. We must conclude from this well known fact, that rays of light do not excite heat; and consequently that the coloured rays from the sun and combustible bodies, since they excite heat, must consist of a mixture of rays of light and rays of caloric. That this is the case was demonstrated long ago by Dr. Hooke, and afterwards by Scheele, who separated the two species from each other by a very simple method. If a glass mirror be held before a fire, it reflects the rays of light, but not the rays of caloric; a metallic mirror, on the other hand, reflects both. The glass mirror becomes hot; the metallic mirror does not alter its temperature. If a plate of glass be suddenly interposed between a glowing fire and the face, it intercepts completely the warming power of the fire, without causing any sensible diminution of its brilliancy; consequently it intercepts the rays of caloric, but allows the rays of light to pass. If the glass be allowed to remain in its station till its temperature has reached its maximum, in that situation it ceases to intercept the rays of caloric, but allows them to pass as freely as the rays of light. This curious fact, which shews us that glass only intercepts the rays of caloric till it be saturated with them, was discovered by Dr. Robinson. These facts are sufficient to convince us, that the rays of light and of caloric are different, and that the coloured rays derive their heating power from the rays of caloric which they contain. Thus it appears that solar light is composed of three sets of rays, the colorific, the calorific, and the deoxidizing. The rays of caloric are refracted by transparent bodies just as the rays of light. We see, too, that, like the rays of light, they differ in their refrangibility; that some of them are as refrangible as the violet rays; but that the greater number of them are less refrangible than the red rays. Whether they are transmitted through all transparent bodies has not been ascertained; neither has the difference of their refraction in different mediums been examined. We are certain, however, that they are transmitted and refracted by all transparent bodies which have been employed as burning-glasses. Dr. Herschell has also proved, by experiment, that it is not only the caloric emitted by the sun which is refrangible, but likewise the rays emitted by common fires, by candles, by hot iron, and even by hot water. The rays of caloric are reflected by polished surfaces in the same manner as the rays of light. This was lately proved by Herschel: but it had been demonstrated long before by Scheele, who had even ascertained that the angle of their reflection is equal to the angle of their incidence. M. Pictet also had made a set of very ingenious experiments on this subject, about the year 1790, which led to the same conclusion.

All the phenomena concur to shew, that the rays of caloric move with a very considerable velocity, though the rate has not been ascertained in a satisfactory manner. Some experiments of Mr. Leslie would lead us to conclude, that they move with the same velocity as sound. The following experiment of M. Pictet indicates a very considerable velocity. He placed two concave mirrors at the distance of 69 feet from each other; the one of tin, the other of plaster gilt, and 18 inches in diameter. Into the focus of this last mirror he put an air thermometer, and a hot bullet of iron into that of the other. A few inches from the face of the tin mirror there was placed a thick screen, which was removed as soon as the bullet reached the focus. The thermometer rose the instant the screen was removed without any perceptible interval, consequently the time which caloric takes in moving 69 feet is too minute to be measured. The velocity of caloric, if it is equal to that of light, would prove that its particles must be equally minute. Therefore, neither the addition of caloric, nor its abstraction, can sensibly affect the weight of bodies.

Caloric agrees with light in another property no less peculiar: its particles are never found cohering together in masses; and whenever they are forcibly accumulated, they fly off in all directions, and separate from each other with inconceivable rapidity. This property necessarily supposes the existence of a mutual repulsion between the particles of caloric. Thus it appears that caloric and light resemble each other in a great number of properties. Both are emitted from the sun in rays, with the velocity of 200,000 miles in a second; both of them are refracted by transparent bodies, and reflected by polished surfaces; both of them consist of particles which mutually repel each other, and which produced no sensible effect upon the weight of other bodies. They differ, however, in this particular: light produces in us the sensation of vision; caloric, on the contrary, the sensation of heat. Upon the whole, we are authorized, by the above statement of facts, to conclude, that the solar light is composed of three distinct substances, in some measure separable by the prism, on account of the difference of their refrangibility. The colorific rays are the least refrangible, the deoxidizing rays are most refrangible, and the calorific rays possess a mean degree of refrangibility. Hence the rays in the middle of the spectrum have the greatest illuminating power; those beyond the red end the greatest heating power; and those beyond the violet end the greatest deoxidizing power: and the heating power on the one hand, and the deoxidizing power on the other, gradually increase, as we approach that end of the spectrum where the maximum of each is concentrated. These different bodies resemble each other in so many particulars, that the same reasoning respecting refrangibility, reflexibility, &c. may be applied to all; but they produce different effects upon those bodies on which they act. Little progress has yet been made in the investigation of these effects; but we may look forward to this subject as likely to correct many vague and unmeaning opinions, which are at present in vogue among chemists.

From this account of the nature of caloric we learn, that it is capable, like light, of radiating in all directions from the surfaces of bodies; and that when thus radiated, it moves with a very considerable velocity. Like light, too, it is liable to be absorbed when it impinges against the surfaces of bodies. When it has thus entered, it is capable of making its way through all bodies; but its motion in this case is comparatively slow. Heat then moves at two very different rates. 1. It escapes from the surfaces of bodies. 2. It is conducted, or passes through bodies.

When bodies artificially heated are exposed to the open air, they immediately begin to emit heat, and continue to do so till they become nearly of the temperature of the surrounding atmosphere. That different substances, when placed in this situation, cool down with very different degrees of rapidity, could not have escaped the most careless observer; but the influence of the surface of the hot body in accelerating or retarding the cooling process, was not suspected till lately. For this curious and important part of the doctrine of heat, we are indebted to the sagacity of Mr. Leslie, who has already brought it to a great degree of perfection. To whose work we refer the philosophical reader for much useful and highly interesting matter.

Although caloric is incapable of moving in rays through solid bodies, yet it is well known that all bodies whatever are pervious to it. Through solids, then, it must pass in a different manner. In general, its passage through them is remarkably slow. Thus, if we put the end of a bar of iron, 20 inches long, into a common fire, while a thermometer is attached to the other extremity, four minutes elapse before the thermometer begins to ascend, and 15 minutes by the time it has risen 15°. In this case, the caloric takes four minutes to pass through a bar of iron 20 inches in length. When caloric passes in this slow manner, it is said to be conducted through bodies. It is in this manner alone that it passes through non-elastic bodies; and though it often moves by radiation through elastic media, yet we shall find that it is capable of being conducted through them likewise. As the velocity of caloric, when it is conducted through bodies, is greatly retarded, it is clear that it does not move through them without restraint. It must be detained for some time by the particles of the conducting body, and consequently must be attracted by them.—Hence it follows, that there is an affinity or attraction between caloric and every conductor. It is in consequence of this affinity that it is conducted through the body.

Bodies then conduct caloric in consequence of their affinity for it, and the property which they have of combining indefinitely with additional doses of it. Hence the reason of the slowness of the process, or, which is the same thing, of the long time necessary to heat or to cool a body. The process consists in an almost infinite number of repeated compositions and decompositions. We see, too, that when heat is applied to one extremity of a body, the temperature of the strata of that body must diminish equably, according to their distance from the source of heat. Every person must have observed that this is always the case. If, for instance, we pass our hand along an iron rod, one end of which is held in the fire, we shall perceive its temperature gradually diminishing from the end in the fire, which is hottest, to the other extremity, which is coldest. Hence the measure of the heat transmitted must always be proportional to the excess of temperature communicated to that side of the conductor which is nearest the source of heat. The passage of caloric through a body by its conducting power must have a limit; and that limit depends upon the number of doses of caloric, with which the stratum of the body nearest the source of heat is capable of combining. If the length of a body be so great, that the strata of which it is composed exceed the number of doses of caloric with which a stratum is capable of combining, it is clear that caloric cannot possibly be conducted through the body; that is to say, the strata farthest distant from the source of heat cannot receive any increase of temperature. This limit depends, in all cases, upon the quantity of caloric with which a body is capable of combining before it changes its state. All bodies, as far as we know at present, are capable of combining indefinitely with caloric; but the greater number, after the addition of a certain number of doses, change their state. Thus ice, after combining with a certain quantity of caloric, is changed into water, which is converted in its turn to steam, by the addition of more caloric. Metals, also, when heated to a certain degree, melt, are volatilized, and oxydated; wood and most other combustibles catch fire, and are dissipated. As to the rate at which bodies conduct caloric, that depends upon the specific nature of each particular body, the best conductors conducting most rapidly, and to the greatest distance. When bodies are arranged into sets, we may lay it down as a general rule, that the densest set conduct at the greatest rate. Thus the metals conduct at a greater rate than any other bodies. But in considering the individuals of a set, it is not always the densest that conducts best: as bodies conduct caloric in consequence of their affinity for it, and as all bodies have an affinity for caloric, it follows as a consequence, that all bodies must be conductors, unless their conducting power be counteracted by some other property.

All solids are conductors; because all solids are capable of combining with various doses of caloric before they change their state. This is the case in a very remarkable degree with all earthy and stony bodies: it is the case also with metals, with vegetables, and with animal matters. This, however, must be understood with certain limitations. All bodies are indeed conductors; but they are not conductors in all situations. Most solids are conductors at the common temperature of the atmosphere; but when heated to the temperature at which they change their state, they are no longer conductors. Thus, at the temperature of 60°, sulphur is a conductor; but when heated to 214°, or the point at which it melts or is volatilized, it is no longer a conductor. In the same manner ice conducts caloric when at the temperature of 20°, or any other degree below the freezing point; but ice at 32° is not a conductor, because the addition of caloric causes it to change its state.

With respect to liquids and gaseous bodies, it would appear at first sight that they also are all conductors; for they can be heated as well as solids, and heated too considerably without sensibly changing their state. But fluids differ from solids in one essential particular: their particles are at full liberty to move among themelves, and they obey the smallest impulse; while the particles of solids, from the very nature of these bodies, are fixed and stationary. One of the changes which caloric produces on bodies is expansion, or increase of bulk; and this increase is attended with a proportional diminution of specific gravity. Therefore, whenever caloric combines with a stratum of particles, the whole stratum becomes specifically lighter than the other particles. This produces no change of situation in solids; but in fluids, if the heated stratum happens to be below the other strata, it is pressed upwards by them, and being at liberty to move, it changes its place, and is buoyed up to the surface of the fluid. In fluids, then, it makes a very great difference to what part of the body the source of heat is applied. If it be applied to the highest stratum of all, or to the surface of the liquid, the caloric can only make its way downwards, as through solids, by the conducting power of the fluid; but if it be applied to the lowest stratum, it makes its way upwards, independently of that conducting power, in consequence of the fluidity of the body, and the expansion of the heated particles. The lowest stratum, as soon as it combines with a dose of caloric, becomes specifically lighter and ascends. New particles approach the source of heat, combine with caloric in their turn, and are displaced. In this manner all the particles come, one after another, to the source of heat; of course the whole of them are heated in a very short time, and the caloric is carried almost at once to much greater distances in fluids than in any solid whatever. Fluids, therefore, have the property of carrying or transporting caloric; in consequence of which they acquire heat independently altogether of any conducting power.

If we take a bar of iron and a piece of stone of equal dimensions, and putting one end of each into the fire, apply either thermometers or our hands to the other, we shall find the extremity of the iron sensibly hot long before that of the stone. Caloric, therefore, is not conducted through all bodies with the same celerity and ease. Those that allow it to pass with facility are called good conductors; those through which it passes with difficulty are called bad conductors.

Metals are the best conductors of caloric of all the solids hitherto tried. The conducting powers of all, however, are not equal. Dr. Ingenhousz procured cylinders of several metals exactly of the same size, and having coated them with wax, he plunged their ends into hot water, and judged of the conducting power of each by the length of wax-coating melted. From these experiments he concluded, that the conducting power of the metals which he examined were in the following order:

Silver,
Gold,
Copper, } nearly equal
Tin, }
Platinum, }
Iron, } much inferior to the others.
Steel, }
Lead, }

Next to metals, stones seem to be the best conductors; but this property varies considerably in different stones. Bricks are much worse conductors than most stones.

Glass seems not to differ much from stones in its conducting power: like them, it is a bad conductor. This is the reason that it is so apt to crack on being suddenly heated or cooled. One part of it, receiving or parting with its caloric before the rest, expands or contracts, and destroys the cohesion. Next to these some dried woods.

Charcoal is also a bad conductor; according to the experiments of Morveau, its conducting power is to that of fine sand :: 2 : 3. Feathers, silk, wool, and hair, are still worse conductors than any of the substances yet mentioned. This is the reason that they answer well for articles of clothing. They do not allow the heat of the body to be carried off by the cold external air. Count Rumford has made a very ingenious set of experiments on the conducting power of these substances. He ascertained that their conducting power is inversely as the fineness of their texture.

Having in the preceding sections considered the nature of caloric, the manner which it moves through other bodies and distributes itself among them, let us now examine, in the next place, the effects which it produces on other bodies, either by entering into them or separating from them. The effects which caloric produces on bodies may be arranged under three heads; namely, changes in bulk; changes in state; and changes in combination.

It may be laid down as a general rule, to which there is no known exception, that every addition or abstraction of caloric makes a corresponding change in the bulk of the body which has been subjected to this alteration in the quantity of its heat.

In general the addition of heat increases the bulk of a body, and the abstraction of it diminishes its bulk; but this is not uniformly the case, though the exceptions are not numerous.

Indeed, these exceptions are not only confined to a very small number of bodies, but even in them they do not hold, except at certain particular temperatures; while at all other temperatures these bodies are increased in bulk when heated, and diminished in bulk by being cooled. We may therefore consider expansion as one of the most general effects of heat. It is certainly one of the most important, as it has furnished us with the means of measuring all the others. See Pyrometer.

Though all bodies are expanded by heat, and contracted by cold, and this expansion in the same body is always proportional to some function of the quantity of caloric added or abstracted, yet the absolute expansion or contraction has been found to differ exceedingly in different bodies. In general, the expansion of gaseous bodies is greatest of all; that of liquids is much smaller; and that of solids the smallest of all. Thus, 100 cubic inches of atmospheric air, by being heated from the temperature of 32° to that of 212°, are increased to 137.5 cubic inches: while the same augmentation of temperature only makes 100 cubic inches of water assume the bulk of 104.5 cubic inches: and 100 cubic inches of iron, when heated from 32° to 212°, assume a bulk scarcely exceeding 100.1 cubic inches. From this example, we see that the expansion of air is more than eight times greater than that of water; and the expansion of water about 45 times greater than that of iron. See Expansion.

All substances in nature, as far as we are acquainted with them, occur in one or other of the three following states; namely, the state of solids, of liquids, or of elastic fluids or vapours. It has been ascertained, that in a vast number of cases, the same substance is capable of existing successively in each of these states.

All solid bodies, a very small number excepted, may be converted into liquids by heating them sufficiently; and, on the other hand, every liquid, except spirit of wine, is convertible into a solid body, by exposing it to a sufficient degree of cold. All liquid bodies may, by heating them, be converted into elastic fluids, and a great many solids are capable of undergoing the same change; and lastly, the number of elastic fluids, which by cold are condensible into liquids or solids, is by no means inconsiderable. These facts have led philosophers to form this general conclusion, "that all bodies, if placed in a temperature sufficiently low, would assume a solid form; that all solids become liquids when sufficiently heated; and that all liquids, when exposed to a certain temperature, assume the form of elastic fluids." The state of bodies then depends upon the temperature in which they are placed; in the lowest temperatures they are all solid; in higher temperatures they are converted into liquids; and in the highest of all they become elastic fluids. The particular temperatures at which bodies undergo those changes are exceedingly various, but they are always constant for the same bodies. Thus we see that heat produces changes on the state of bodies, converting them all, first into liquids, and then into elastic fluids.

When solid bodies are converted by heat into liquids, the change in some cases takes place at once. There is no interval between solidity and liquidity; but in other cases a very gradual change may be perceived: the solid becomes first soft, and it passes through all the degrees of softness, till at last it becomes perfectly fluid. The conversion of ice into water is an instance of the first change; for in that substance there is no intervening state between solidity and fluidity. The melting of glass, of wax, and of tallow, exhibits instances of the second kind of change; for these bodies pass through every degree of softness before they terminate in perfect fluidity. In general, those solid bodies which crystallize or assume regular prismatic figures, have no interval between solidity and fluidity; while those that do not usually assume such shapes have the property of appearing successively in all the intermediate states.

Caloric not only increases the bulk of bodies, and changes their state from solids to liquids, and from liquids to elastic fluids, but its action decomposes a great number of bodies altogether, either into their elements, or it causes these elements to combine in a different manner. Thus, when ammonia is heated to redness, it is resolved into azotic and hydrogen gases. Alcohol, by the same heat, is converted into carbureted hydrogen and water.

This decomposition is in many cases owing to the difference between the volatility of the ingredients of a compound. Thus, when weak spirits, or a combination of alcohol and water, are heated, the alcohol separates, because it is more volatile than the water. In general, the compounds, which are but little or not at all affected by heat, are those bodies which have been formed by combustion. Thus water is not decomposed by any heat which can be applied to it; neither are sulphuric, phosphoric, or carbonic acids. Almost all the combinations into which oxygen enters, without having occasioned combustion, are decomposable by heat. This is the case with nitric acid, hyperoxymuriatic acid, and many of the metallic oxides.

All bodies that contain combustibles as component parts are decomposed by heat. Perhaps the metallic alloys are exceptions to this rule; at least it is not in our power to apply a temperature high enough to produce their decomposition, except in a few cases.

When two combustible ingredients and likewise oxygen occur together in bodies, they are always very easily decomposed by heat. This is the case with the greater number of animal and vegetable substances.

Having examined the nature, and some few of the properties and effects of caloric, as far as the subject has been hitherto investigated, it now only remains for us to mention the different methods by which caloric may be evolved or made sensible, or the different sources from which it may be obtained. These sources may be reduced to five: it radiates constantly from the sun; it is evolved during combustion; and it is extricated in many cases by percussion, friction, and mixture. The sources of heat, then, are, the SUN, COMBUSTION, PERCUSSION, FRICTION, MIXTURE, which see. See also CAPACITY.

CALORIMETER, in chemistry, an instrument contrived by Lavoisier and La Place for measuring the comparative quantities of caloric in bodies.

CALTHA, in botany, a genus of the Polyandria Polygynia class and order.

Natural order of Multisiliquæ. Ranunculaceæ, Jussieu. Essential character: calyx none; petals five; nectary none; capsule several, many-seeded. There is but one species; *viz.* C. palustris, marsh marigold. This is the first flower that announces the spring in Lapland, where it begins to blow towards the end of May. The variety with very double flowers is preserved in our gardens for its beauty.

CALTROP, in military affairs, an instrument with four iron points, disposed in a triangular form, so that three of them are always on the ground, and the fourth in the air. They are scattered over the ground where the enemy's cavalry is to pass, in order to embarrass them.

Caltrop, in botany, the English name of the tribulus of botanists. See Tribulus.

CALVARY, in heraldry, a cross so called, because it resembles the cross on which our Saviour suffered. It is always set upon steps.

CALVINISTS, a sect of christians who derive their name from John Calvin, an eminent reformer, who was born at Nogen in Picardy, in the year 1509. He first studied the civil laws, and was afterwards made professor of divinity at Geneva, in the year 1536.

The name of Calvinists seems to have been given at first to those who embraced not merely the doctrine, but the church government and discipline established at Geneva, and to distinguish them from the Lutherans. But since the meeting of the synod of Dort, the name has been chiefly applied to those who embrace his leading views of the gospel, to distinguish them from the Arminians. The leading principles taught by Calvin were the same as those of Augustin. The main doctrines, by which those who are called after his name are distinguished from the Arminians, are reduced to five articles; and which, from their being the principal points discussed at the synod of Dort, have since been denominated the five points. These are, predestination, particular redemption, total depravity, effectual calling, and the certain perseverance of the saints.

1. They maintain that God hath chosen a certain number of the fallen race of Adam in Christ, before the foundation of the world, unto eternal glory, according to his immutable purpose, and of his free grace and love, without the least foresight of faith, good works, or any conditions performed by the creature; and that the rest of mankind he was pleased to pass by, and ordain to dishonour and wrath for their sins, to the praise of his vindictive justice.

2. They maintain that, though the death of Christ be a most perfect sacrifice and satisfaction for sins, of infinite value, abundantly sufficient to expiate the sins of the whole world, and though on this ground the gospel is to be preached to all mankind indiscriminately, yet it was the will of God that Christ, by the blood of the cross, should efficaciously redeem all those, and those only, who were from eternity elected to salvation, and given to him by the Father.

3. They maintain that mankind are totally depraved, in consequence of the fall of the first man, who being their public head, his sin involved the corruption of all his posterity; and which corruption extends over the whole soul, and renders it unable to turn to God, or to do any thing truly good, and exposes it to his righteous displeasure, both in this world and that which is to come.

4. They maintain that all whom God hath predestinated unto life,he is pleased in his appointed time effectually to call, by his word and spirit, out of that state of sin and death, in which they are by nature, to grace and salvation by Jesus Christ. They admit that the Holy Spirit, as calling men by the ministry of the gospel, may be resisted; and that where this is the case, "the fault is not in the gospel, nor in Christ offered by the gospel, nor in God calling by the gospel, and also conferring various gifts upon them; but in the called themselves. They contend, however, that where men come at the divine call, and are converted, it is not to be ascribed to themselves, as though by their own free-will they made themselves to differ, but merely to him who delivers them from the power of darkness, and translates them into the kingdom of his dear Son, and whose regenerating influence is certain and efficacious."

Lastly, they maintain that those whom God has effectually called and sanctified by his spirit, shall never finally fall from a state of grace. They admit that true believers may fall, partially, and would fall totally and finally, but for the mercy and faithfulness of God, who keepeth the feet of his saints: also, that he who bestoweth the grace of perseverance bestoweth it by means of reading and hearing the word, meditation, exhortations, threatenings, and promises: but that none of these things imply the possibility of a believer's falling from a state of justification.

Some think Calvin, though right in the main, yet carried things too far: these are commonly known by the name of Moderate Calvinists. Others think he did not go far enough; and these are known by the name of High Calvinists. It is proper to add, that the Calvinistic system includes in it the doctrine of three coordinate persons in the Godhead, in one nature; and of two natures in Jesus Christ, forming one person. Justification by faith alone, or justification by the imputed righteousness of Christ, forms also an essential part of this system. They suppose that on the one hand our sins are imputed to Christ, and on the other that we are justified by the imputation of Christ's righteousness to us; that is, Christ, the innocent, was treated by God as if he were guilty, that we, the guilty, might, out of regard to what he did and suffered, be treated as if we were innocent and righteous.

CALVITIES, or Calvitium, in medicine, baldness, or want of hair, particularly on the sinciput, occasioned by the moisture of the head, which should feed it, being dried up by some disease, old age, &c.

CALUMET, a mystic kind of pipe, used by the American Indians as the ensign of peace and for religious fumigations. It is made of red, black, or white marble; the head resembles our tobacco-pipes, but larger, and is fixed on a hollow reed, to hold it for smoaking: they adorn it with rounds of feathers and locks of hair, or porcupine's quills, and in it they smoke in honour of the sun, especially if they want fair weather or rain. This pipe is a pass and safe conduct amongst all the allies of the nation who has it given: in all embassies the embassador carries it as an emblem of peace, and it always meets with a profound regard; for the savages are generally persuaded that a great misfortune would befal them, if they violated the public faith of the calumet.

CALX properly signifies lime, but was formerly used by chemists for a fine powder remaining after the calcination of metals and other mineral substances. The term oxide has now taken place of that of calx. See Calcination.

CALYCANTHEMÆ, in botany, the name of the seventeenth order in Linnæus's "Fragments of a Natural Method," consisting of plants, which, among other characters, have the corolla and stamina inserted into the calyx.

CALYCANTHUS, in botany, a genus of the Icosandria Polygynia class and order. Essential character: calyx one-leafed, pitcher-form, squarrose, with coloured leaflets; corolla calycine; styles very many, with a glandulous stigma; seeds very many, tailed, within a succulent calyx. There are two species, of which C. floridus, Carolina allspice, is a shrub which rises to the height of eight or ten feet. Where it grows naturally, the bark of this shrub is brown, and has a strong aromatic scent, whence the inhabitants of Carolina give it the name of allspice.

CALYCERA, in botany, a genus of the Syngenesia Segregata class and order. Calyx many-leaved; calycle five-toothed, one flowered; florets tubular, male and hermaphrodite; receptacle chaffy; seeds naked. One species; *viz.* C. herbacea, found in Chili.

CALYCIFLORÆ, the sixteenth order in Linnæus's "Fragments of a Natural Method," consisting of plants, which, as the title imports, have the stamina inserted into the calyx. The plants of this order want the corolla: the flowes are either hermaphrodite and male on the same root, or male and female upon different roots. The seed-vessel is pulpy, of a berry or cherry kind, and contains a single seed or stone.

CALYPTRANTHES, in botany, a genus of the Icosandria Monogynia class and order. Natural order of Hesperideæ. Onagræ and Myrti, Jussieu. Essential character: calyx superior, truncate, covered with a veil-shaped, deciduous lid; corolla none; berry one-celled, one to four-seeded. There are six species, all natives of the West Indies and Cochin China.

CALYX, among botanists, a general term expressing the cup of a flower, or that part of a plant which surrounds and supports the other parts of the flower. Linnæus describes it to be the termination of the cortical epidermis, or outer bark of the plant, which, after accompanying the trunk or stem through all its branches, breaks out with the flower, and is present in the fructification in this new form. He has distinguished it into seven different kinds. 1. A perianth contiguous to the other parts of the fructification. This is frequently called empalement, or flower-cup, by English writers, and to it, as professor Martyn well observes, should the term cup, if admitted at all, be confined. 2. An involucre, remote from the flower, as in many umbelliferous plants. 3. An amentum, or catkin, from a common, chaffy, gemmaceous receptacle. 4. A spathe, bursting longitudinally. 5. A glume, formed of valves embracing the seed. 6. A calyptra, covering the capsules of mosses like a hood. 7. A volva, a membranaceous covering to the fructification of the fungi. The involucre is rather a number of bractes; and the amentum a species of inflorescence. See BOTANY.

CAMAX, in botany, a genus of the Pentandria Monogynia class and order. Essential character: corolla, wheel-shaped; filaments inserted between the segments of the corolla; berry four-celled, many seeded, all villose. There is but one species; *viz.* C. guianensis, is a shrub growing to the height of fifteen feet; it is a native of Guiana, and flowers in January. The inhabitants and negroes use the branches of this shrub for wattling their huts.

CAMBLET, or CAMLET, a plain stuff, composed of a warp and woof, which is manufactured on a loom, with two treddles. There are camlets of several sorts, some of goat's hair, both in the warp and woof; others, in which the warp is of hair, and the woof half hair and half silk; others again, in which both the warp and the woof are of wool; and lastly, some, of which the warp is of wool and the woof of thread. Some are dyed in the thread, others are dyed in the piece, others are marked or mixed; some are striped, some waved or watered, and some figured.

Camblets are proper for several uses, according to their different kinds and qualities; some serve to make garments both for men and women; some for bed-curtains; others for household furniture, &c.

CAMBOGIA, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Tricoccæ. Guttiferæ, Jussieu. Essential character: corolla four-petalled; calyx four-leaved; pome eight-celled; seeds solitary. There is but one species; *viz.* C. gutta, is a tall tree, with a trunk sometimes as thick as two men can compass, with spreading, opposite branches; native of the East Indies and China; it is very abundant in Siam and Cambodia, where incisions are made in the bark, and a great quantity of gummi guttæ, or gamboge, is extracted, and exported into foreign countries; it is very much in use for miniature painting and water colours.

CAMEL, in zoology, a genus of quadrupeds, of the order of Pecora; distinguished from the rest by having no horn. See CAMELUS.

CAMELEON *mineral*, a compound, so called on account of the changes of colour which it exhibits. It is prepared from the black oxide of manganese, finely levigated, and purified nitre, in the proportion of one part of the former to five of the latter. They are to be fused together for half an hour at a high heat, in an earthen crucible. A green mass is produced, which deliquates by exposure to the atmosphere, and of course requires to be kept in a well-stopped vial. It readily dissolves in hot water, making a dark green solution. This solution, though kept in a close vessel, will in a few days deposit a yellow powder, and the liquor becomes of a fine blue, which being diluted with water, assumes a violet colour, that afterwards grows red, and finally loses its colour, a grey oxide of manganese being thrown down. By the addition of a few drops of acid to the blue liquor, the change to the red is instantaneous, and the colour is a very beautiful tint, between crimson and pink.

CAMELLIA, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Aurantia, Jussieu. Essential character: calyx imbricate, many-leaved; the inner leaflets larger. There are three species, of which C. japonica, Japan rose, is a great and lofty tree, in high esteem with the Japanese for the elegance of its beautiful flowers, which exhibit a great variety of colours, and for its evergreen leaves, but has no scent. It is common in their gardens, flowering from October to April. It varies with single and double flowers, white, red, and purple. It is also a native of China.

CAMELOPARDALIS, the *camelopard giraffe*, in natural history, a genus of the Mammalia, and order Pecora. The generic character: horns covered with a bristly skin, bony and permanent; in the lower jaw eight teeth in front, and on each side the exterior tooth deeply bilobate. There is but one species; *viz.* the Giraffe, which, when fully grown, has been known to attain the extraordinary height among quadrupeds of seventeen feet. Its head is small; its aspect gentle; its foreparts are much higher than those behind, its colours arranged so as particularly to please the eye, and its form, notwithstanding the very great length of the neck, and a general singularity, possesses great beauty and elegance. It is a native of several parts of Africa, living in forests, principally upon the foliage of trees. It is mild and inoffensive, and in all cases of danger has recourse, in the first instance, to flight; when obliged to defend itself, however, it employs very forcible kicking. Its general pace is a brisk trot. Giraffes are sometimes seen in small groups of six or seven. They were first introduced into Europe at the Circean games, by Julius Cæsar, and in the sixteenth century one was presented to Laurentius de Medicis by the Dey of Tunis. The most accurate describer of this animal is La Vaillant. See Plate IV. fig. 1.

CAMELOPARDALUS, a new constellation of the northern hemisphere, formed by Hevelius, consisting of thirty-two stars, first observed by him. It is situated between Cepheus, Cassiopeia, Perseus, the two Bears, and Draco. See ASTRONOMY.

CAMELUS, *camel*, in natural history, a genus of the Mammalia, of the order Pecora. The generic character: horns none; six front teeth in the lower jaw, thin and broad; the canine teeth distant, three in the upper jaw, and in the lower two; upper lip divided. There are seven species enumerated by Shaw, of which we shall briefly notice the following: C. dromedarius, or Arabian camel: its general appearance, particularly in consequence of the dorsal bunch, gives the idea of deformity, or even of monstrosity; but in some attitudes, its aspect is far from inelegant. It inhabits various parts of Asia and Africa, is found even in Jamaica and Barbadoes, and is easily domesticated. Even a country, such as Arabia, destitute of water and of verdure, and under a burning sun, where the traveller seldom breathes under a shade, and feels lost in a boundless expanse of desolation, by the assistance of the camel, is rendered habitable, and the seat of independence and comfort. These animals are trained with great assiduity by the Arabs. They will carry a weight of 1200*lbs*., and have been known to complete a journey of 300 leagues within eight days. They will travel eight or nine days without water, which they scent at the distance of half a league, and drink most copiously when they reach it. Delicate food is far from being requisite for them, and they seem even to prefer the thorns and nettles of the wilderness; and while they find plants to brouse, can dispense easily with the want of drink. They have, besides the four stomachs common to all ruminating animals, a fifth, in which they preserve a great quantity of water, unmixed with the liquors of the body and the digestive juices, and from which, by the contraction of certain muscles, they make the water mount into their stomachs and throats, to macerate their dry food.

Travellers in the East, when hard pressed with thirst, have killed their camels, to obtain a supply from this natural and singular receptacle.

In Turkey, Persia, Arabia, Egypt, and Barbary, camels are almost uniformly employed in the conveyance of merchandize. They are considered as living carriages, and their burden is often not taken off during their sleep. They kneel down to be loaded and unloaded, at the command of their keepers, and are the most patient, laborious, and valuable of slaves. Their milk, and even their flesh, are used by the Arabians for food. Their hair is extremely soft, and wrought into a great variety of the most useful, and indeed costly stuffs. See Mammalia, Plate IV. fig 3.

C. bactrianus, the Bactrian camel. This is somewhat larger and swifter than the former, and has on its back two bunches. In the deserts bordering on China it is found wild, as also in the north of India, whence it is imported into Arabia, chiefly for the use of the great and opulent. In China a particular breed of them is distinguished by the designation of "Camels with feet of wind." Fig. 2.

C. glama. These animals have by some authors been called the Peruvian sheep. They are particularly abundant in Peru, feeding in immense herds on the bleakest mountains. Their size is about that of a stag. They were the only beasts of burden among the ancient Peruvians, and will carry a weight of 150 pounds. This animal can abstain from water four or five days, and may be supported on the coarsest food, and that in very small quantity. When irritated, it endeavours to bite, and ejects an acrimonious and caustic saliva. Its flesh is fat, and excellently flavoured.

C. vicugna, or purplish brown camel, abounds in the highest mountains of the Indies. It is smaller and more slender than the former, and tamed only with considerable difficulty. It will bear small burdens. Its hair is of admirable softness and silkiness on the breast, particularly wavy and woolly, and extending three inches in length. It is wrought into cloth of the most delicate fineness and beauty. The vicugna and the paco, another species of the camel, are both caught by the Peruvians, by the simple process of stretching across the narrow passes of the mountains a cord, with bits of wool attached to it at small distances, and waving in the wind, which, by the terror or fascination it excites, confines them as effectually as bars of iron.

CAMERA *obscura*, in optics, a machine representing an artificial eye, wherein the images of external objects are exhibited distinctly, in their native colours, either invertedly or erect. See Optics.

CAMERARIA, in botany, a genus of the Pentandria Monogyia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; follicles two, horizontal; seeds inserted into their proper membrane. There are two species, of which C. latifolia, bastard mangeneel, is an elegant tree, about thirty feet in height, abounding with an acrid milky juice; flowers small and white; follicles brown, bivalve in their structure, but not opening. Native of Cuba, Jamaica, and Domingo.

CAMP, the ground upon which an army pitch their tents. It is marked out by the quarter-master-general, who appoints every regiment their ground.

CAMPAIGN, in the art of war, denotes the space of time that an army keeps the field, or is encamped, in opposition to quarters.

CAMPANACEÆ, in botany, bell-shaped flowers. The name of the twenty-ninth order in Linnæus's "Fragments of a Natural Method." There are two sections: 1. bell-shaped flowers, with distinct anthers or summits: 2. bell-shaped flowers, with anthers united into a cylinder. The plants of this order are generally herbaceous and perennial. Some of the bell-flowers and bind-weeds are annual; and a few foreign species of the latter have woody stalks.

CAMPANULA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Campanaceæ. Campanulaceæ, Jussieu. Essential character: corolla bell-form, the bottom closed with staminiferous valves; stigma three-cleft; capsule inferior, gaping, with lateral pores. There are seventy-eight species, most of them natives of our own country, well known in the gardens and fields.

CAMPANULACEÆ, in botany, the fourth order of the ninth class of Jussieu's natural orders, so called from their affinity to the genus Campanula. Jussieu gives them the following character: calyx superior, border divided; corolla inserted on the upper part of the calyx, border divided; stamens inserted under the corolla; anthers either distinct or united; germ glandular above; style one; stigma either simple or divided; capsule most commonly five-celled, often many seeded, and generally opening at its sides; seeds fixed to the interior angle of the cells; stems generally herbaceous; leaves most frequently alternate; flowers distinct, or in a few instances aggregate, and enclosed in a common calyx.

CAMPHOR is a principle of vegetables, which, in many of its properties, resembles the volatile oils. Like them, it is odorous, pungent, volatile, inflammable, sparingly soluble in water, and abundantly soluble in alcohol. It differs from them principally in its concrete form, in its peculiar odour, in its relation to the acids and alkalies, and the results of its decomposition by heat. Camphor is a principle contained in many vegetables, especially the aromatic plants, and even those of our own country, as peppermint, rosemary, marjoram, and others; it appears to be volatilized in combination with their essential oil in the process of distillation, and, when these are long kept, is deposited in a crystalline form.

The camphor of commerce is procured, however, from a particular plant, the laurus camphora, a native of the east of Asia. It exists ready formed in the wood of this tree, can be seen interspersed through it in vesicles, and can be picked out. It then forms what has been named native camphor. It is usually procured, however, by the process of sublimation. The wood of the stem and branches, cut into small billets, is exposed with a little water to a moderate heat, in a kind of alembic, to the head of which is adapted a capital, in which straw is put. The camphor is volatilized, and attaches itself to the straw. It is a little impure, but is purified in Europe by a second sublimation. The camphor of commerce, from its mode of preparation, is in the form of large semi-spherical cakes: when broken, it appears in fragments of a texture somewhat striated, having a degree of ductility, in consequence of which it can be compressed, and is not easily reduced to powder; of a white colour, and semi-transparent: a little unctuous to the feel; having a very strong, peculiar, and rather fragrant odour, and a taste which is pungent and bitter. It is also susceptible of crystallization: when slowly sublimed, or when slowly precipitated from its solution in water by the affusion of alcohol, it appears in the form of acicular prisms.

Camphor, though a concrete substance, is even more volatile than the essential oils. It evaporates quickly at the common temperature of the atmosphere, losing in weight, and an angular fragment becoming spherical; and at a temperature between 100 and 150, it sublimes in close vessels unchanged. It is highly inflammable, kindles very readily, and burns with the emission of much light, and with a dense black smoke, which condenses into a smooth light charcoal. Carbonic acid gas is produced, and a portion of the peculiar acid which has been named camphoric acid.

Camphor is very sparingly soluble in water. When triturated with it, it merely communicates its smell and taste to the water, which remains odorous, and somewhat pungent, even when filtrated; but no appreciable quantity is dissolved. A phenomenon which has excited some attention is presented, when pieces of camphor are placed on the surface of pure water. They soon begin to move with rapidity, and while moving dissolve, the solution taking place at the line where the water and the air are in contact; as is proved by immersing a cylinder of camphor in water part of its length: it becomes excavated, and at length is cut through, exactly on a level with the surface of the water.

Camphor is abundantly soluble in alcohol: the solution is immediately decomposed, and the camphor precipitated in the form of a white powder, by the affusion of water; but if the water be very slowly added, and merely in such a quantity as to weaken the affinity of the alcohol to the camphor, the latter, in separating, presents a deutritic crystallization. It is also soluble in expressed and essential oils. The alkalies do not dissolve camphor, or produce in it any sensible change. Of the earths, magnesia appears to exert some action on it, as, when they are triturated together, the camphor is reduced to a smooth impalpable powder, which is easily diffused in water. The action of the stronger acids on camphor is peculiar, and presents some singular results.

By distilling nitric acid from camphor, it is more completely changed, and by this process is converted into an acid, which has received the name of camphoric acid. The process consists in distilling from four ounces of camphor in a retort, 1*lb.* of nitric acid, so far diluted as to be of the specific gravity of 1.33, the heat being gradually applied by the medium of a sand-bath: nitric oxide and carbonic acid gases are disengaged; part of the camphor rises in vapour, while the other part receives oxygen from the acid.

Camphoric acid, thus produced, is different from all the known acids. It has a slightly acid bitter taste, and reddens infusion of litmus. Its crystals effloresce on exposure to the air; they are sparingly soluble in cold water, an ounce of water at 50° of Fahrenheit not dissolving more than 6 grains; at 212°, about 48 grains are dissolved. When the acid is placed on ignited fuel, it emits a dense aromatic vapour, and is entirely dissipated. By applying heat to it in close vessels, it first melts and sublimes, but by a higher heat its properties are changed; it no longer reddens litmus, acquires an aromatic smell, its taste is less penetrating, and it is no longer soluble in water, or in sulphuric or muriatic acid. Nitric acid heated on it turns it yellow, and dissolves it.

Camphoric acid is soluble in the mineral acids: it is likewise soluble in alcohol, and in the volatile and fixed oils. It produces no change in sulphur. The salts, formed by this acid, with the alkaline, earthy, and metallic bases, are named Camphorates. Their properties have been examined by La Grange. Their taste is somewhat bitter: they are decomposed by heat, the acid being sublimed: and they all exhibit a blue flame when heated before the blow-pipe. The alkaline and earthy camphorates are formed by adding the camphoric acid to the alkali or earth, either pure, or in the state of carbonate; the carbonic acid, in the latter case, being disengaged.

CAMPHORATES, } See the preceding
CAMPHORIC *Acid*, } article.

CAMPHOR *tree*, the tree from which the camphor of the shops is prepared, being a species of Laurel. See LAURUS.

CAMPHORASMA, in botany, from camphora, a genus of the Tetrandria Monogynia class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: calyx pitcher-form, two of the teeth opposite, and the alternate ones very small; corolla none; capsule one-seeded. There are five species, of which C. monspeliaca, hairy camphorasma, is an annual plant, with trailing branches, extending a foot or more in length; leaves linear: the flowers are produced from the joints, and are so small as to be scarcely perceptible. Native of France and Spain. The whole plant smells of camphor; it abounds in a volatile oily salt, and is warm and stimulating.

CAMUS, (Charles Stephen Lewis) in biography, a celebrated French mathematician, was born at Cressy en Brie, the 25th of August, 1699. His early ingenuity in mechanics, and his own entreaties, induced his parents to send him to study at a college in Paris, at 10 years of age; where, in the space of two years, his progress was so great, that he was able to give lessons in mathematics, and thus to defray his own expenses at the college, without any farther charge to his friends. By the assistance of the celebrated Varignon, this youth soon ran through the course of the higher mathematics, and acquired a name among the learned. He made himself more particularly known to the Academy of Sciences in 1727, by his memoir upon the subject of the prize which they had proposed for that year, *viz.* "To determine the most advantageous way of masting ships;" in consequence of which he was named, that year, Adjoint-Mechanician to the Academy; and in 1730 he was appointed Professor of Architecture. In less than three years after he was honoured with the secretaryship of the same; and the 18th of April, 1733, he obtained the degree of Associate in the Academy, where he distinguished himself greatly by his memoirs upon living forces, or bodies in motion acted upon by forces, on the figure of the teeth of wheels and pinions, on pump work, and several other ingenious memoirs.

In 1736 he was sent, in company with Messrs. Clairaut, Maupertuis, and Monnier, upon the celebrated expedition to measure a degree at the north polar circle; in which he rendered himself highly useful, not only as a mathematician, but also as a mechanician and an artist, branches for which he had a remarkable talent.

In 1741, he invented a gauging rod and sliding rule, by which the contents of all kinds of casks might be immediately ascertained. He was employed in works of importance in his own country, and elected Geometrician in the French Academy. In 1765 he was chosen a Fellow of the Royal Society of London. On the 4th of May, 1768, he died, in his 69th year, and was succeeded in his office of Geometrician to the Academy by D'Alembert. His works are numerous, and of great reputation: the principal are, "A Course of Mathematics," "Elements of Mechanics," and "Elements of Arithmetic."

CANAL, an aqueduct made for the purposes of inland navigation. This great improvement in the conveyance of commodities has arrived at a high degree of perfection, and enables us to transport them even over mountains, where it would appear impossible to preserve a communication, or rather a continuity of water carriage with the subjacent plains. This is effected by the means of locks built of masonry, each of which serves as the conjunction of two different levels. The locks are made only large enough to admit the vessels employed in the business, and have two gates, one at each end. When a vessel should ascend to a superior level, the upper gate is shut, and the vessel being brought within the lock, the lower gate is also closed, and the upper one opened. By this means the water flows in, and the vessel is raised to the intended height. The upper gate is closed as soon as the vessel has passed, but the water in the lock is preserved for the purpose of letting a vessel down, which is done by shutting the upper gate after she is in the lock, and opening the lower one; so that she is lowered gradually to the next level. The water in all cases is let in or out by means of a small hatch, making its rise and fall very gradual; else the gates would be torn from their hinges by the rush of so large a body, and the vessel would be endangered. We have instances of about twenty locks all in half a mile's distance; but they require very powerful springs to supply a due quantity of water. Sometimes canals are raised above the level of the country; and we have instances where one canal passes over another.

The particular operations necessary for making artificial navigations depend upon a number of circumstances. The situation of the ground; its vicinity or connection with rivers; the ease or difficulty with which a proper quantity of water can be obtained: these, and many other circumstances, necessarily produce great variety in the structure of artificial navigations, and augment or diminish the labour and expense of executing them. When the ground is naturally level, and unconnected with rivers, the execution is easy, and the navigation is not liable to be disturbed by floods; but when the ground rises and falls, and cannot be reduced to a level, artificial methods of raising and lowering vessels must be employed, which likewise vary according to circumstances.

In Mr. Donaldson's "View of the Present state of Husbandry," it is observed, that the canals already completed or forming have had wonderful effects upon the agriculture, as well as upon the manufactures and general state of many parts of the kingdom; these, and the navigable rivers, render the carriage of bulky articles more easy and less expensive. The conveyance of manure, fuel, &c. into districts, whither, without that medium, they could scarcely have been transmitted, has tended materially to the improvement of these particular districts; and the ease with which the inhabitants can export the produce of the country to otherwise almost inaccessible markets, while it tends to the same end, has also considerable effects on the general markets of the kingdom, and lessens the number of horses that would be requisite for transporting these articles from one place to another.

Owing to some cause or other, inland navigations in many parts of the island have proved ruinous to the adjoining lands; while in many others the injury done to the soil in the districts through which these inland navigations are carried, by obstructing the free passage of the rivers to the sea, and by their frequently overflowing their banks, and destroying the crops in the low grounds, is infinitely greater than any commercial advantages that can possibly be derived from them, except by those who are more immediately interested. To render canals, or inland navigations of any sort, of general utility, says he, much circumspection is necessary in framing the acts of Parliament: so that, while the commerce of the country is increased, its agriculture may not be injured. It might, he thinks, be a wise regulation, that in every instance, without exception, all sorts of manure should be carried at one half or one third of lockage-dues made payable for articles of any other description. Were this point attended to, and minute investigation made as to the probable consequences that were likely to result from granting leave to form canals, and deepen the beds of rivers, for the purpose of inland navigations, these means of lessening the expense of carriage would not so often prove injurious to the best interest of the country,—its agricultural improvement.

It has been well observed by Mr. Middleton, in his able Survey of Middlesex, that "canals calculated to navigate much smaller boats than any which have fallen under his observation, even down to ten tons, might be made at a very reduced expense; and after certain leading ones were executed, every man of considerable landed property would find it to be his interest to make a small canal through his estate, at least capable of floating boats of five tons, which would be equally convenient for bringing manure, and to carry away the produce. In all the marsh and fen districts, most of the present sewers would only want," he thinks, "a little cleansing, to fit them for the purpose." And he adds, that "the extension of canals may become the most powerful means of promoting general cultivation. Good roads are certainly very essential, and he thinks canals are at least equally so, in an agricultural view. On the best roads, produce and manure can seldom be carried more than ten miles with profit, at the present price of horse-keep; but if canals were as numerous as roads, corn, hay, manure, &c. could be sent to every part of Britain, without using more road than the towing-paths, and to ten times the former distance, without increasing the expense. A general canal-scheme would, says he, tend to equalize the price of every article in life more than all other things put together. It would afford the cheapest, the safest, and speediest conveyance of every article, that might be too bulky and heavy for stage and mail coaches. The benefits would be universal in this island. The inhabitants of London and its environs would be infinitely more plentifully and cheaply supplied by canals, than by any system of roads whatsoever. The remoter parts of this, and every other country, would be placed more on terms of equality with those that are near, and every other part of the island might reap advantages, which may be foreseen, but which are much too great for calculation." And he concludes by remarking, that "canals and irrigation might be made the means of cultivating every inch of this island, except rocky ground and mountain tops, and these ought to be planted." He states, that "of two methods of raising the money for making canals, the one which seems to deserve the preference is, the mode by which turnpike roads are usually provided for, instead of entrusting it to the management of interested companies. The latter method is exceptionable, from its creating a perpetual charge on all goods sent by that conveyance, without regarding the money expended, or the interest it may ultimately produce, which is a very imprudent bargain for the public in this country, where population, trade, manufactures and commerce, are so much upon the increase."

CANARINA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Campanaceæ. Campanulaceæ, Jussieu. Essential character: calyx six-leaved; corolla six-cleft, bell-form; stigmas six; capsule inferior, six-celled, many-seeded. There are two species, of which C. campanula, Canary bell flower, has a perennial root; stem three feet high; corolla resembling that of a crown imperial, with a yellow eye; style club-form. Native of the Canary Islands.

CANARIUM, in botany, a genus of the Dioecia Pentandria class and order. Essential character: male, calyx two-leaved; corolla three-petalled: female, calyx two-leaved; corolla three-petalled; stigma sessile; drupe with a three-cornered nut. There is but one species; *viz.* C. commune. This tree is a native of the Molucca islands, Banda, and New Guinea. The nuts are eaten both raw and dressed by the inhabitants; and oil is expressed from them, which is used at the table when fresh, and for lamps when stale: bread is also made from them, cakes, biscuits, &c. for the table.

CANARY *bird.* See FRINGILLA.

CANCER. See CARCINOMA.

CANCER, in astronomy, one of the twelve signs of the zodiac, represented on the globe in the form of a crab, and thus marked (♋) in books. See ASTRONOMY.

CANCER, *tropic of,* in astronomy, a lesser circle of the sphere, parallel to the equator, and passing through the beginning of the sign Cancer.

CANCER, the *crab,* in natural history, a genus of insects of the order Aptera. The generic character: eight legs in general, sometimes six or ten, besides two chelated arms; two eyes, distant; in general foot-stalked, elongated, and moveable; tail unarmed, and jointed. Animals of this genus at particular periods cast their shells, previously to which the limbs shrink, to facilitate their extrication. The loss of a limb, with other animals irreparable, is of little consequence to these, as a few weeks suffice to reproduce one: and in cases of bruise or mutilation, a consciousness of this eventual, and indeed speedy, reproduction induces them violently to rid themselves of the injured member, and to await in seclusion the formation of a complete substitute for it. Some species, which are unprovided by nature with any shelly covering, uniformly have recourse to such shells as they find best accommodated to their purpose, and in which their bodies are immersed, while their claws are protruded and unprotected. The correspondence of parts in both sides of almost all other animals is far from being universally observable in these. The claspers on one side are often of extraordinary size, and on the other slender and small; and in some instances the large arm is obliged to be supported by the back of the animal, both while walking and at rest, from its unwieldy and extravagant size. The genus comprehends an immense variety of species; but the chief division is into the Brachyouri and the Macrouri, or the short-tailed and the long-tailed: under the form of which the crab commonly used in this country, for food, is the principal. It is found chiefly on the rocky coasts. Among the Macrouri, the common lobster is the principal, and a well-known specimen. It inhabits in the clearest water, and at the base of rocks which project over the sea. It is extremely prolific, depositing about 12,000 eggs each time of laying. The warmth of summer is required for maturing them. The C. Norwegicus, or Norwegian crab, is naturally of a pale red colour, and variegated with yellow It is longer, and more slender, than the ordinary lobster. For a representation of it, see Entomology, Plate II. fig. 1. C. grapsus, or the streaked crab, is an inhabitant of the American and Indian seas. Its general pale yellow is finely interspersed with red streaks and spots. For a specimen, see Entomology, Plate II. fig. 2.

CANCROMA, the *boat-bill,* in natural history, a genus of birds of the order Grallæ. Generic character: bill gibbous, shaped like an inverted boat; nostrils placed in a furrow, and small; tongue small, and toes divided. Of these there seems to be only one species, though Gmelin speaks, somewhat doubtfully indeed, of a second. The C. cochlearia, or crested boat-bill, is principally found in places near the water. It is a native of South America, particularly abounding in the northern parts of it. Perching on trees which overhang the brooks and rivers, it darts down on the fish swimming underneath, which constitutes its chief food. It is supposed, but not ascertained, that it feeds also upon crabs.

CANDLE, a small taper of tallow, wax, or spermaceti; the wick of which is commonly of several threads of cotton, spun and twisted together.

There are two sorts of tallow-candles; the one dipped, the other moulded: the former are the common candles.

Tallow candles should be made of equal parts of bullock's and sheep's fat. The cotton made use of in the manufacture of candles comes from Turkey. This is first wound into rather a fine thread, which is cut into proper lengths, and five, six, or more united, so as to make it of a fit size for the candle required. The machine for cutting the cotton is a smooth board, fastened on the knees, and the upper surface is the blade of a razor, and a round piece of cane, placed at a certain distance from one another, according to the length of the cotton wanted. The cotton is carried round the cane, and being brought to the razor, is instantly separated from the balls. The cotton is then made smooth by pulling, and spread at equal distances, on rods about half an inch in diameter, called broaches. The tallow is melted, and after it is well skimmed, it is brought to the mould, in which the cottons are dipped. The workman holds three of these broaches between his fingers, and immerses the cottons into the melted tallow; these he afterwards hangs up till they become cold and hard, during which others are dipped. When cold, they are dipped a second and a third time, and so on till the candles are of the proper size. During the operation the tallow is kept to a proper temperature, by means of a small charcoal fire. An invention of modern date has taken off much of the labour of the tallow-chandler: this consists of a beam with fixed pullies, round which ropes are made to pass, and on one end of the ropes can be suspended six or more broaches, the weight of which is balanced by weights in an opposing scale, and which may be increased, as the candles become larger. The workman by this means has only to guide the candles, and not to support them between his fingers. Mould candles are so called, from their being run or cast in moulds made of pewter. In these the cotton is intruded by means of a wire, and kept in a perpendicular position till the tallow is poured in, and when cold the candles are easily drawn out.

Wax candles are made of a cotton or flaxen wick, slightly twisted, and covered with white or yellow wax. Of these, there are several kinds; some of a conical figure, used to illumine churches, and in processions, funeral ceremonies, &c. Others of a cylindrical form, used on ordinary occasions. The first are either made with a ladle or the hand. To make wax candles with the ladle: the wicks being prepared, a dozen of them are tied by the neck, at equal distances, round an iron circle, suspended directly over a large basin of copper tinned, and full of melted wax: a large ladle full of this wax is poured gently on the tops of the wicks, one after another, and this operation continued till the candle arrive at its destined bigness; with this precaution, that the three first ladles be poured on at the top of the wick; the fourth at the height of three-fourths; the fifth at one-half; and the sixth at one-fourth; in order to give the candle its pyramidal form. Then the candles are taken down, kept warm, and rolled and smoothed upon a walnut-tree table, with a long square instrument of box, smooth at the bottom.

As to the manner of making wax-candles by the hand, they begin to soften the wax, by working it several times in hot water, contained in a narrow, but deep, caldron. A piece of the wax is then taken out, and disposed, by little and little, around the wick, which is hung on a hook in the wall, by the extremity opposite to the neck; so that they begin with the big end, diminishing still as they descend towards the neck. In other respects, the method is nearly the same as in the former case. However, it must be observed, that in the former case, water is always used to moisten the several instruments, to prevent the wax from sticking; and in the latter, oil of olives, or lard, for the hands, &c. The cylindrical wax candles are either made, as the former, with a ladle, or drawn. Wax-candles drawn, are so called, because actually drawn in the manner of wire, by means of two large rollers of wood, turned by a handle, which, turning backwards and forwards several times, pass the wick through melted wax contained in a brass basin, and at the same time through the holes of an instrument like that used for drawing wire fastened at one side of the basin.

Candles, *sale or auction by inch of*, is when a small piece of candle being lighted, the bystanders are allowed to bid for the merchandize that is selling; but the moment the candle is out, the commodity is adjudged to the last bidder.

Candle *berry-tree*, in botany. See Myrica.

CANDLEMAS, a feast of the church, held on the second day of February, in honour of the purification of the Virgin Mary. It is borrowed from the practice of the ancient Christians, who on that day used abundance of lights, both in their churches and processions, in memory, as is supposed, of our Saviour's being on that day declared, by Simeon, "to be a light to lighten the Gentiles." In imitation of this custom, the Roman Catholics, on this day, consecrate all the tapers and candles which they use in their churches during the whole year.

CANDY, or *sugar* CANDY, a preparation of sugar, made by melting and crystallizing it six or seven times over, to render it hard and transparent. It is of three kinds, white, yellow, and red. The white comes from the loaf-sugar, the yellow from the cassonado, and red from the muscovado.

CANE is the name of a long measure, which differs according to the several countries where it is used. At Naples, the cane is equal to 7 feet 3½ inches English measure; the cane of Toulouse, and the upper Languedoc, is equal to the varre of Arragon, and contains 5 feet $8\frac{2}{8}$ inches: at Montpellier, Provence, Dauphine, and the lower Lauguedoc, to 6 English feet 6½ inches.

CANELLA, in botany, a genus of the Dodecandria Monogynia class and order. Essential character; calyx three-lobed; corolla five-petalled; anthers twenty-one, fastened to a pitcher-shaped nectary; berry three-celled; seeds two to four. There is but one species, *viz.* C. alba, laurel leaved canella, is a tree, the stem of which rises from ten to fifty feet in height, straight upright, branching only at the top. The flowers grow at the tops of the branches in clusters, upon divided peduncles. It is common in most of the West India islands. The whole tree is very aromatic, and when in blossom perfumes the whole neighbourhood. The flowers, dried, and softened again in warm water, have a fragrant odour, resembling that of musk.

CANEPHORA, in botany, a genus of the Pentandria Monogynia class and order: common calyx tubular, toothed, many flowered; perianthum five or six-cleft; corolla campanulate, five or six-cleft; fruit inferior, two-seeded. There are two species, *viz.* the axillaris and capitata, natives of Madagascar.

CANES, *walking*, are said by Bradley to be joints of the roots of a sort of reed, called Canna Indica. This plant shoots in joints of about three or four feet long, near the surface of the ground, and at every knot produce great numbers of fibres, by which it receives its nourishment. The joints are made straight by the fire, which occasions those shades or clouds frequently seen in them. Bradley thinks the cane-tree might be propagated here, by planting some of the roots with their knots in artificial bogs, &c.

CANES, *rattan*, are a smaller sort, brought from China, Japan, and Sumatra, very tough; which, being split, are used for making of cane chairs. They are the produce of a reed called rattang malabarica minor, or lesser rattan. The specific name is rotang, whence rattan, and in the Malayan language signifies a staff or walking stick. These, when dry, being struck against each other, will give fire, and are used accordingly in some places in lieu of flint and steel. Being twisted together, they make cordage of them. The Chinese and Japanese vessels are said to have their cables made of them, which are less liable to rot in the water than hemp.

CANES *venatici*, in astronomy, the greyhounds, two new contellations, first established by Hevelius, between the tail of the great Bear and the arm of Bootes, above the Corona Berenices. That next the Bear's tail is called Asterion, the other Chara.

CANICULA, or CANICULUS, in astronomy, the same as the Canis Minor. See CANIS MINOR.

It is also a name given to one of the stars of the constellations, Canis Major, called the Dog-star, and by the Greeks Sirius.

CANICULAR *days*, commonly called dog days, a certain number of days preceding and ensuing the heliacal rising of the Canicula, or the Dog-star, in the morning. The Ethiopians and Egyptians began their year at the rising of the Dog-star, reckoning to its rise again the next year, which is called the annus canarius. The Romans supposed it to be the cause of the sultry weather usually felt in the dog-days, and, therefore, sacrificed a brown dog every year, at its rising, to appease its wrath.

CANINE *teeth*, in anatomy, are two sharp-edged teeth in each jaw; one on each side, placed between the incisores and molares.

CANINE *muscles*, a pair of muscles common to both lips. They arise from the hollow on each side under the os jugularis, in the os maxillare, and are inserted into the angle of the lips.

CANIS, the dog, in natural history, a

genus of Mammalia, of the order Feræ. Generic character: six upper foreteeth; lateral ones longer, distant; the intermediate ones lobate; in the lower jaw six, lateral ones lobated; tusks solitary and incurvated; grinders six or seven, or more than in other genera of this order.

This genus is distinguished by its voracity, and by tearing what it devours. It is unable to climb trees; can move with great swiftness; has the crown of its head usually flat, with a lengthened snout; its body very considerably thicker before than behind; its claws are long, somewhat curved, but not retractile. The female produces many at a time, and has usually four teats on the breast and six on the belly. In the savage state of the dog, his irritable and ferocious character renders him a dangerous enemy to other animals; but, when domesticated, his grand object appears to be to please his employers, and to convert to their service his courage, his swiftness, and all his striking and valuable instincts. He is extremely docile, and accommodates himself to the manners and habits of those with whom he lives, with a facility which furnishes an admirable lesson. His vigilance over whatever is committed to his charge is connected with a courage in defence of it, arising even to rage. His suspicions are perpetually alive: his inferences, with respect to the just grounds of apprehension, are astonishingly judicious and correct, and he not only sounds the tocsin of alarm to the whole family by which he is employed as centinel, but darts on a supposed culprit with a vigour and intrepidity, which generally overwhelm the power of resistance. By the assistance of the dog, man has reduced the other animals to slavery. Dangerous and ferocious beasts are hunted down by its means. By conciliating, among the various animals by which he was surrounded, those, which, at the same time that they abound in energies, are also capable of affection and obedience, man has been enabled to oppose and destroy others, with which he would have been able to establish no compromise, whose ferocity is untameable, and whose power is connected only with ravage and desolation. The training of the dog was probably one of the first objects of the attention of man, and aided him extremely in subduing the earth to his unmolested government.

The capability of instruction, and the imitative powers of the dog, have furnished innumerable curious and interesting anecdotes. A Florentine nobleman possessed a dog, which would attend his table and change his plates, and carry his wine to him with the utmost steadiness, and the most accurate attention to his master's notices.

It is related by the illustrious Leibnitz, that a Saxon peasant was in possession of a dog, of the middling size, and about three years of age, which the peasant's son, perceiving accidentally, as he imagined, some resemblance in its sounds to those of the human voice, attempted to teach it to speak. By the perseverance of the lad, the dog acquired the power, we are told, of pronouncing about thirty words. It would, however, exercise this extraordinary faculty only with reluctance, the words being first spoken always by the preceptor, and then echoed by the pupil. The circumstance is attested by Leibnitz, who himself heard it speak, and was communicated by him in a memoir to the Royal Academy of France.

In the theatre of Marcellus, what many will consider more probable, but what is still extraordinary, is mentioned to have occurred, by Plutarch. A dog was here exhibited, who excelled in various dances of great complication and difficulty, and represented also the effects of disease and pain upon the frame, in all the contortions of countenance and writhings of the body, from the first access to that paroxysm, which often immediately precedes dissolution: having thus apparently expired in agony, he would suffer himself to be carried about motionless, as in a state of death, and, after a sufficient continuance of the jest, he would burst upon the spectators with an animation and sportiveness, which formed a very interesting conclusion of this curious interlude, by which the animal seemed to enjoy the success of his scenic efforts, and to be delighted with the admiration which was liberally and universally bestowed upon men.

This genus comprehends twenty-one species, several of which, particularly the C. familiaris, include numerous varieties. The following appear principally deserving of notice.

The C. familiaris, or the familiar dog, of which the variety known by the name of the shepherd's dog is imagined to approach most nearly to the original animal. Its use is inferible from its designation. It keeps the flock collected, and defends it from injury. In the Alps, and some other regions of Europe, it is considerably larger and stronger than in England. See Mammalia, Plate V. fig. 1.

Another variety is the dingo, Australasian, or New Holland dog. Plate V. fig. 2. This dog does not bark so readily as the European dogs: its appearance much resembles the larger kind of the shepherd's dog, and it is extremely fierce and untractable.

The Pomeranian dog, another variety, is generally white, and is distinguished, among several characteristics, by the curvature of its tail, extending very nearly to a circle. Plate V. fig. 3.

A fourth variety is the Siberian. These dogs are frequently employed in Siberia and Kamtschatka, in drawing sledges on the frozen snow, and four or six of them yoked to a sledge will convey three persons with the usual quantity of baggage, forty miles or more in a day. The exertions of these dogs, however, are more to be praised than their fidelity or attachment. Their perverseness and subtlety are a source of great vexation to their employers, who, however, notwithstanding the malignity and cunning they are thus so incessantly called upon to counteract, find these animals indispensable to the convenience and intercourse of these arctic regions. See Plate V. fig. 4.

The Iceland dog is but little different from the last, as will be seen by a reference to Plate V. fig. 5. Its general colour is black.

For the great barbet, see Plate V. fig. 6.

The blood-hound was, some ages since, highly esteemed in England, and much employed in the pursuit of robbers. The accuteness of its smell is so extraordinary, that it has traced a man to the distance of seven miles, along a much frequented high-way, and through several market towns, to the very upper room in which he was taking refreshment.

The Irish grey-hound, now extremely rare even in Ireland itself, is perhaps the most beautiful and majestic, as well as the largest of all dogs. It was this dog which was principally employed in clearing the island of wolves. It is, however, unfit for hunting foxes, hares, or stags, and is kept by a few persons merely for its beauty and size. Dr. Goldsmith has seen one four feet high.

The mastiff, another variety, is of a very strong and thick structure, with a large head, and the sides of the lips pendulous. In the reign of James I. a trial of its vigour and courage was made in the Tower of London, and three mastiffs being opposed to a lion, two were mutilated and disabled, but the third obliged the lion to have recourse to flight.

The terrier, another variety, is much employed in unearthing foxes, and to all those quardrupeds, which are comprehended in the class of Vermin, bears the strongest antipathy. A well-trained terrier is frequently found an over-match even for the fierce and hardy badger. This dog is extremely useful as an attendant on every pack of hounds, to compel the game from its close cover of earth or thicket.

The chief peculiarities of the species, of which these few varieties out of many have been given, are these. It cultivates the society of man; has rarely been found wild; feeds on flesh and farinaceous vegetables, but not on greens; it digests bones; urines frequently, holding up its leg; dungs upon a stone; vomits itself by grass; runs in an oblique direction; very rarely sweats, but lolls out its tongue when hot. The male young resemble the dog, and the female the bitch. It is extremely docile, affectionate, and vigilant, in its intercourse with man; it eats with a glancing and envious eye; has a great aversion to strangers, and particularly to beggars; licks wounds; hears and dreams in its sleep; sets up a howl on hearing musical sounds; and bites stones thrown at it; possesses a most acute sense of smell; is liable to gonorrhœa; is subject also to madness, which it imparts by biting, and in old age is addicted to gnawing itself. It is regarded by the followers of Mahomet as unclean.

C. lupus, the wolf. These animals are found in almoat all the temperate and cold climates of the globe. They abounded formerly in Great Britain and Ireland, but were extirpated by government's commuting the punishment for several offences for a proportionate number of wolves' tongues, or by the substitution in Wales of a certain number of wolves' heads for a particular amount of money in taxes. Some lands were also held, on condition of the occupiers destroying yearly a certain number of these dangerous animals.

In America, wolves are reported to go in droves, and to hunt various animals with the most terrific and hidious howlings, not scrupling, when urged by hunger, to attack even the buffaloe itself. To allay their hunger, it is stated that they will swallow large quantities of mud. In Sweden the carcases of animals are purposely laid in their way, stuffed with tree moss and pounded glass, which render the repast fatal to them. They are, like-the dog, subject to madness, communicated also by bite, but generally coming on in winter rather than in summer. In the north of Europe they live much on seals, and extending their excursions far on the ice, when that is detached, in consequence of a change of weather, from the land, they are carried off into the ocean, and express the sense of their dreadful and insuperable danger by the most bitter howlings of despair.

There is no animal, whose carnivorous appetite is stronger than that of the wolf, and he is endowed by nature with all the means of satisfying it, being strong, agile, subtle, and enabled not only to explore, but to seize and subdue his prey.

By the perpetual war in which he is involved with man, however, he is often reduced to extreme difficulties, and driven far into wilds and forests, where the means of satisfying his appetite are scarcely to be found: remoteness from human habitation, in proportion as it adds to his scarcity, embarrases his subsistence. The urgency of his wants drives him back to those dangers which he was eager to shun, and inspires him often with courage by no means natural to him, and rising to all the vehemence of fury and distraction. He will in these circumstances of pressure make no scruple of attacking women and children, and occasionally assault and devour men. The Paris gazette for 1764, states the ravages and devastation by one of these creatures, near Languedoc, to have comprehended the destruction of no less than twenty persons. It will devour its own species as well as the human. It is remarkable for suspicion, for terror at the sound of a trumpet, for exquisite acuteness of smell, for its endurance of extreme cold and hunger, for its fearfulness of a cord or rope drawn along the ground, and for leaping over fences rather than passing through doors or gates. When taken young, its savage character has, by assiduous education, been not merely greatly mitigated, but, in a few instances, completely subdued. The time of gestation in the wolf is 100 days, being forty more than that of the dog, which may be considered as a radical difference between these species of animals. See Mammalia, Plate VI. fig. 2.

C. hyæna, or the striped hyæna. These animals are generally about the size of a large dog, and abound in many parts of Asia and Africa. They have been almost universally believed to be untameable, but several decided instances to the contrary have occurred. Their manners, however, are particularly untractable and ferocious, and truly indicated by that unremitted gloom and malice expressed in their countenance. They inhabit, principally, rocks and caves, and, shunning the light of day, avail themselves of darkness to commit their depredations. They feed not only on prey which they have themselves killed, but putrid carcases supply them with a delicious banquet, and the bodies of the dead are often, with most persevering labour, torn up from their graves in churchyards, where they have some time been deposited, and devoured with the keenest relish. They follow the motions of contending armies, anticipating, by the associations furnished from experience, and which are formed in the inferior animals as well as in man, the feast to be supplied from human conflict and carnage. When they are first put in motion, they appear, as is not uncommon with dogs, to labour under some fracture or dislocation in their hind legs. This, however, in a short time totally vanishes. In Syria, and about Algiers, they live mnch, if not principally, on bulbous roots, in the choice of which they are uncommonly fastidious. In Barbary, the Moors will not hesitate to pull the hyæna by the ears in the day-time, and, indeed, experience from it no attempt at injury: they will even enter his cave with a torch, and throwing a blanket over him, hawl him out without any inconvenience. In the same country some small animals have been shut up with a hyæna fasting, during a whole day, and yet have been found alive and uninjured; but by night, a young ass, a goat, and a fox, locked up with one, were destroyed, and, excepting some of the larger bones of the ass, completely devoured before morning.

In Abyssinia these animals are nearly equally active aud bold by day and night. They abound in every part, and are scarcely less numerous even than sheep. Mr. Bruce complains of their being the plague of his life in that country, the terror of his night-walks, and the destruction of his mules and asses, which were, with them a favourite food. One night, having, for a moment, quitted his tent, where he had previously heard some noise within it, the cause of which, however, he was unable to discover, and had ceased to think of, he observed on his return, in the dark, two large blue eyes most fixedly glaring on him. A light being speedily brought, he discovered, near the head of his bed, a hyæna, with several bundles of candles in his mouth. Mr. Bruce immediately struck at him with a long pike, which penetrated completely through him, near his heart. The animal no sooner felt the smarting of the wound, than he appeared animated by the most fierce and desperate vengeance, and strove actually to climb up the shaft of the pike, to reach his destroyer. The servant, however, cleft his head asunder with a battle-axe. Plate VI. fig. 1.

C. aureus, the jackal. In the warm latitudes of Asia and Africa, these animals abound, and no where more than in Barbary. The jackal is of a light yellow colour, with black shades about the back and legs; and about the size of a middling dog. In its excursions, which are chiefly during night, it commits promiscuous ravage among the more defenceless animals, though vegetables are sometimes used for food by it. Jackals frequently assemble in large droves, or troops, even so numerous as two hundred, and hunt the vast herds of deer or antelopes which abound in these regions, sounding the most horrid yells, and pursuing their prey till it sinks under the exhaustion of fatigue and terror. The feast of the jackals, however, is generally intercepted, or at least delayed, by the appearance of the lion, who, roused by their sounds, and aware that they are preparing a banquet which he may enjoy at his leisure, follows their footsteps. While he gratifies his appetite, these humble and trembling purveyors await at a distance the moment, when the lord of the forest shall have completed his repast, and they may safely approach, to devour the mutilated remains he was unable to dispose of.

It is supposed by some judicious and sagacious naturalists, that the jackal is the real origin of the dog. In the structure of the short intestine, called the cæcum, they both agree, and their instinct and manners are extremely similar. They both are fond of the society of man, and approach on being called by their names. The jackall is easily tamed, and shows an attachment to dogs; it fawns on its owner, and exhibits all those indications of joy, sportiveness and gratitude, which characterize the dog. The jackal and the dog also readily intermix. The wolf and the fox naturally shun mankind. The native regions of the wolf, also, are those of extreme cold, which do not suit the dog; and the construction of some of the intestines of the fox, is extremely different from those answering similar purposes in dogs. The different times of gestation, however, in the jackal, and in the dog, appears no slight objection to the theory thus advocated. Plate VI. fig. 3.

C. vulpes, the fox. This animal is generally of a yellowish brown colour, with its tail straight, bushy, and tipped with white, from the base of which it emits a rank and fetid odour. The skill of the fox in the construction of its mansion ranks it among the higher order of quadrupeds. He burrows under firm earth, and often where the roof of his dwelling is prevented from falling in by the wattling of the roots of trees. His subterraneous residence is generally extensive, and he provides to it several avenues, for his convenience or security. Thus, instead of being a houseless vagrant, he possesses all the ideas and comforts which attach to a home, and which are justly supposed to imply superior sentiment and intelligence.

The fox is not unfrequently observed, in fine weather, to quit his retreat, and bask at his full length in the sun. His ravages are reserved for the night, and are generally committed at a distance from his home. He destroys for his food various species of vermin. Poultry and young lambs very frequently fall under his power, where he has secure access to them. The dung of other animals, berries, snails, frogs, and insects, are sometimes taken by him. Of grapes he is proverbially fond, and the vineyards suffer very considerably from his depredations. He wastes or destroys far more than he devours, often hiding large quantaties of his prey in thickets, or beneath the roots of trees. His sagacity to discern his prey and his enemies is extraordinary. In Palestine, foxes certainly abound; but, from the narrative of Samson's fire-brands, might be supposed still more abundant. The animals employed by him in that destructive stratagem were probably jackals, which are at least equally abundant, and far more easily accessible. In very northern latitudes, the fox is frequently black, and affords a fur more valued than that of almost any other animal: it has been sometimes sold from Kamtschatka for 400 rubles. The fox has been found sometimes perfectly white. The arctic fox, found particularly in Nova-Zembla, is one of the hardiest of all animals, unremitted in its pursuit of prey during the severest rigours of winter. In some parts it is compelled to sustain itself by berries, shell-fish, or whatever is thrown up by the sea. In others, the sustenance of these animals consists of wild geese, and every kind of water-fowls, with their eggs; and in Lapland, particularly, they feed upon a species of mice called lemings, which, being migratory at uncertain periods, induce the consequent migrations of the arctic fox, who will, in the pursuit of this prey, be absent from his native country sometimes for three, or even four years. The ground in Spitzbergen being eternally frozen, these animals being consequently here unable to burrow, reside in the cliffs of rocks, and two or three are often found in the same hole. The cunning supposed to be characteristic of the fox, and which it might be supposed that embarrassment and hardship would increase, is by no means a quality of the variety under consideration, which is indeed rather noted for its simplicity, instances having been known, in which the arctic fox, after standing by while a trap was baited, has immediately thrust his head into it. The Greenlanders convert the skins of these animals, which are light and warm, but not lasting, to the purposes of merchandize, manufacturing some of the thicker and harder parts into buttons. They occasionally eat the flesh, and the tendons are divided by them into slender filaments, and substituted for thread. For a representation of the fox, see Mammalia, Plate VI. fig. 4.

Canis, *Major*, in astronomy, a constellation of the southern hemisphere.

Canis *Minor*, *Caniculus*, or *Canicula*, in astronomy, a constellation in the northern hemisphere. See Astronomy.

CANKER, a disease incident to trees, proceeding chiefly from the nature of the soil. It makes the bark rot and fall.

CANNA, in botany, *Indian flowering reed*, or *Indian shot*, a genus of the Monandria Monogynia class and order. Natural order of Scitamineæ. Cannæ, Jussieu. Essential character; corolla six parted, erect; lip two-parted, revolute; style lanceolate, growing to the corolla; calyx three-leaved. There are five species, most of them natives of the northern provinces of America.

CANNABIS, in botany, *English hemp*, a genus of the Dioecia Pentandria class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character: male, calyx five-parted; corolla none; female, calyx one-leafed, entire, gaping on one side; corolla none; styles two; not bivalve, within the closed calyx. There is but one species, *viz.* C. sativa. The uses of hemp are well known, as well as its great importance to the navy for sails and cordage. Exceedingly good huckaback is made from it for towels and common table-cloths. The low priced hempen cloths are a general wear for husbandmen, servants, and labouring manufacturers. The hemp raised in England is not of so dry and spongy a nature as what we have from Russia, and therefore it requires a smaller proportion of tar to manufacture it into cordage. English hemp, properly manufactured, stands unrivalled in its strength, and is superior to the Russian. Like many other plants, generally cultivated, it is difficult to ascertain the original place of its native growth. Linnæus gives it to the East Indies and Japan.

CANNEL *coal*. See Ampelites.

CANNON, in the military art, an engine or fire-arm for throwing iron, lead, or stone bullets, by force of gun-powder. Cannons at first were called bombardæ, from the noise they made; they had likewise the name of culverin, basilisk, &c. from the beasts that were represented upon them; and the Spaniards, from devotion, gave them the name of saints; witness the twelve apostles which Charles V. ordered to be cast at Malaga, for his expedition to Tunis.

Cannon are classed as field-pieces or battering pieces; the former are usually made of mixed metals, but sometimes of pure brass; the latter, with very few exceptions, are of cast iron. Every cannon is made by running fused metal into a mould, and is afterwards finished by being turned on a lathe. The chase is bored by means of a strong machine. Some suspend the cannon vertically over the borer, making it press downwards as the borer revolves: others have a horizontal process, in which the cannon is firmly fixed on a frame, and the borer approaches as the chase proceeds. There is a large cylindrical projection on each side of a cannon, nearly in the middle of its length; these are called trunnions; they serve to support it on the carriage, and as pivots, whereon a due degree of elevation or depression may be given. The variation in the elevation is made in field-pieces, which usually carry balls of 3, 6, 9, 12, and up to 18*lb.* weight, by means of a screw fixed to a strong piece of wood, that joins the two cheeks of the carriage, and is fastened by a loop and bolt to the round knob at the end of the cannon, called the cascabel. As there is great force in the powder when ignited by means of a match applied to the vent, which communicates with the end of the chase, the quantity of metal must, of necessity, be augmented about the breech, or hinder parts. Thus all cannons are fortified in that part; but battering cannons are generally double-fortified, by an additional quantity of metal, in consequence of the large charges of powder given, for the purpose of adding to the impetus or force of the shot's action on the place to be battered.

Battering-pieces are generally from 24 to 42 pounders, sometimes 18 pounders are used, but their effect is feeble, compared with that of cannons of a larger calibre.

Cannon intended for field service are mounted on a carriage, with two stout wheels, about four feet and a half high, on a solid wooden or an iron axle, and suspended by their trunnions on the two cheeks, which are as near to each other as the size of the cannon will permit, tapering down a little towards the ground, at a sufficient angle to oppose the recoil, or run backward, made by every piece when fired. The cheeks diverge a little, and are kept very firm in their places by means of cross pieces called transoms, which are vertical in and secured by strong bolts. The cannon is turned about to any direction by means of a handspike which fixes into the train. The piece is transported by raising its train, and passing the tail-transom, which is perforated for the purpose, on to a very substantial iron gudgeon firmly fixed on the centre of an axle, which has two wheels rather lower than those of the carriage. This appendage is called a limber, and carries a stout water-proof box full of ammunition of various descriptions, for the service of the cannon; it has likewise a pole, or shafts, whereby horses are attached, and the piece thus travels with tolerable ease; the limber wheels traversing under the cheeks of the carriage.

The modes of charging cannon are various, but in general with cartridges, over which wads of spun yarn are well rammed; then the shot, either round or grape; and, lastly, a second wad rammed home: but in field service, where grape or canister shot are used, the whole charge is sometimes made to fit in immediately after the cartridge, which is invariably made of serge, shalloon, or other woollen stuff. Grape is made by putting many small balls together, so as to fit the bore of the piece; they are usually netted to a round piece of board. Canister is nothing more than a number of still smaller balls put into a tin canister; these are intended for close attacks, especially among cavalry, or large bodies of infantry, round shot being mere suited to distant operations. Ship guns, and such others as are intended to be stationary, are placed on low substantial carriages, moving on four small trucks; these ere elevated by means of wedges called quoins. Some are discharged by locks, on the same principles as those for musquets; and for ship use are certainly the safest, and best adapted to a certainty of aim. Brass six-pounders often weigh so little as 4 *cwt.* but some of the double fortified battering cannon amount to full 3 *tons* each.

A short kind of a cannon, called a carronade, is much in naval use: we have some that throw balls of near 70 *lbs.*: their purpose is chiefly for close attacks, when their effects are dreadful: these slide in grooves on a bed carriage. The pieces used for throwing shells, which are hollow balls filled with powder that explode when the fuse burns into them, are howitzers and mortars; the former are mounted in every respect similar to cannon, but are very short, and chambered. These throw either shells or grape with great effect. The mortar is always fired at an elevation of 45 degrees from the horizon, and its range, *i. e.* the distance at which the shell is to fall, is determined by putting a greater or less charge of powder into the chamber. Shells for mortars sometimes measure a diameter of 21 inches, but those for howitzers rarely exceed 11 inches, and generally are from 4¾ to 8½, or thereabouts. The point blank range of a cannon is that distance at which the shot cuts a line, supposed to be drawn parallel with the surface of earth, at a distance equal to the height of the chase of the cannon when horizontal. No shot goes in a right line from the muzzle to the object, but forms a curve often many yards above the horizontal line. The point blank distance is according to the calibre of the piece, and the proportion of powder, and its quality, used for a charge; we may however, state the ranges to be from 400 to 1000 yards.

Mortars will throw shells more than a mile. The carriage of a mortar is a large horizontal bed of timber, strongly clamped together, and placed on loose sand; it should be perfectly level. The breech of a mortar is round, and rests in a hollow made in the centre of the bed; its muzzle is held up by a curved iron stay, which being acted upon by a screw gives the mortar more or less elevation: the trunnions are close to the breech, and move upon the bed.

We shall conclude this article with a short description of the method of cannon boring.

Fig. 1. Plate cannon, &c. in an elevation of a machine for boring cannon, and fig. 2. is a plan of it; the same references are used in both figures: A is a cast iron frame to support the bearing for an iron shaft, B, turned by a steam engine, or water wheel; this has a square box on its end, into which a square knob cast on the end of the gun is fitted by screws; the mouth of the gun is supported on an iron frame, D, sliding on the two bed beams, E, E, and can be fixed at any place by screws; it has also screws to elevate or depress the brass which forms the bearing for the gun; F is the boring bar, fastened at its end to a large block, G, running on the bed beams with small wheels: H is a rack fastened by its ends to puppets wedged on the bed, passing through the block G: a pinion which works in this rack is attached to the block G, and its spindle has a wheel, I, with pins projecting from it: K is a bar going between these pins, and carrying a weight which turns the pinion, and forces the block G, and the boring bar, towards the gun. When the weight reaches the ground it must be lifted up, and its lever, K, hooked between two fresh pins of the wheel.

Cannon, with letter-founders and printers, a large sized letter distinguished by this name.

CANNONADE, in marine affairs, is the application of artillery to the purposes of naval war, or the direction of its efforts against some distant objects intended to be seized or destroyed, as a ship, battery, fortress, &c.

CANNULA, in surgery, a tube made of different metals, principally of silver and lead, but sometimes of iron.

CANOE, a small boat, made of the trunk of a tree, bored hollow, and sometimes also of pieces of bark, sewed together. It is used by the natives of America to go a fishing in the sea, or upon some other expedition, either by sea, or upon the rivers and lakes.

CANON, commonly called prebendary, a person who possesses a prebend, or revenue allotted for the performance of divine service in a cathedral or collegiate church. Originally canons were only priests, or inferior ecclesiastics, who lived in community, residing near the cathedral church, to assist the bishop, depending entirely on his will, supported by the revenues of his bishopric, and living in the same house as his domestics or counsellors, &c. By degrees, these communities of priests, shaking off their dependence, formed separate bodies; in time they freed themselves from their rules, and at length ceased to live in a community. It is maintained that the colleges of canons, which have been introduced into each cathedral, were not in the ancient church, but are of modern appointment.

Canon, in an ecclesiastical sense, a law, rule, or regulation of the policy and discipline of a church, made by councils, either general, national, or provincial.

Canon *of scripture*, a catalogue or list of the inspired writings, or such books of the bible as are called canonical; because they are in the number of those books which are looked upon as sacred, in opposition to those which are either not acknowledged as divine books, or are rejected as heretical and spurious, and are called apocryphal. This canon may be considered as Jewish and Christian, with respect to the sacred writings acknowledged as such by the Jews, and those admitted by the Christians.

Canon, in music, a short composition of two or more parts, in which one leads, and the other follows; or it is a line of any length, shewing, by its divisions, how musical intervals are distinguished, according to the ratios, or proportions, that the sounds terminating the intervals bear one to another, when considered according to their degree of being acute or grave.

Canon, in arithmetic, algebra, &c. is a rule to solve all things of the same nature with the present inquiry; thus, every last step of an equation in algebra is such a canon; and, if turned into words, is a rule to solve all questions of the same nature with that proposed. Tables of logarithms, artificial sines and tangents, are called likewise by the name of canon.

Canon *law*. a collection of ecclesiastical laws, serving as the rule and measure of church government.

Canons *of the apostles*, a collection of ecclesiastical laws, which, though very ancient, were not left us by the apostles. It is true, they were sometimes called apostolic canons; but this means no more than that they were made by bishops, who lived soon after the apostles, and were called apostolical men. They consist of regulations, which agree with the discipline of the second and third centuries: the Greeks generally count eighty-five, but the Latins receive only fifty, nor do they observe all these.

CANONICAL, something belonging to, or partaking of, the nature of a canon: thus we read of canonical obedience, which is that paid by the inferior clergy to their superiors, agreeably to the canon law.

CANOPUS, in astronomy, a star of the first magnitude in the rudder of Argo, a constellation of the southern hemisphere.

CANSIERA, in botany, a genus of the Tetrandria Monogynia class and order. Calyx ventricose, four-toothed; no corolla; nectary four-leaved, surrounding the base of the germ; berry one-celled, one-seeded, superior. One species, C. scandens, native of India.

CANTATA, in music, a song or composition, intermixed with recitatives, airs, and different movements, chiefly intended for a single voice, with a thorough base, though sometimes for other instruments. The cantata, when performed with judgment, has something in it very agreeable, the variety of the movements not clogging the ear, like other compositions. It was first used in Italy, then in France, whence it passed to us.

CANTEEN, a small vessel made of tinplate or wood, in which soldiers, when on their march, or in the field, carry their liquor. They are cylindrical like barrels, 7½ inches diameter, and about four inches deep, holding three pints.

CANTHARIDES, in the Materia Medica, are insects used to raise blisters. They differ in their size, shape, and colour; the largest are about an inch long. Some are of a pure azure colour, others of that of pure gold, and others again have a mixture of gold and azure colours, all brilliant and extremely beautiful. These insects are more common in hot countries, though they are occasionally to be met with in all parts of Europe, at some seasons of the year; particularly among wheat and on meadows, upon the leaves of the ash, the poplar, the willow, &c. Such numbers of these insects are sometimes together in the air, that they appear like swarms of bees; they have likewise a very disagreeable smell, which is a guide for those who make it their business to catch them. Those who collect them, tie them in a bag or piece of linen cloth, that has been well worn, upon which they are killed with the vapours of hot vinegar, and dried in the sun, and kept in boxes. When dried, they are so light, that fifty of them will scarcely weigh a drachm. The Sicilian cantharides, and particularly those of Etna, are reckoned better than those of Spain. See Materia Medica and Pharmacy.

CANTHARIS, in natural history, a genus of insects of the order Coleoptera, Generic character; antennæ filiform; thorax mostly margined, shorter than the head; shells flexile; sides of the abdomen edged with folded papillæ. There are more than a hundred species enumerated, which are separated into three divisions; A. four feelers, hatchet-shaped: B. feelers filiform, the last joint setaceous: C. fore-feelers projecting, the last joint but one with a large ovate cleft appendage, the last joint ovate, acute. This division is denominated Lymexylon. The whole genus, excepting the last division, which in the grub and perfect state feeds on green wood, is most rapacious, preying on other insects, and even on its own tribe: C. bipustulata is a very beautiful insect, of a slender and cylindric shape; its colour is a very dark, but elegant, gilded green, with the tips of the wing-shells red, and on each side the thorax, a little below the setting on the wing-shells, is a triple vesicle, of a bright red colour, extensile or retractile at the pleasure of the insect, and which, if accurately examined by the microscope, will generally be found to exhibit an alternate inflation and contraction, resembling that of the lungs in the larger animals. This species is found during the summer on various plants, and particularly on nettles.

CANTHIUM, in botany, a genus of the Tetrandria Monogynia class and order. Calyx four-toothed, superior; corolla one-petalled, with a short inflated tube, and four-parted border; the mouth downy; drupe two-celled, with a one-celled nut in each. One species, C. parviflorum, found in Coromandel.

CANTICLES, or the *Song of Songs*, in biblical history, a Hebrew mode of expression to denote a song superlatively excellent in style and sentiment. Of this ancient poem the author is asserted, by the unanimous voice of antiquity, to have been Solomon, and this tradition is corroborated by many internal marks of authenticity. In the very first verse it is said to belong to Solomon: he is the subject of the piece, and the principal actor in the conduct of it. Though the Song of Songs comes down to us recommended by the voice of antiquity, its divine authority has been called in question by many writers in modern days. Whiston thinks it a dissolute loose song, composed by Solomon when advanced in years, and degenerate in practice; and that therefore it ought to be excluded from the canon of the sacred books. Taken indeed in its primary and literal sense, it must be considered as describing a royal marriage, and may therefore be denominated an epithalamium, or hymeneal song. The celebrated Michælis supposed that the object of it was, to teach God's approbation of marriage. But the ideas of Harmer appear much more rational; who, though unwilling to give it the name of epithalamium, thinks it a marriage song, to be explained by compositions of a similar nature in eastern countries. "What can be more likely," says he, "to lead us into the literal sense of an ancient nuptial poem, than the comparing it with similar modern productions of the east, along with antique Jewish compositions of the same kind?" Bossuet, bishop of Meaux, was of opinion that this song was to be explained by the consideration, that the Jews were wont to celebrate their nuptials for seven days together, distinguished from each other by different solemnities; and this notion has been adopted by the author of "A new Translation of Solomon's Songs, with a Commentary and Annotations." The principal objection to this opinion is, that the conduct of the poem does not admit of such a distribution; and the distinguishing each day by some distinct ceremony is a mere supposition, unsupported by fact. The elegant and learned bishop Lowth devotes two of his Prælectiones to an examination of this poem, and he determines it, with Bossuet, to be a sacred drama, though deficient in some of the essential requisites of dramatic composition. Sir William Jones, from his knowledge of eastern poetry, was led to compare some parts of it with similar productions among the Arabians, and delivers it as his opinion, that it is to be classed with the Hebrew idyls.

Supported by the high authority of this illustrious scholar, Mr. M. Good, in an elegant metrical version with which he has favoured the public, considers the Song of Songs as forming, not one continued and individual poem, but a series of poems, each distinct and independent of the other; and he denominates them sacred idyls. "The Song of Songs," he says, "cannot be one connected epithalamium, since the transitions are too abrupt for the wildest flights of the Oriental Muse, and evidently imply a variety of openings and transitions; while, as a regular drama, it is deficient in every requisite that could give it such a classification." It has been also regarded as a parable in the form of a drama, in proof of which, we are told, First, when closely examined, it will appear to possess all the essential qualities of a drama. The marriage of Solomon with the daughter of Pharaoh, (as related 1 Kings i. 1,) a political event, which, from the personages concerned in it, would be interesting to to the Jewish nation, was, as such, proper to furnish the fable of it. The writer is entirely left behind the curtain, and the whole of the composition is brought forward before the reader in parts between the speakers. The *dramatis personæ* are, Solomon, the bride, her attendants, and the virgins of Jerusalem. It should be observed, though the fact has indeed been overlooked by the critics, that all advance is made by the lady herself. She comes to his palace, unfetched, and apparently unsolicited. Finding him not there, she goes in search of him, intreats to be received into his embrace; and when without denying, he eludes her entreaties, she pursues him in the ardour of her affection almost beyond the bounds of female delicacy and modesty. On the contrary, the royal spouse is cold at heart, and distant, prone to recede, and to intrigue with his favourite concubines, but anxious to conceal his indifference and infidelity under laboured encomiums on the beauty of his spouse. The action is complete, possessing a beginning, a middle, and an end, and composed of scenes, the shifting of which, if observed by a modern reader, as by an ancient spectator, would have preserved the conduct of the piece uniform and consistent. The plot, it must be allowed, is very simple, the intricacies of it arising only from those unforseen impediments which were thrown by rival beauties in the way of the royal bride, and which threatened to deprive her of the object of her attachment. The catastrophe is the triumph of honourable love over the allurements of seduction, and the security of virtuous enjoyment over the torments of jealousy and illicit fruition. Secondly, considered as a parable; like other parables, while it conveys a literal sense interesting and appropriate, it conveys likewise a religious lesson of great importance. Now the method of decyphering a fable or parable is, not by seeking, under the veil of the allegory, certain maxims of recondite wisdom, which bear no resemblance to the literal sense, but by facts generally known and fully understood: nor is the interpretation to be deemed true, unless, as in the case of the parable of Nathan, or that of the sower, there subsists an obvious and characteristic analogy between the simple and the metaphorical acceptation. On this principle, it is apprehended that, in the parable of the Canticles, the bride means the Jewish religion, and the royal spouse the Jewish nation, represented under the name and person of their ruler and chief; and the object of it is, to delineate, under images borrowed from the connubial state, the conduct of the Israelites at large, and that of Solomon in particular, in respect of their knowledge and worship of Jehovah. In proof of this position, it would be necessary to enter farther into the subject than our limits will allow: the reader is therefore referred, for a justification of this theory, to Rees's New Cyclopedia.

CANTO, in music, the treble, or, at least, the higher part of a piece.

CANTON, (JOHN), in biography, an ingenious natural philosopher, was born at Stroud, in Gloucestershire, in 1718; and was placed, when young, under the care of Mr. Davis, an able mathematician of that place, with whom he had learned both vulgar and decimal arithmetic before he was quite nine years of age. He next proceeded to the higher parts of the mathematics, and particularly to algebra and astronomy, in which he had made a considerable progress, when his father took him from school and set him to learn his own business, which was that of a broad-cloth weaver. All his leisure time was devoted to the assiduous cultivation of astronomical science; by which he was soon able to calculate eclipses, and to construct various kinds of sun-dials, even at times when he ought to have slept, being done without the knowledge and consent of his father, who feared that such studies might injure his health. It was during this prohibition, and at these hours, that he computed, and cut upon stone, with no better an instrument than a common knife, the lines of a large upright sun-dial, on which, beside the hour of the day, were shewn the sun's rising, his place in the ecliptic, and some other particulars. When this was finished, and made known to his father, he permitted it to be placed against the front of his house, where it excited the admiration of several neighbouring gentlemen, and introduced young Canton to their acquaintance, which was followed by the offer of the use of their libraries. In the library of one of these gentlemen he found Martin's Philosophical Grammar, which was the first book that gave him a taste for natural philosophy. In the possession of another gentleman he saw a pair of globes; a circumstance that afforded him great pleasure, from the great ease with which he could solve those problems that he had hitherto been accustomed to compute.

Among other persons with whom he became acquainted in early life was Dr. Henry Miles, of Tooting, who, perceiving that young Canton possessed abilities too promising to be confined within the narrow limits of a country town, prevailed on his father to permit him to come up to London. Accordingly he arrived at the metropolis the 4th of March 1737, and resided with Dr. Miles at Tooting till the 6th of May following, when he articled himself, for the term of five years, as a clerk to Mr. Samuel Watkins, master of the academy in Spital Square. In this situation, his ingenuity, diligence, and prudence, were so distinguished, that on the expiration of his clerkship, in May, 1742, he was taken into partnership with Mr. Watkins for three years; which gentleman he afterwards succeeded in the school, and there continued during the remainder of his life.

Towards the end of 1745, electricity received a great improvement by the discovery of the famous Leyden phial. This event turned the thoughts of most of the philosophers of Europe to that branch of natural philosophy; and our author, who was one of the first to repeat and to pursue the experiment, found his endeavours rewarded by many notable discoveries. Towards the end of 1749, he was engaged with his friend, the late ingenious Benjamin Robins, in making experiments to determine the height to which rockets may be made to ascend, and at what distance their light may be seen. In 1750 was read at the Royal Society, Mr. Canton's "Method of making Artificial Magnets, without the use of, and yet far superior to, any natural ones." This paper procured him the honour of being elected a member of the Society, and the present of their gold medal. The same year he was complimented with the degree of A. M. by the University of Aberdeen. And in 1751 he was chosen one of the council of the Royal Society; an honour which was twice repeated afterwards.

In 1752, Mr Canton was so fortunate as to be the first person in England, who, by attracting the electric fire from the clouds during a thunder-storm, verified Dr. Franklin's hypothesis of the similarity of lightning and electricity. Next year his paper, entitled "Electrical Experiments, with an Attempt to account for their several Phenomena," was read at the Royal Society. In the same paper Mr. Canton mentioned his having discovered, by many experiments, that some clouds were in a positive, and some in a negative state of electricity: a discovery which was also made by Dr. Franklin in America much about the same time. This circumstance, together with our author's constant defence of the doctor's hypothesis, induced that excellent philosopher, on his arrival in England, to pay Mr. Canton a visit, and gave rise to a friendship which ever after continued between them. Mr. Canton was a contributor to the Philosophical Transactions, and, among many other papers, he sent, in 1765, an account of the transit of Venus of the 6th of June that year, observed in Spital Square. On the 16th of December, the same year, another curious addition was made by him to philosophical knowledge, in a paper, entitled "Experiments to prove that Water is not incompressible." And on Nov. 8, the year following, were read before the Society, his farther "Experiments and Observations on the Compressibility of Water, and some other fluids." These experiments are a complete refutation of the famous Florentine experiment, which so many philosophers have mentioned as a proof of the incompressibility of water. For this communication he had a second time the Society's prize gold medal. Mr. Canton was a contributor to many other publications, particularly to the Gentleman's Magazine. In every period of his life he was an ardent promoter of useful science; and while philosophy lives, the name of Canton will not be forgotten. He died of the dropsy, in his 54th year, on the 22d of March, 1772.

CANTONING, in the military art, is the allotting distinct and separate quarters to each regiment of an army; the town where they are quartered being divided into so many cantons, or divisions, as there are regiments.

CANTUA, in botany, a genus of the Pentandria Monogynia class and order. Calyx three to five-cleft; corolla funnel-form; stigma three-cleft; capsule three-celled, three-valved, many seeded; seeds winged. There are four species, natives of America.

CANVASS, in commerce, a very clear unbleached cloth of hemp, or flax, wove very regularly in little squares. It is used for working tapestry with the needle, by passing the threads of gold, silver, silk, or wool, through the intervals or squares. This also is the name of a coarse cloth of hemp, unbleached, somewhat clear, which serves to cover women's stays, also to stiffen men's clothes, and to make some other of their wearing apparel, &c. It is likewise the name of a very coarse cloth made of hemp, unbleached, serving to make towels, and answering other domestic purposes. It is also used to make sails for shipping, &c.

CAOUTCHOUC, or, as it is usually, though improperly named, *elastic gum*, is a vegetable matter, which, in several of its physical qualities, as well as in its chemical relations, has some similarity to vegetable gluten, and which so far agrees both with it and albumen, as to approach in the nature of its composition to animal matter.

The substance to which the name of caoutchouc, or elastic gum, has been more particularly given, was brought from Spanish America, in the form of hollow spheres or bottles, in which state it is still imported into Europe; it was evident, therefore, that it had undergone some artificial preparation. Condamine gave the information, that it is the inspissated juice of a tree belonging to the family of the Euphorbia, which has since received the botanical name of Havea guianensis, or Havea caoutchouc. Incisions are made in the bark of this tree: a milky juice exudes, which is collected. It is applied in successive coatings over a mould of clay; is dried up by exposure to the sun, and afterwards by being placed in the smoke from burning fuel; when dry, the clay mould is crushed, and the fragments extracted, and in this manner the spherical bottles are formed. It has since been discovered, that caoutchouc is not exclusively the produce of this vegetable; but that it is furnished likewise by other plants, either perfectly the same, or with very slight variations of properties. It is obtained in large quantity from the Jatropha elastica, a native likewise of different provinces of South America. Fourcroy procured specimens of the juice of the caoutchouc, in the state in which it exists previous to its inspissation, from the Island of Bourbon, from Cayenne, and the Brazils, and examined its properties. From experiments he concluded, that caoutchouc exists ready formed in the juice of the tree, and is capable of being separated in the concrete form ; but that a portion also exists, not sufficiently perfect to be deposited with its elastic property ; that it acquires this, together with its inspissation, from the action of oxygen; and that, by this operation, exposure to the atmosphere influences the concretion of caoutchouc in the usual process in which it is brought to the solid form.

The purest caoutchouc Fourcroy supposes to be that which separates spontaneously from the juice in close vessels. It is white, or of a slight fawn colour. The properties of caoutchouc have been determined, principally, from the state in which it exists in the elastic bottles which are imported to Europe ; and in this state its properties do not seem to have undergone any important change, or to be different from those of the pure caoutchouc. Its colour is a dark brown ; its external surface is smooth ; its internal texture is rough, and presents a fibrous appearance. Its specific gravity is nearly the same with water, being from 9.3 to 10.0. It is inodorous, and is also destitute of taste.

The most remarkable physical property of which this substance is possessed, and which eminently distinguishes it, is its high elasticity. It can be stretched out to a great length, and when the force that has been applied to it is withdrawn, it instantly returns to its former dimensions. Its pliancy is increased by heat, while it is rendered more rigid by cold ; and its softness, which is connected with the former quality, is so much increased by warmth, that it can be moulded into any form, and two parts newly cut may even be pressed together, so as to be intimately united.

Caoutchouc, exposed in a dry state to a high temperature, softens, swells up, and emits a fetid odour, similar to that of animal substances: as the heat is increased, it melts into a viscid matter, and remains in this state when cold. If heated sufficiently high, it takes fire, and burns with a vivid light and dense smoke ; in the countries in which it is produced it has been used for torches. It is perfectly insoluble in water and alcohol, but is dissolved in either.

This substance is capable of being applied to important purposes, from its softness and flexibility, its elasticity, and particularly its indestructibility, and not being affected by air, water, or indeed the greater number of chemical agents. Tubes for conveying gases, and other chemical instruments, are accordingly prepared from it; and bougies, catheters, and similar surgical instruments of caoutchouc, are much preferable to what can be prepared from any other substance.

The solution of caoutchouc in some of the oils has been used as a varnish, to render flexible substances, as silk, &c. impermeable to water or air. It has the advantage of being perfectly flexible; but it is long before it dries, and is liable to be softened by a very moderate heat. To render it less viscid, it is generally prepared from a mixture of volatile and expressed oils.

CAP *of maintenance*, one of the regalia, or ornaments of state, belonging to the kings of England, before whom it was carried at the coronation, and other great solemnities. Caps of maintenance are also carried before the mayors of several cities in England.

It is of crimson velvet, faced with ermine, and was formerly esteemed a badge and symbol of dignity, and suitable to a prince of the blood, being worn by King Edward III. and succeeding sovereigns down to Edward VI. but of late it has been granted to private families. It is frequently to be met with above the helmet, instead of a wreath, under gentlemen's crests.

Cap, in a ship, a square piece of timber put over the head or upper end of any mast, having a round hole to receive the mast. By means of these caps the top-masts and top-gallant-masts are kept steady and firm in the tressel-trees where their feet stand.

Cap *of a gun*, a piece of lead which is put over a touch-hole of a gun, to keep the priming from being wasted or spoiled.

CAPACITY, in a general sense, an aptitude or disposition to retain or hold any thing.

Capacity, in geometry, is the solid contents of any body ; also our hollow measures for wine, beer, corn, salt, &c are called measures of capacity.

Capacity, in the modern doctrine of heat, signifies the proportional capability of a given quantity of any substance to absorb and retain caloric, or that disposition or property, by which various bodies respectively require more or less of this fluid to superinduce any given temperature in a given mass. See CALORIC.

That this capacity varies in different bodies, and even in the same substance in different states, may be easily shewn. If the quantities of heat necessary to be added to or taken from bodies, in order to produce equal changes in their temperature, were in all cases proportional to their respective quantities of matter; as if, for example, it would require the same quantity of this fluid to heat a pound of water, a pound of oil, or a pound of mercury, 20 degrees, this would, of course, indicate that their capacities were equal: but if, on the contrary, it should be found that the same quantity of caloric, applied to these various substances, should produce different changes in the temperature of equal quantities, or equal changes in the temperature of different quantities of each, it would follow, that their capacities from this fluid must proportionally vary. Let us conceive, that having three several pounds of water at the temperature of 110° of Fahrenheit's thermometer in separate vessels, there be added to the first a quantity of water at 50°; to the second a quantity of spermaceti oil, also at 50°; and to the third a quantity of mercury at the like temperature of 50°; and that each of the mixtures be stirred together, and the addition continued, till they have all assumed throughout a common temperature of 70°. Now, as each of the pounds of water has, in this case, been deprived of an equal quantity of caloric, (*viz.* as much as was necessary to raise its temperature 40°, or from 70° to 110°, the absolute capacities of the whole of the water, the oil, and the mercury, which have been added, must, of course, be equal, whatever be the quantity of each; each of them having absorbed an equal quantity of heat. On comparing the quantities of these latter substances, however, it will be found that we have employed in the experiment about two pounds of water at 50°, four pounds of oil, and nearly sixty pounds of mercury, each of which has been heated 20°; so that it requires as much caloric to heat one pound of water 20°, as to produce the same effect on two of oil, or 30 of mercury; and their relative capacities are therefore inversely in this proportion. A change of capacity in the same body is producible in three ways: by mechanical compression or dilatation, by chemical combination, or by the action of heat itself, of each of which we shall say a few words. With regard to the first, the general fact appears to be, that wherever a body is by any means condensed, its capacity becomes diminished; but that where it is dilated or enlarged in its bulk, it is proportionally increased. Thus, if a thermometer be suspended in a receiver, and a quantity of air condensed into it, the mercury will rise; a part of the caloric which is contained in the air being, as it were, squeezed out by its compression, and forced into the mercury in the bulb, whose temperature is consequently raised: if, however, on the contrary, the air be rarefied, the thermometer will indicate cold; the capacity of the air in the receiver being increased by its rarefaction, and a portion of the caloric in the contiguous bodies consequently absorbed, whereby their temperature is lowered and their bulk diminished.

The second mode of changing the capacities of bodies is by their chemical combination; and, perhaps, there is no combination unaccompanied by such a change. In some instances this takes place in a very remarkable degree, and it is from hence that we derive the effects of calorific and frigorific mixtures. If, for example, a quantity of sulphuric acid, diluted with an equal measure of water, be poured on a quantity of crystals of Glauber's salt, recently powdered, the capacity of the compound is considerably greater than that of its component ingredients; it becomes, therefore, strongly absorbent of caloric, which it attracts from the bodies in its vicinity, and a quantity of water in a phial placed in the mixture will be soon frozen.

The third case of change of capacity, by the action of heat itself, is, perhaps, productive of more important effects in nature than either of the other two. The capacities of all bodies are increased in some proportion to the dilatation of their bulk, and the disaggregation of their constituent particles, as well by the agency of caloric as by any other cause. Hence, when a solid is fused, or a liquid resolved into vapour, cold is produced by the augmentation of its capacity; and, *e converso*, when steam is condensed, or congelation takes place, heat is developed by its diminution. Thus, if equal quantities of pounded ice and water, each at 32° of Fahrenheit, be exposed to heat in two similar vessels in a water-bath, the water will be heated in 178° before the ice is all dissolved, the water produced from which will, of course, still remain at 32°, so that the increase of capacity in the ice, during its solution, is sufficient to enable it to absorb, without any elevation of its temperature, as much caloric as has raised the temperature of an equal quantity of water 146°; and the like quantity is also again emitted on its becoming again congealed. If a quantity of water be exposed without agitation to a degree of cold equal to 24° or 25°, it will frequently acquire this temperature without freezing; but as soon as congelation begins, the thermometer will immediately rise to 32°, and the whole will remain at that temperature till all the water is converted into ice.

This latter change of capacity appears to be absolutely essential to the well-being of the universe, as affording a constant modification of the action of heat and cold, whose effects would otherwise be inordinate. If this did not take place, the whole of a mass of water which was exposed to a temperature above the boiling point would be instantly dissipated in vapour with explosion. The fact, however, is, that the capacity of those portions of the liquid, which are successively resolved into a vapour, becomes thereby sufficiently augmented to enable them to absorb the superabundant caloric as fast as it is communicated: and it is for this reason that boiling water in an open vessel never reaches a higher temperature than 212°. The polar ices would all instantaneously dissolve, whenever the temperature of the circumambient air was above 32°, if it were not that each particle absorbs a quantity of caloric in its solution, and thereby generates a degree of cold, which arrests and regulates the progress of the thaw; and the converse of this takes place in congelation, which is in its turn moderated by the heat developed in consequence of the diminution of capacity, which takes place in the water during its transition to a solid state.

Capacity, in law, the ability of a man, or body politic, to give or take lands, or other things, or sue actions.

Our law allows the king two capacities, a natural and a political; in the first he may purchase lands to him and his heirs; in the latter to him and his successors. The clergy have the like.

CAPARASON, or horse-cloth, a sort of cover for a horse. For led horses it is commonly made of linen cloth, bordered round with woollen, and enriched with the arms of the master upon the middle, which covers the croupe, and with two cyphers on the two sides. The caparasons for the army are sometimes a great bear's skin, and those for stables are of single buckram in summer, and of cloth in the winter.

CAPELLA, in astronomy, a bright fixed star of the first magnitude, in the left shoulder of the constellation Auriga. It is in the Britannic Catalogue the fourteenth in order of that constellation. Its longitude is 17° 31′ 41″, it latitude 22° 51′ 47.″

CAPER. See Capparis.

CAPIAS, is a writ of two sorts, one whereof is called *capias ad respondendum*, before judgment, where an original is sued out, &c. to take the defendant and make him answer the plaintiff: and the other a writ of execution, after judgment, being of divers kinds.

Capias *ad respondendum*, is a writ commanding the sheriff to take the body of the defendant, if he may be found in his bailiwic or county, and him safely to keep, so that he may have him in court on the day of the return, to answer to the plaintiff of a plea of debt, or trespass, or the like, as the case may be. And if the sheriff return that he cannot be found, then there issues another writ, called an *alias capias*; and after that another, called *pluries capias;* and if upon none of these he can be found, then he may be proceeded against unto outlawry. But all this being only to compel an appearance, after the defendant hath appeared, the effect of these writs is taken off, and the defendant shall be put to answer, unless it be in cases where special bail is required, and there the defendant is actually to be taken into custody.

Capias *ad satisfaciendum*, is a writ directed to the sheriff, commanding him to take the body of the defendant, and him safely to keep, so that he may have his body in court at the return of the writ, to make the plaintiff satisfaction for his demand; otherwise he is to remain in custody till he do. When a man is once taken in execution upon this writ, no other process can be sued out against his lands or goods. But if a defendant die whilst charged in execution upon this writ, the plaintiff may, after his death, sue out new executions against his lands, goods, or chattles.

Capias *utlegatum*, is a writ that lies against a person that is outlawed in any action, whereby the sheriff is commanded to apprehend the body of the party outlawed, and keep him in safe custody till the day of the return of the writ, and then present him to the court, there to be dealt with for his contempt. But this being only for want of appearance, if he shall afterwards appear, the outlawry is most commonly reversed.

Capias *in withernam*, is a writ directed to the sheriff, in case where a distress is carried out of the county, or concealed by the distrainer, so that the sheriff cannot make deliverance of the goods upon a replevin, commanding him to take so many of the distrainer's own goods, by way of reprisal, instead of the other that are so concealed.

CAPILLARY *tubes*, in physics, little pipes, whose canals are extremely narrow, their diameter being only a half, third, or fourth of a line.

The ascent of water, &c. in capillary tubes, is a phenomenon that has long embarrassed philosophers; for let one end of a glass tube, open at both ends, be immerged in water, and the liquor within the tube will rise to some sensible height above the external surface; or if two or more tubes are immerged in the same fluid, one of them a capillary one, the other of a larger bore; the fluid will ascend higher in the capillary tube than in the other, and this in the reciprocal ratio of the diameters of the tubes.

In order to account for this phenomenon, it will be necessary first to premise that there is a greater attraction between the particles of glass and water, than there is between the particles of water themselves: this appears plain from experience which proves the attractive power in the surface of glass to be very strong; whence it is easy to conceive how sensible such a power must act on the surface of a fluid not viscid, as water contained within the small cavity or bore of a glass tube; as also that it will be in proportion stronger as the diameter of the bore is smaller; for that the efficacy of the power follows the inverse proportion of the diameter is evident from hence, that only such particles as are in contact with the fluid, and these immediately above the surface, can affect it. Now these particles form a periphery, contiguous to the surface, the upper part of which attracts and raises the surface, and the lower part, which is in contact with it, supports and holds it up, so that neither the thickness nor length of the tube avails any thing, only the said periphery of particles, which is always proportional to the diameter of the bore: the quantity of the fluid raised will therefore be as the surface of the bore which it fills, that is, as the diameter; as the effect would not be otherwise proportional to the cause, since the quantities follow the ratio of the diameters, the heights to which the fluids will rise in different tubes will be inversely as the diameters.

Some, however, doubt whether the law holds throughout, of the ascent of the fluid being always higher as the tube is smaller. Dr. Hook's experiments, with tubes almost as fine as cobwebs, seem to shew the contrary. The water in these, he observes, did not rise so high as one would have expected. The highest he ever found was at 21 inches above the level of the water in the basin, which is much short of what it ought to have been by the law above mentioned.

Capillary *vessels*, in anatomy, the smallest and extreme parts of the veins and arteries.

CAPITAL, the head, chief, or principal of a thing. Thus,

Capital, in geography, denotes the principal city of a kingdom, province, or state; as London is the capital of Britain.

Capital, among merchants, traders, and bankers, signifies the sum of money which individuals bring, to make up the common stock of a partnership when it is first formed. It is also said of the stock which a merchant at first puts into trade for his account. It signifies likewise the fund of a trading company, or corporation, in which sense the word stock is generally added to it: thus, we say, the capital stock of the bank, &c.—The word capital is opposed to that of profit or gain, though the profit often increases the capital, and becomes itself a part of it.

Capital *crime*, such a one as subjects the criminal to capital punishment, that is, the loss of life.

Capital, in architecture, the uppermost part of a column or pilaster, serving as the head or crowning, and placed immediately over the shaft, and under the entablature.

The capital is the principal part of an order of columns or pilasters. It is of a different form in the different orders, and is that which chiefly distinguishes and characterizes the orders. Such of these as have no ornaments, as the Tuscan and Doric, are called capitals of mouldings; and the rest, which have leaves and other ornaments, capitals of sculptures.

Capital, *Tuscan*, consists of three members, *viz.* an abacus, under this an ovolo or quarter round, and under that a neck or colarino, terminating in an astragal or fillet, belonging to the shaft.

Capital, *Doric*, has its abacus plain,

and three annulets under the ovolo, or echinus.

Capital, *Ionic*, that which is distinguished by volutes and ovolos. The ovolo is adorned with eggs and darts.

Capital, *Corinthian*, is the richest of all, being adorned with a double row of leaves, with eight large and as many small volutes, situated round a body, which by some is called campana, or bell, and by others tambour or capsule.

Capital, *composite*, that which has the double row of leaves of the Corinthian, and the volutes of the Ionic capital.

Capitals, among printers, large or initial letters, in which titles are composed.

The English printers some years ago made it a rule to begin almost every substantive with a capital; a custom not more absurd than that of using no capitals at all.

Capitals, however, may very properly commence the first word of every book, chapter, letter, note, or any other piece of writing: the first word after a period, and if the two sentences are totally independent, after a note of interrogation or exclamation; but if a number of interrogative or exclamatory sentences are thrown into one general group, or if the construction of the latter sentences depends on the former, all of them except the first, may begin with a small letter: the appellations of the deity: proper names of persons, places, streets, mountains, rivers, ships: adjectives derived from the proper names of places: the first word of a quotation, introduced after a colon, or when it is in a direct form; but when a quotation is introduced obliquely after a comma, a capital is unnecessary: the first word of an example: every substantive and principal word in the titles of books: and the first word of every line in poetry. The pronoun I, and the interjection O, are also written in capitals. Other words, beside the preceding, may likewise begin with capitals, when they are remarkably emphatical, or the principal subject of the composition. The ancient MSS. both Greek and Latin, are written wholly in capitals.

CAPITATION, a tax or imposition raised on each person, in consideration of his labour, industry, office, rank, &c.

CAPITE, in law, an ancient tenure of land, which was held immediately of the king, as of his crown, either by knight's service or socage. The tenure in capite was of two kinds, the one principal and general, the other special or subaltern. The former was of the king, the fountain from whence all tenures have their main original. The latter was of a particular subject, so called, because he was the first that granted the land in such manner, and hence he was styled "capitalis dominus, and caput terræ illius." This tenure is now abolished, and, with others, turned into common socage.

CAPITULATION, in military affairs, a treaty made between the garrison or inhabitants of a place besieged, and the besiegers, for the delivering up the place on certain conditions.

The most honourable and ordinary terms of capitulation are, to march out at the breach, with arms and baggage, drums beating, colours flying, a match lighted at both ends, and some pieces of cannon, waggons, and convoys for their baggage, and for the sick and wounded.

CAPPARIS, in botany, English *caper-bush*, a genus of the Polyandria Monogynia class and order. Natural order of Putamineæ. Caparides, Jussieu: Essential character: calyx four-leaved, coriaceous; petals four; stamens long; berry corticose, one-celled, pedicelled. There are twenty-five species. This genus consists of shrubs. The leaves are simple in the berry-bearing sorts, having frequently two spines at the base, but in those which bear pods commonly naked or bi-glandular. Flowers in a kind of corymb, terminating. Some of the species have a berry, others have a silique or pod for a fruit. C. spinosa, common caper-bush, is a low shrub, generally growing out of the joints of old walls, the fissures of rocks, and among rubbish. It grows wild in the southern countries of Europe, and in the Levant. Dr. Smith thinks it surprising that this beautiful shrub, which is as common in the South of France as the bramble with us, should be almost unknown in our gardens, where it can scarcely be made to flower, except in a stove with great care.

CAPRA, the goat, in natural history, a genus of Mammalia, of the order Pecora. Generic character: horns hollow, compressed; rough, almost close at their base, turned back; eight lower fore teeth; no tusks; chin in the male bearded. Of these there are three species, of which we shall attend particularly to the C. hircus, or common goat. This animal is found domesticated in almost every part of the Globe, but was introduced into America only on its discovery by Europeans. In its internal structure it extremely resembles sheep, but is far superior to them in alertness, sentiment, and intelligence. The goat approaches man without difficulty, is won by kindness, and capable of attachment. Confinement is ill suited to his excursive tendencies, and he is fond of retiring into solitude, and ranging on the cliffs of the most rugged and barren mountains. He will not only climb and stand on the loftiest craggs, but sleep also on the verge of the most steep and terrific precipices. He is capable of enduring both cold and heat, and the most ardent rays of the sun produce in him no vertigo or sickness of any description; the violence of storms causes him little or no inconveniencies, but he suffers somewhat from very rigorous cold. His organs are extremely supple, and his frame is robust and nervous. Almost all herbs are used by him for food, and few are noxious to him. His favourite nourishment, however, is derived from the tender branches and bark of trees and shrubs, from lichens and hemlock. He is sprightly, roaming and lascivious in the extreme; inconstant and capricious in his temper; and the vivacity of his feelings is exhibited in a perpetual succession of rapid, abrupt, and sportive movements. He prefers barren heats to luxuriant pastures, avoids moist and marshy places, and never flourishes but in mountainous, or at least elevated situations. The female will allow itself to be sucked by the young of various other animals, and a foal which has lost its mother has been seen thus nourished by a goat, which, in order to facilitate the process, was placed on a barrel. The attachment between the nurse and foal appeared strong and natural. The milk of the goat, containing few oily particles, is much valued in medicine, and being easily curdled, is formed into cheese of high estimation.—The celebrated Parmesan cheese is made of it.

The goats of Wales are generally white, and are both stronger and larger than those of other hilly countries. Their flesh is much used by the inhabitants, and often dried and salted, and substituted for bacon. The skins of kids are much valued for gloves, and were formerly employed in furniture, when painted with rich colours, of which they are particularly capable, and embellished with ornamental flowers and works of silver and gold.

The extremely unpleasant odour attending these animals is supposed to be beneficial, and horses appear so much refreshed by it, that a goat is on this account often kept in the stables of the great. Of the many varieties of this species, that of Angora is the most curious. It is principally valued for its long and exquisitely fine hair, which it loses by a change of pasture from the immediate vicinity of Angora, and which the owners are incessantly assiduous in washing and combing, and otherwise promoting its growth and cleanliness.—It is formed into camlets of the finest texture.

The Syrian goat is remarkable for its pendulous ears, and is common in various parts of the East: the animals of this variety are driven in flocks through the Oriental towns every morning and evening, and each house-keeper sees drawn from them, before her door, as much milk as she is in want of. See Mammalia, Plate VI. fig. 6.

The Chamois goat inhabits the most elevated mountains of Europe, and feeds on shrubs, roots and herbs: its chase is extremely laborious and dangerous: its sight and smell are both exquisite: it is particularly shy: its swiftness is also very great, and it makes its way with speed over the most pointed rocks, can mount or descend precipices with facility, and hang on steeps nearly perpendicular.—Plate VI. fig. 5.

C. Ibex, or the Ibex goat of Pennant. This is considerably larger than the last species: its blood was formerly deemed a specific in the materia medica for various diseases: its strength and feeling are extraordinary: it is found in the Carpathian and Pyrennean mountains, in the Rhœtian Alps, in Crete, and in Tartary. When hardly pressed, it will throw itself from a vast height with little or no injury, contriving always to fall on its horns. Plate IV. fig. 4.

C. Caucasica, the Caucasan goat, inhabits the most rugged rocks of mount Caucasus, and is, perhaps, superior in vigour and agility to all that have been mentioned. A bezoar is sometimes found in the stomach of this animal, as well as in that of several others quadrupeds. Monardes states that he saw one of these creatures leap from a high tower, and having reached the ground upon his horns, immediately, without any wound, dislocation, or contusion, rise on his feet.

CAPRARIA, in botany, *goat-weed*, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu: Essential character: calyx five-parted; corol bell-form, five-cleft, acute; capsules bivalve, bilocular, many seeded. There are seven species, of which C. biflora, shrubby goat-weed, or sweet-weed, is a shrub, seldom exceeding four feet in height; branches long and woody; leaves oblong acuminate at both ends, an inch and half long; peduncles one-flowered, slender; flowers without scent, calyx smooth; corolla white; capsule furrowed on both sides the length of the calyx; seeds small. It is common in Jamaica, in all the Caribbees, and the neighbouring continent.

CAPRICORN, in astronomy, one of the twelve signs of the zodiac, represented on globes in the form of a goat, and characterized in books by this mark ♑. See ASTRONOMY.

CAPRICORN, *tropic of*, a lesser circle of the sphere, which is parallel to the equinoctial, and at 23° 30′ distance from it southwards.

CAPRIFOLIA, the third order of the eleventh class of Jussieu's natural system. It has the following characters: calyx one-leafed, superior, often calycled or bracteated at its base; corolla generally monopetalous, either regular or irregular, in a few instances polypetalous; petals united by a broad base; stamens of a definite number, often five: in the monopetalous genera always inserted into the corolla, and alternating with its segments; in the polypetalous ones sometimes placed upon the pistil, alternating with the petals, and sometimes fixed to the middle of each petal; germ inferior; style generally single, sometimes none; stigma single, or rarely three; fruit inferior, either a berry or a one or many-celled capsule; each cell with one or many seeds; corculum of the seed in a large upper cavity of the large solid perisperm; stem either a shrub or a tree, rarely herbaceous; leaves in most opposite, in a few alternate; stipules none.

CAPRIMULGUS, the *goatsucker*, in natural history, a genus of birds of the order Passeres. Generic character: bill short and hooked at the end; mouth extremely wide, with seven or more stiff bristles on the upper mandible; tongue entire at the end and small; tail of ten feathers, and not forked; legs short; toes united as far as the first joint by a membrane; middle claw with a broad serrate edge.

The birds of this genus, unless disturbed, or in cloudy and gloomy weather, seldom make their appearance by day, but by night are active and alert in the pursuit of insects, which constitute their food. The female deposits only two eggs, and on the bare ground. There are according to Gmelin nineteen species, though Latham enumerates only fifteen. The most curious and interesting are—

C. Europæus, or the European goatsucker. This is the only species met with in Europe, in every part of which it may be found, though no where abundantly, and it is never observed to unite in companies. Being migratory, it arrives in England in May, and quits it in September. It is a mortal enemy to various insects, and particularly to cockchafers, six of which, besides four very large moths, have been found in its stomach. The glare of day is overpowering to its sight, which is cleared by twilight. During this, therefore, it is in quest of food, and in full activity. It is singular for perching, not across a branch as other birds do, but lengthwise: the female lays her eggs on the ground instead of a nest, apparently little anxious for their maturity: though when disturbed she will move them it is said to a place imagined by her to be more secure.

C. Virginianus, or the Virginian goatsucker. This bird arrives in Virginia in April, and inhabits principally the mountainous parts of that country. As the evening advances, it approaches the habitations of man, and, fixing on a post or rail, utters many times one plaintive cry; and from the evening till the morning this movement and cry are with short intervals repeated. Instead of pursuing insects always on the wing, it often leaps up for them as they pass with the most successful dexterity, falling back again upon its perching place. Its flesh is valued for food.

CAPSICUM, in botany, English Guinea-pepper, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla rotated; berry exsuccous. There are five species according to Martyn, but many botanists mention sixteen, and others twenty. C. annum, annual capsicum, or Guinea-pepper, is two feet high, upright, branched, leaves ovate lanceolate, smooth, and of a dark green colour; flowers white, lateral, solitary. The fruit is a berry, varying in size and shape, extremely smooth and shining on the outside, scarlet or yellow. The beauty of the capsicum is in their ripe fruit, forming a pretty contrast to their dark leaves and white flowers, making a beautiful appearance in the gardens when properly disposed, or when planted in pots for the decoration of courts. Most of the sorts of capsicum are natives of both the Indies, but they are chiefly brought to Europe from America, where they abound in all the Caribbee islands, and are greatly used in sauces, whence the fruit is called Guinea-pepper. From the C. minimum is obtained the Cayenne-pepper, so much used in highly-seasoned cookery. See CAYENNE-PEPPER.

CAPSTAN, or *main-capstan*, in a ship, a great piece of timber in the nature of a windlass, placed next behind the main-mast, its foot standing in a step on the lower deck, and its head between the upper deck; formed into several squares with holes in them. Its use is to weigh the anchors, to hoist up or strike down top-masts, to heave any weighty matter, or to strain any rope that requireth a main force.

CAPSTAN-*bars*, the pieces of wood that are put into the capstain-holes to heave up any thing of weight into the ship.

CAPSTAN, *pawl of a*, a short piece of iron made fast to the deck, and resting upon the whelps, to keep the capstain from recoiling, which is of dangerous consequence.

CAPSTAN, *whelps of a*, are short pieces of wood made fast to it, to keep the cable from coming too nigh in turning it about.

CAPSULE, among botanists, a species of pericarpium, or seed-vessel, composed of several dry elastic valves, which usually burst open at the points when the seeds are ripe: it differs from a pod in being roundish and short. This kind of pericarpium sometimes contains one cell or cavity, sometimes more; in the first case it is called unilocular, as it is bilocular, trilocular, &c. when it contains two, three, &c. cells or cavities

CAPTION, in law, is where a commission is executed, and the commissioners subscribe their names to a certificate, declaring when and where the commission was executed. It relates chiefly to commissions to take answers in chancery, and depositions of witnesses, and take fines of lands, &c.

CAPTION and *horning*, in the law of Scotland. When a decree or sentence is obtained against any person, the obtainer thereof takes out a writ, whereby the party discerned is charged to pay or fulfil the will of the decree, under the pain of rebellion: this writ is called letters of horning. If he refuse to comply, then the writ or letters of caption may be raised, whereby all the inferior judges and magistrates are commanded to assist in apprehending the rebel, and putting him in prison.

CAPTURE, a prize taken by a ship of war at sea: vessels are looked upon as prizes, if they fight under any other standard than that of the state from which they have their commissions, if they have no charter-party, invoice, or bill of lading aboard; if loaded with effects belonging to the king's enemies, or even contraband goods. Those of the king's subjects recovered from the enemy, after remaining twenty-four hours in their hands, are deemed lawful prizes, if taken. In ships of war the prizes are to be divided among the captors, *i. e.* officers, seamen, &c. as his Majesty shall appoint by proclamation; but among privateers the division is according to agreement among the owners. See PRIZE.

CAPURA, in botany, a genus of the Hexandria Monogynia class and order. Essential character; calyx none; corolla six-cleft; stamina within the tube; germ superior; stigma globular; pericarp berry. There is but one species, *viz.* C. purpurata, native of the East Indies.

CAPUT *Draconis*, the *Dragon's head*, in astronomy, the ascending node of the moon. See NODE. Caput Draconis is also a star of the first magnitude in the head of the constellation Draco.

CAPUT *mortuum*, in chemistry, that thick dry matter which remains after distillation of any thing, but of minerals especially. These residues were formerly thrown away as of no value. Glauber was the first person who examined them with minuteness, and in the research he discovered the sulphate of soda, then named after himself, Glauber's salt. This he obtained in the caput mortuum remaining after the distillation of muriatic acid from common salt and green vitriol.

CARABINE, a fire-arm, shorter than a musket, carrying a ball of twenty-four in the pound, borne by the light-horse, hanging at a belt over the left shoulder. The barrel is two feet and a half long, and is sometimes furrowed spirally within, which is said to add to the range of the piece.

CARABUS, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ filiform, feelers mostly six; the last joint obtuse and truncate; thorax flat, margined; shells margined. This is an exceedingly numerous genus, and the insects of it are extremely active and quick in running; they devour the larvæ of other insects, and all the weaker animals they can overcome; the legs are long; thighs compressed; shanks rounded and ciliate within, the fore ones spinous before the tip: the larvæ are found under ground, or in decayed wood. Many species are to be found in our own country, among which one of the largest is the C. hortensis, so named from its being frequently seen in gardens and pathways. Among the smaller species is the C. cupreus, a very frequent insect, being seen almost every where during the summer months, in gardens, dry pathways, &c. generally running, like the rest of the genus, with a very brisk motion; its usual length is about half an inch, and its colour varying from the copper to the gold green. Of the British species more than a hundred have been enumerated. On the continent the C. cripitans is the most remarkable; so named from the power which it possesses of discharging from behind, several times in succession, on being pursued, a fetid and penetrating vapour, accompanied by a very smart explosion, thus escaping by terrifying its pursuers.

CARACT, CARAT, CARRAT, the name of that weight which expresses the degree of fineness that gold is of. The mint-master, or custom, have fixed the purity of gold at 24 caracts; though it is not possible so to purify and refine that metal, but it will want still about one-fourth part of a caract in absolute purity and perfection. These degrees serve to distinguish the greater or lesser quantity of alloy therein contained: for instance, gold of 22 caracts is that which has two parts of silver, or of any other metal, and 22 of fine gold. The caract is divided in $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, and $\frac{1}{32}$.

CARACT is also a certain weight which goldsmiths and jewellers use, wherewith to weigh precious stones and pearls. The caract by which jewellers estimate the weight of diamonds and pearls is about $\frac{1}{15}$ of an ounce troy: hence the caract is about $3\frac{1}{5}$ grains troy.

CARAVAN, in the East, signifies a company or assembly of travellers and pilgrims, and more particularly of merchants, who, for their greater security, and in order to assist each other, march in a body through the deserts, and other dangerous places, which are infested with Arabs or robbers. There is a chief, or aga, who commands the caravan, and is attended by a certain number of janizaries, or other militia, according to the countries from whence the caravans set out; which number of soldiers must be sufficient to defend them, and conduct them with safety to the places for which they are designed, and on a day appointed. The caravan encamps every evening near such wells or brooks as their guides are acquainted with; and there is as strict discipline observed upon this occasion, as in armies in time of war. Their beasts of burden are partly horses, but most commonly camels, who are capable of undergoing very great fatigue. The Grand Signior gives one-fourth of the revenues of Egypt to defray the expense of the caravan that goes yearly to Mecca, to visit Mahomet's tomb: the devotees in this caravan are from forty to seventy thousand, accompanied with soldiers, to protect them from the pillage of the Arabs, and followed by eight or nine thousand camels, laden with all necessary provisions for so long a passage across deserts.

CARAVAN, is also used for the voyages or campaigns which the knights of Malta are obliged to make at sea against the Turks and Corsairs, that they may arrive at the commendaries or dignities of the order. The reason of their being thus called is, because the knights have often seized the caravans going from Alexandria to Constantinople.

CARAVANSERA, or KARAVANSERA, a large public building or inn, appointed for receiving and lodging the caravans. It is commonly a large square building, in the middle of which there is a very spacious court; and under the arches or piazzas that surround it there runs a bank, raised some feet above the ground, where the merchants, and those who travel with them in any capacity, take up their lodgings as well as they can; the beasts of burden being tied to the foot of the bank. Over the gates that lead into the court there are sometimes little rooms, which the keepers of the caravanseras let out, at a very high price, to such as have a mind to be private. The caravanseras in the East are something in the nature of the inns in Europe, only that you meet with little accommodation either for man or beast, but are obliged to carry almost every thing with you: there is never a caravansera without a well or spring of water. These buildings are chiefly owing to the charity of the Mahometans: they are esteemed sacred dwellings, where it is not permitted to insult any person, or to pillage any of the effects that are deposited there. They even carry their precautions so far, as not to suffer any man who is not married to lodge there; because they are of opinion, that a man that has no wife is more dangerous than another.

CARBON, in chemistry. The term carbon having been understood in different senses, and having been actually applied to different substances, it is necessary to guard against the ambiguity arising from this circumstance, and with this view to trace in a general manner the progress of those discoveries, from which the name originated, and by which its application has since been changed.

When vegetable matter, especially the more solid parts of plants, the wood for example, is exposed to heat in close vessels, it is decomposed; the more volatile principles are disengaged, and there remains a black, shining, porous body, composed of the various substances which are not convertible by a high temperature to the gaseous form. This substance is termed charcoal. While the atmospheric air is excluded, it is neither fused nor volatilised by any increase of heat; but when the air is admitted, it suffers combustion, and it continues to burn till nearly the whole of it is consumed; the residuum amounting to not more than the 200th part of the weight of the original charcoal. This residuum is uninflammable, and consists principally of saline and metallic matter. Charcoal then is a heterogeneous substance. By far the greater part of it consists of an inflammable substance, which combines with oxygen, and forms the carbonic acid of the modern nomenclature. But this inflammable matter, as it exists in the charcoal, is mixed or combined with the saline and metallic substances left after its combustion. For the sake of precision, a distinction is made in the new nomenclature, between the pure inflammable base and the substance in which it is thus presented to us. Charcoal is that black porous substance obtained from vegetable matter, especially from wood, by exposing it to heat; and the pure inflammable substance, which composes by far the greater part of the charcoal, was termed carbon. Carbon, therefore, according to this signification, was charcoal destitute of the small quantity of saline and metallic matter usually mixed with it. The principal advantage of the introduction of the name carbon was, not merely that of distinguishing the inflammable base from the substance in which it was mixed with other ingredients, but also that of giving a term capable of combination, and of affording those derivative appellations which the modern system requires. This substance is not a hypothetical being, since, by certain chemical processes, by the decomposition of carbonic acid for instance, or of alcohol by heat, it is possible to obtain it perfectly pure. It exists in a large quantity as a component part of vegetable substances; it enters into the composition of animal matter, and is contained in substances belonging to the mineral kingdom. This substance, which, when it is obtained pure, exists in the form of a very light black powder, was, until within these few years, considered as a simple body; but experiments have proved, that it is a compound, containing an inflammable substance, according to some chemists, in a state of imperfect oxydation; according to others, combined with hydrogen. It had been known for a considerable time, that the diamond, the most beautiful and most unchangeable of the productions of nature, is combustible, or that when heated with oxygen gas it suffers combustion. Lavoisier made some experiments to ascertain the nature of the product of this combustion; and he found it to be an acid precisely the same with that which is produced by the burning of charcoal—what is termed the carbonic acid. He did not, however, ascertain the proportion of it with sufficient accuracy to draw any precise conclusion. Some time after, Mr. Tennant repeated the experiment of oxydizing the diamond, by exposing it to heat along with nitrate of potash in a gold tube. He also found that carbonic acid was formed; and from an experiment on a small scale, it appeared that about the same quantity of carbonic acid was afforded by the oxygenation of the diamond, as would have been produced by the combustion of the same weight of charcoal. He concluded that the diamond was carbon, and differed from charcoal principally in its form and state of aggregation; that, in short, it might be considered as carbon crystallized.

At length Guyton resolved to examine this subject, and his experiments afforded very important results. The diamond on which he experimented was burnt in a vessel of oxygen gas, by directing the solar rays upon it through a very powerful lens. It assumed at first a leaden colour; by the farther continuance of the heat its surface appeared charred. At length it appeared sensibly to diminish, and in little more than an hour and a half was entirely consumed. The product of the combustion was then examined, and was found to be pure carbonic acid, the same as that formed in the burning of charcoal; but what surprised Guyton was, the quantity produced was much greater than what would have been produced by the combustion of the same weight of charcoal in oxygen gas: 28 parts of charcoal form by combustion 100 parts of carbonic acid; that is, combined with 72 of oxygen; but from only 17.8 of diamond, the same quantity of carbonic acid is produced, that quantity having combined with 82.1 of oxygen. In other words, one part of charcoal combines with 2 of oxygen, forming 3½ of carbonic acid, while one part of diamond requires 4 of oxygen, and produces 5 of acid. As the term carbon in the new nomenclature is understood to be applied to the simple base of carbonic acid, it is evident that it can no longer be applied to the inflammable matter of charcoal; for in that matter it must be combined with some other principle. Guyton supposes that this principle is oxygen, or that that inflammable body is an oxide of carbon, standing in the same relation to carbon and carbonic acid that nitrous oxide does to nitrogen and nitric acid. Berthollet, on the contrary, has supposed that charcoal contains hydrogen as a constituent part. Whichever of these opinions is adopted, the name carbon, it is obvious, must now be applied to the simple base, and will therefore be the chemical or systematic term appropriated to the diamond. See Diamond.

Besides charcoal and carbonic acid, other substances have been discovered to be binary compounds of carbon. The one known by the name of black-lead, or plumbago, approaches nearer to the diamond, or combines with more oxygen in forming carbonic acid, than charcoal does; and between charcoal and carbonic acid is a gaseous compound, into the composition of which oxygen enters, though it is still of the nature of an oxide. Carbon too combines with hydrogen and oxygen, forming various elastic compounds. See Gas.

CARBONATES, in chemistry, salts formed by combination of the alkalies and the carbonic acid. As the acid powers which carbonic acid actually exerts are weak, the changes which it occasions in the properties of the alkalies are in general inconsiderable. They retain their peculiar taste and acrimony, at least to a certain extent: ammonia has still its penetrating odour, and in part its volatility: they still, even when saturated with it, change the vegetable colours to a green. They combine with oils, forming imperfect soaps, and the presence of the carbonic acid scarcely opposes any obstacle to the combination of their bases with the other acids.

CARBONIC *acid*, a gaseous product of the full saturation of carbon with oxygen. It was made known to chemists by Dr. Black, under the name of fixed air, and may be regarded as the first of the aerial fluids that obtained accurate examination. It is composed of 75 parts of carbon, and 25 of oxygen. See Gas.

Carbonic *oxide*, in chemistry, a gas supposed to be compounded of carbon and oxygen, in the proportion of about 38 to 62. This gas possesses the mechanical properties of air. It burns with a deep blue flame, and gives out little light. See Gas.

CARBUNCE, in heraldry, a charge or bearing consisting of eight radii, four whereof make a common cross, and the other four a saltier.

CARBURET, in chemistry, a compound substance, in which carbon is a constituent part. Carburet of iron, long known under the names of plumbago and black-lead, is composed of 90 parts of carbon and 10 of iron. It is found native, is of a dark grey or blue colour, and has something of a metallic lustre. It is found in many parts of the world, particularly in Cumberland. From the substance obtained there the best black-lead pencils are manufactured.

CARCASE, in architecture, the shell or ribs of a house, containing the partitions, floors and rafters, made by carpenters; or it is the timber-work (or as it were the skeleton) of a house, before it is lathed and plastered: it is otherwise called the framing.

CARCASSE, or Carcuss, in the art of war, an iron-case or hollow capacity, about the bigness of a bomb, of an oval figure, made of ribs of iron, filled with combustible matters, as meal-powder, salt-petre, sulphur, broken glass, shavings of horns, turpentine, tallow, &c. The design of it is, to be thrown out of a mortar to set houses on fire, and do other execution. It has two or three apertures, through which the fire is to blaze.

CARCINOMA, in surgery and medicine, a hard schirrus tumour, accompanied with acute lancinating pains, ending in ulceration.

CARD, among artificers, an instrument consisting of a block of wood, beset with sharp teeth, serving to arrange the hairs of wool, flax, hemp, and the like: there are different kinds of them, as hand-cards, stock-cards, &c.

Cards, among gamesters, little pieces of fine thin pasteboard, of an oblong figure, of several sizes, but most common in England three inches and an half long, and two and half broad, on which are painted several points and figures. The moulds and blocks for making cards are exactly like those that were used for the first books; they lay a sheet of wet or moist paper on the block, which is first slightly done over with a sort of ink made of lampblack, diluted in water, and mixed with some starch, to give it a body. They afterwards rub it off with a round list. The court-cards are coloured by means of several patterns, styled stane-files. These consist of papers cut through with a pen-knife, and in the apertures they apply severally the various colours, as red, black, &c. These patterns are painted with oil-colours, that the brushes may not wear them out; and when the pattern is laid on the pasteboard, they slightly pass over it a brush full of colour, which, leaving it within the openings, forms the face or figure of the card.

CARDAMINE, in botany, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ or Cruciform flowers. Essential character: silique opening elastically the valves revolute; stigma entire; calyx rather gaping. There are eighteen species; of which C. bellidifolia has a simple root, white, and very long; stem filiform, striated, flexile, an inch long. Flowers white, sometimes purplish, with claws the length of the calyx; siliques half an inch in length. This plant has no smell. It flowers in July and August.

CARDAMOM, in the materia medica, is distinguished into three kinds, exclusive of the ammomum, which is evidently of the cardamom kind. They are called by the names of the great cardamom, or grain of paradise; the long or middle cardamom; and the lesser common cardamom of the shops.

CARDAN (Hieronymus,) in biography, was born at Pavia, Sept. 24, 1501. At four years old he was carried to Milan, his father being an advocate and physician in that city: at the age of twenty he went to study in the university of the same city, and two years afterward he gave lectures on Euclid. In 1524 he went to Padua; the same year he was admitted to the degree of Master of Arts, and the year following to that of Doctor of Physic. In 1539 he was admitted a member of the College of Physicians at Milan: in 1543 he read public lectures on medicine there, and the same at Pavia the year following; but he discontinued them, because he could not get payment of his salary, and returned to Milan.

In 1552, he went into Scotland, having been sent for by the Archbishop of St. Andrews, to cure him of a grievous disorder, after trying the physicians of the King of France and of the Emperor of Germany without benefit. He began to recover from the day that Cardan prescribed for him. Our author took his leave of him at the end of about six weeks, leaving him prescriptions, which in two years wrought a complete cure. Upon this visit Cardan passed through London, and calculated King Edward's nativity, being famous for his knowledge in astrology. Returning to Milan after four months absence, he remained there till the beginning of October, 1552, and then went to Pavia, from whence he was invited to Bologna in 1562. He taught in this last city till the year 1570, at which time he was thrown into prison, but some months after he was sent home to his own house. He quitted Bologna in 1571, and went to Rome, where he lived for some time without any public employment. He was however admitted a member of the College of Physicians, and received a pension from the Pope, till the time of his death, which happened at Rome on the 21st of September, 1575.

No man of his time seems to have made greater progress in philosophy, medicine, and other branches of natural science, than Cardan: in algebra he was a great adept, and made many improvements in the analytic art. His dexterity in solving cubic questions has given him a lasting name. It is affirmed by Scaliger, that Cardan having, by his pretended skill in astrology, predicted the time of his death, abstained from all food, in order that he might verify the truth of his prophecy.

CARDINAL, in a general sense, an appellation given to things on account of their pre-eminence: thus we say, cardinal winds, cardinal virtues, &c.

The cardinal virtues are these four, justice, prudence, temperance, and fortitude, upon which all the rest hinge.

Cardinal *points,* in cosmography, are the four intersections of the horizon with the meridian, and the prime vertical circle. Of these two, *viz.* the intersection of the horizon and meridian, are called north and south, with regard to the poles they are directed to. The other two, viz. the intersections of the horizon and first vertical, are called east and west. The cardinal points therefore coincide with the four cardinal regions of the heavens, and are 90° distant from each other. The intermediate points are called collateral points.

Cardinal *signs*, in the zodiac, are Aries, Libra, Cancer, and Capricorn.

Cardinal, more particularly, signifies an ecclesiastical prince in the Romish church, being one who has a voice in the conclave at the election of a Pope.—The cardinals were originally nothing more than deacons, to whom was entrusted the care of distributing the alms to the poor of the several quarters of Rome; and as they held assemblies of the poor in certain churches of their several districts, they took the title of these churches. They began to be called cardinals in the year 300, during the pontificate of St. Sylvester, by which appellation was meant the chief priests of a parish, and next in dignity to a bishop.—This office grew more considerable afterwards, and by small degrees arrived at its present height, in which it is the reward of such as have served his holiness well, even princes thinking it no diminution of their honour to become members of the college of cardinals.

The cardinals compose the Pope's council, and till the time of Urban VIII. were styled most illustrious; but by a decree of that Pope in 1630, they had the title of eminence conferred upon them.

At the creation of a new cardinal, the Pope performs the ceremony of shutting and opening his mouth, which is done in a private consistory. The shutting his mouth, implies the depriving him of the liberty of giving his opinion in congregations; and the opening his mouth, which is performed fifteen days after, signifies the taking off this restraint. However, if the Pope happens to die during the time a cardinal's mouth is shut, he can neither give his voice in the election of a new Pope, nor be himself advanced to that dignity.

The privileges of the cardinals are very great: they have an absolute power in the church during the vacancy of the holy see: they have a right to elect the new Pope, and are the only persons on whom the choice can fall: most of the grand offices in the court of Rome are filled by cardinals. The dress of a cardinal is a red sourtanne, a rochet, a short purple mantle, and a red hat. When they are sent to the courts of princes, it is in quality of legates a latere: and when they are appointed governors of towns, their government is called by the name of legation.

CARDING, the combing and preparing of wool, cotton, flax, &c. with the instruments called cards.

CARDIOID, in the higher geometry, an algebraical curve, so called from its resemblance to a heart.

CARDIOSPERMUM, in botany, a genus of the Octandria Trigynia class and order. Natural order of Trihilatæ. Sapindi, Jussieu. Essential character: calyx four-leaved; petals four; nectary four-leaved, unequal; capsules three, cornate inflated. There are three species, all of them natives of warm countries. They are annual, and perish soon after they have perfected their seeds. They do not thrive with us excepting in a stove.

CARDIUM, in natural history, the *cockle*, a genus of worms of the order Testacea; animal a tethys; shell bivalve, nearly equilateral, equivalve, generally convex, longitudinally ribbed, striate or grooved, with a toothed margin; hinge with two teeth near the beak, and a larger remote lateral on each side, each locking into the oppsite. There are nearly 60 species.

CARDUUS, in botany, *English thistle*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Juss. Essential character: calyx ovate, imbricate, with spiny scales; receptacle hairy. There are fifty-one species.—Little need be said of this genus, nature having made abundant provision for their increase, by annexing to their seeds a light down, which makes them readily float in the air, and scatters them wide over the neighbouring fields. As they are usually considered as noxious weeds, rather than ornamental plants, few of them are admitted into the flower garden, and those few are valued more for their variety, than for their beauty.

CAREENING, in the sea language, the bringing a ship to lie down on one side, in order to trim and caulk the other side. A ship is said to be brought to the careen, when, the most of her lading being taken out, she is hauled down on one side by a small vessel as low as necessary; and there kept by the weight of the ballast, ordnance, &c. as well as by ropes, lest her masts should be strained too much, in order that her sides and bottom may be trimmed, seams caulked, or any thing that is faulty under water mended.—Hence, when a ship lies on one side when she sails, she is said to sail on the careen.

CARET, among grammarians, a character marked thus ‸, signifying that something is added on the margin, or interlined, which ought to have come in where the caret stands.

CAREX, in botany, *English sedge*, a genus of the Monoecia Triandria class and order. Natural order of Calamariæ. Cyperoideæ, Jussieu. Essential character: ament imbricate; calyx one-leafed; corolla none; female, nectary inflated; three-toothed; stigmas three; seeds three-sided, within the nectary. There are ninety-seven species. These plants are very nearly allied to the grasses, agreeing with them in their general appearance and leaves. They are, however, of a much harsher texture; the stem is not hollow, but filled with a spongy substance. The difference in the fructification is very considerable, as will appear from a comparison of the generic characters. They are perennial, and flower in May and June. The carices or sedges are classed rather among the noxious plants than with such as are useful, for they yield a very coarse grass and fodder, to the exclusion of real grass and other profitable plants, which they subdue by their strong creeping roots.

CARGO, denotes all the merchandize and effects which are laden on board a ship, exclusive of the crew, rigging, ammunition, provisions, guns, &c. though all these load it sometimes more than the merchandize.

We say that a ship has its cargo, when it is as full of merchandize as it can hold; that it has half its cargo, when it is but half full; that it brings home a rich cargo, when it is laden with precious merchandize and in great quantity; that the merchant has made the whole cargo of the ship, or only one half, or one quarter of the cargo, when he has laden the whole ship at his own expense, or only one half, or one fourth of it.

Disposing of any part of the cargo, before the vessel reaches her intended port, is called breaking bulk.

Cargo, *super*, a person employed by merchants to go a voyage, and oversee the cargo, and dispose of it to the best advantage.

CARICA, in botany, a genus of the Dioecia Decandria, or rather Polygamia class and order. Natural order of Tricoccæ. Cucurbitaceæ, Jussieu. Essential character: male calyx very small, five-toothed; corolla five-parted, funnel-form; filaments in the tube of the corolla, alternately shorter; herm. calyx five-toothed; corolla five-parted; stigmas five; berry one-celled, many seeded.—There are two species, *viz.* C. papaya, common papaw-tree, and C. posoposo, dwarf papaw-tree. These plants, being natives of hot countries, will not thrive in England without the assistance of the warm stove. Where there are conveniences of a proper height, they deserve a place, as well as almost any of the plants which are cultivated for ornament. They grow to the height of twenty feet, with upright stems, garnished on every side near the top with large shining leaves. The flowers of the male sort come out in clusters on all sides, and the fruit of the female growing round the stalks between the leaves, forming altogether a beautiful appearance.

CARICATURA, in painting, denotes the concealment of real beauties, and the exaggeration of blemishes, but still so as to preserve a resemblance of the object.

CARIES, in surgery, the ulceration of a bone. See Surgery.

CARINA, in botany, a keel, the name which Linnæus gives to the lower concave petal of a pea-bloom, or butterfly-shaped flower, from its supposed resemblance to the keel of a ship.

CARISSA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: corolla contorted; berries two, many seeded. There are two species, natives of the East-Indies and Africa.

CARLINA, in botany, English *carline thistle*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compound Flowers: division of Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx radiated, with long, coloured, marginal scales. There are nine species, most of them natives of the South of France, Italy, and Spain.

CARLINES, or Carlings, in a ship, two pieces of timber, lying fore and aft, along from beam to beam, whereon the ledges rest on which the planks of the ship are fastened. All the carlings have their ends let into the beams culvertail-wise: they are directly over the keel, and serve as a foundation for the whole body of the ship.

CARMINATIVES, in pharmacy, medicines used in cholics, or other flatulent disorders, to dispel the wind. See PHARMACY.

CARMINE, a powder of a very beautiful red colour, bordering upon a purple, and used by painters in miniature, though but rarely, because of its great price.

CARNATION, in botany. See DIANTHUS.

CARNATION *colour*, among painters, is understood of all the parts of a picture, in general, which represent flesh, or which are naked and without drapery.

CARNELIAN. See CHALCEDONY.

CARNIVAL, or CARNAVAL, a time of rejoicing, a season of mirth, observed with great solemnity by the Italians, particularly at Venice, lasting from Twelfth-day till Lent.

CARNIVOROUS, in zoology, an epithet generally applied to animals of every description that subsist for the most part, or entirely, on animal food. In a more limited sense we understand, by carnivorous animals, those only of a savage and voracious nature, assimilating in our ideas some instinctive ferocity of character in the manners of those creatures, when seeking and attacking their prey, as well as actually feeding on flesh. We naturally consider, for this reason, among the principal carnivorous animals, the lion, the tiger, and the wolf; or among birds, the eagle and the kite; with a host of other rapacious creatures, upon which nature has bestowed pre-eminent advantages of courage, strength, and arms, to aid them in seizing upon, and tearing into pieces, those animals on which they feed: they have either formidable canine teeth or fangs; claws or talons; the quadrupeds possessing both, and the birds the latter. Fishes, with very few exceptions, are carnivorous, but their only offensive weapons are the teeth, or in some species the spines and prickles disposed on various parts of the body. Quadrupeds, that subsist both on flesh and vegetables, are more or less deficient with respect to those characters, by which carnivorous quadrupeds are known; and those still more so that subsist entirely on roots, barks, fruits, grass, or other vegetables; the brutæ have no cutting teeth either in the upper or lower jaw; the pecoræ have them only in the lower jaw; and the front teeth of the bellulæ are obtuse. The food of those animals is vegetables. See MAMMALIA.

Carnivorous animals are characterised both by their internal organization, and their capacity and inclination for the destruction of their prey; their teeth are sharp and pointed, even though situated in the back part of the mouth; and these teeth denominated canine are so long in most of the beasts of prey, that they pass a considerable way beyond each other when the jaws are closed. The distribution of the enamel, which is confined to the superficies of the teeth, renders them extremely hard, and this circumstance, joined to an extraordinary bulk of those muscles employed in raising the lower jaw, gives to carnivorous quedrupeds the power of breaking the strongest bones.

The rapacious birds are distinguished by a sharp hard bill, furnished on each side with a pointed process, by which they are enabled to tear asunder the parts of the animals they feed upon. As the digestion of animal substances is accomplished in a short time, the stomach of the carnivorous tribes has a simple figure, without any processes or separations of its cavity, to retain its contents, or to delay their passage into the intestines; and as animal food furnishes but little excrement, the intestinal canal is short, and either totally unprovided with those dilatations which are so remarkable in vegetable eaters, or possesses them only in a slight degree.

Carnivorous animals are further distinguished by the extraordinary strength of their members, which are commonly furnished with sharp claws; these are so contrived, both in the beasts of prey and the accipitrine birds, that they turn inwards by the flexion of the limbs, or the action of seizing any thing, and are retracted by the extension of the toes: thus giving facility and certainty to the capture and retention of fugitive animals. The senses of vision and smell are particularly acute in the carnivorous tribes, as it is by means of them that they discover or seek out their prey.

Carnivorous animals are usually cruel and treacherous in their dispositions; they are even unsocial with respect to their own species; and hence it is that their numbers are so few, in comparison to that of the graminivorous kind: if it were not for this wise ordinance of nature, the defenceless orders of animals would soon be devoured, and the carnivorous would become the prey of each other.

CARNOSITY, a term sometimes used for an excrescence, or tubercle, in the urethra, the neck of the bladder, &c.

CAROLINEA, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: monogynous; calyx simple, tubular, truncate; petals ensiform; pome five-grooved, two-celled. There are two species, of which C. princeps is a large thornless tree. Leaves alternate; stipules two, short, caducous. Flowers solitary, very large and beautiful; petals yellow. The fruit has the appearance of that of the chocolate, or of cucumber, with seeds like almonds; native of Guiana.

CAROLUS, an ancient English broad piece of gold, struck under Charles I. Its value has of late been at twenty-three shillings sterling, though at the time it was coined it is said to have been rated at only twenty shillings.

CAROLUS, a small copper coin, with a little silver mixed with it, struck under Charles VIII, of France

CAROTIDS, in anatomy, two arteries of the neck, which convey the blood from the aorta to the brain, one called the right carotid, and the other the left. See ANATOMY.

CAROXYLON, in botany, a genus of the Pentandria Monogynia class and order. Essential character: corolla five-petalled; nectary five-leaved, converging, inserted into the corolla; seed clothed. There is but one species, *viz.* C. salsola; has a perennial root; stem arborescent, erect, very branching, naked. Leaves on the branchlets, frequent, imbricate, sessile, subglobular, ovate, concave within and smooth; axils loaded with other leaves. In Africa they use the ashes with mutton suet to make soap.

CARPENTRY, the art of cutting, framing, and joining pieces of wood, for the uses of building. It is one of the sciences subservient to architecture, and is divided into house carpentry and ship-carpentry; the first is employed in raising, roofing, flooring of houses, &c. and the second in the building of ships, barges, &c. The rules in carpentry are much the same with those of joinery; the only difference is, that carpentry is used in building, and joinery in furniture.

CARPESIUM, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compound flowers; division of Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate; the outer scales reflex; down none; receptacle naked. There are swo species, *viz.* C. cernuum, drooping carpesium, is a native of the south of France, Italy, Carniola, Austria, Switzerland, and Japan; and C. abrotanoides is a native of China and Japan.

CARPET: this beautiful covering for floors is of several descriptions, being made of various materials, and various forms. The Turkey, Persia, and Brussels carpets, are chiefly made of silk; the two former, owing to the vivid colours with which the materials are dyed, and the fineness of the texture, are peculiarly rich and beautiful. We have various extensive manufactories, of which those at Wilton and Kidderminster may be accounted the principal. Carpets are there made in large pieces, suited to the full extent of apartments; while the Scotch carpetting, being made in breadths of not more than four feet, affords the convenience of making up to any size; but it is not so lasting. The great carpets are made on frames and rollers, not unlike those for tapestry, and under similar guidance, where the pattern is intricate. Carpet-making supports many thousands of the industrious poor of this country; and being almost wholly founded on the produce of our own island, is of great importance as a national benefit.

CARPHALEA, in botany, a genus of the Tetrandria Monogynia class and order: corolla one-petalled, funnel-form, hairy within; calyx four-cleft, with spatulate scarious segments; capsule two-celled, two-valved, many-seeded. One species, C. corymbosa, found in Madagascar.

CARPINUS, in botany, *English hornbeam*, a genus of the Monoecia Polyandria class and order. Natural order of Amentaceæ. Essential character; calyx one-leafed, with a ciliate scale; corolla none; male stamens twenty; female germs two, with two styles on each; nut ovate. There are four species, of which C. betulus, horn-beam, is very common in many parts of England, but is rarely suffered to grow as a timber tree, being generally reduced to pollards by the country people; but where the young trees have been properly treated, they have grown to a large size, nearly seventy feet in height, with large fine stems perfectly straight and sound.

CARPODETUS, in botany, a genus of the Pentandria Monogynia class and order. Essential character; calyx five-toothed, fastened to the germ; corolla five-petalled; stigma flat-headed; berry globular, five-celled. There is but one species, *viz.* C. serratus, a native of New Zealand.

CARR, among the ancients, a kind of throne, mounted on wheels, and used in triumphs and other solemn occasions. The carr on medals, drawn by horses, lions, or elephants, signifies a triumph, or an apotheosis; sometimes a procession of the images of the gods at a solemn snpplication; and sometimes of those of some illustrious families at a funeral. The carr, covered and drawn by mules, only signifies a consecration, and the honour done any one of having his image carried at the games of the circus.

CARRIAGE, *letter or bill of*, a writing given to a carrier, or the master of any carriage, containing the number and quality of the pieces, bales, &c. of merchandises, which he is intrusted with, that he may demand the payment of the carriage, and that the person to whom they are addressed may see whether they are delivered in the same number, and in as good condition as they were given to the carrier.

Carriage *of a cannon*, the frame or timber-work on which it is mounted, serving to point it for shooting, or to carry it from one place to another. It is made of two planks of wood, commonly one half the length of the gun, called the cheeks, and joined by three wooden transoms, strengthened with three bolts of iron. It is mounted on two wheels; but on a march has two fore-wheels, with limbers added. The principal parts of a carriage are, the cheeks, transoms, bolts, plates, train bands, bridge, bed, hooks, trunnion holes, and capsquare.

Carriages. This subject, in detail, would form many an ample volume. The great variety of opinions, the imperious demands of locality, and the appropriation to particular purposes, must inevitably create a curious diversity in the practices of a nation. Confining ourselves to general principles, we shall discuss only those points which serve as a general guide, and may prove useful in giving the reader some idea as to the several properties of the vehicles now in use.

1. We consider ease of draught as indispensible. For this purpose the fore-wheels of a carriage should always be sufficiently large to bring the centre of the axle to an angle, of about fifteen degrees, with that part of the haime, or collar-frame, on which the trace fixes; that being ascertained to be the best relative position between the animal and what he has to draw at.

2. We look to proximity of rotation, that is, the place where the wheel touches the ground, and its relation to a perpendicular draft from the croup of the horse, as being an essential matter: for the draft will assuredly be more oppressive in proportion as the point of rotation is removed. Hence long shafts, great space between the fore and hind wheels, and all the representatives of those primary errors, should be, *in toto*, abolished.

3. We judge the size of wheels, that is, the length of lever, by which they are moved around their axis, to be of the greatest moment.

4. Where a road is firm, we hold it expedient to reduce the bearing point, namely, the edge of the wheel, into as small a diameter as may be found capable of sustaining the incumbent pressure.

5. Where roads are soft and quaggy, we deem the broad tire to be preferable; both because it bears up the load, and allows of less sinking, whereby considerable opposition would be created; and that such a construction is more favourable to the track in which the carriage may have often to travel.

6. The axis of every wheel ought to move with as little friction as possible: this may be effected by making the spindle as small and as short as circumstances may allow; taking care to lubricate the connecting parts well, so as not to allow of the smallest tendency to adhesion. Wheels intended for travelling over unequal surfaces should be dished, so that the spokes may successively be upright whenever they come under the axle. The bend of each end of the axle downwards is a convenience, and contributes to the foregoing effect, while it causes the upper parts of the wheels to diverge, and gives more scope for the body of the machine: in some instances, where light but bulky burthens are in question, this is a desideratum; though it contracts the space between the points of rotation, and renders the machine more liable to overturn. The load should generally be carried more in the centre of four-wheeled carriages than is usually done. Carmen have a great partiality for burthening the fore-wheels: this is a most absurd practice, because they, being less in diameter, are more subject to be impeded by low obstacles than the hind wheels, which, being larger, travel over ruts and clods with much more facility. In regard to the height of loads, it is proper to state, that whenever a line drawn perpendicular to the horizon, and touching the corner of a square load, touches the ground on the outside of the tire of the opposite wheel, the carriage must overset, the line of gravity then becoming exterior to the support; and *vice versa.* From this we see, that loads carried low are in general very safe; while such as are injudiciously elevated, which too many of our stage-coaches are, teem with danger. In two wheel carriages, the load in going down

hill bears extremely heavy on the shaft-horse: this should be obviated by cocking the cart backwards, according to the practice in the west of England.

CARRIER, *laws relating to.* Every person carrying goods for hire is deemed a carrier, and as such is liable in law for any loss or damage that may happen to them whilst in his custody. Waggoners, captains of ships, lightermen, &c. are therefore carriers; but a stage-coachman is not within the custom as a carrier: neither are hackney-coachmen carriers within the custom of the realm, so as to be chargeable for the loss of goods, unless they are expressly paid for that purpose, for their undertaking is only to carry the person. If a person take hire for carrying goods, although he be not a common carrier, he may nevertheless be charged upon a special assumpsit; for where hire is taken, a promise is implied; and where goods are delivered to a carrier, and he is robbed of them, he shall be charged and answer for them, on account of the hire; and the carrier can be no loser, as he may recover against the hundred.

Goods sent by a carrier cannot be distrained for rent; and any person carrying goods for all persons indifferently is to be deemed a common carrier, as far as relates to this privilege. A delivery to a servant is a delivery to the master, and if goods are delivered to a carrier's porter, and lost, an action will lie against the carrier.

Where a carrier gives notice by printed proposals that he will not be responsible for certain valuable goods if lost, if more than the value of a sum specified, unless entered and paid for as such, and valuable goods of that description are delivered to him, by a person who knows the conditions, but, concealing the value, pays no more than the ordinary price of carriage and booking, the carrier is, under such circumstances, neither responsible to the sum specified, nor liable to repay the sum paid for carriage and booking.

A carrier, who undertakes for hire to carry goods, is bound to deliver them at all events, unless damaged and destroyed by the act of God, or the king's enemies; and if any accident, however inevitable, happen through the intervention of human means, a carrier becomes responsible.

CARRONADE, a cannon of peculiar construction, being much shorter and lighter than the common cannon, and having a chamber for the powder like a mortar; they are generally of a large calibre, and carried on the upper works, as the poop and forecastle. They are named from Carron in Scotland, the town in which they were first made.

CARTES (RENES DES,) in biography. Few persons have a higher claim to distinction than this philosopher; we shall, therefore, in the present article, interweave an account of his system with that of his life.

Des Cartes was a native of Touraine, in France, and born in 1596. While a child, he discovered an eager curiosity to inquire into the nature and causes of things, which procured him the appellation of the young philosopher. At eight years of age he was committed to the care of a Jesuit, under whom he made very uncommon proficiency. He soon began to discover defects in existing systems, and hoped to be the means of giving to science a new and more pleasing aspect. After spending five years in the study of the languages and polite literature in general, he entered upon a course of mathematics, logic, and morals, according to the methods by which they were then taught. With these he was so much disgusted, that he determined to frame for himself a brief system of rules or canons of reasoning, in which he followed the strict method of the geometricians. He pursued the same plan with respect to morals. After all, however, he was so little satisfied with his own attainments, that he left college, lamenting that the fruits of eight years' study were only the full conviction, that as yet he knew nothing with perfect clearness and certainty. He even threw aside his books, with a resolution to pursue no other knowledge, than that which he could find within himself and in the great volume of nature. At the age of seventeen he was sent to Paris, where the love of pleasure, for a moment, seemed to overcome all desire of philosophical distinction, but an introduction to some learned men recalled his attention to mathematical studies: these he again prosecuted in solitude and silence for the space of two years, after which he entered as a volunteer in the Dutch army, in order that he might study the living world as well as read books. In this situation he wrote a dissertation to prove that brutes are automata. From the Dutch army Des Cartes passed over to the Bavarian service, but wherever he went he conversed with learned men, and rather appeared in the character of a philosopher than that of a soldier. In 1622 he quitted the army, returned to his own country, with no other profit, he said, than that he had freed himself from many prejudices, and rendered his mind more fit for the reception of truth. He fixed his residence at Paris, and began to study the mathematics, in hopes of discovering general principles of relations, measures, and proportions, applicable to all subjects, by means of which truth might with certainty be investigated, and the limits of knowledge enlarged. From mathematics he turned his attention to ethical inquiries, and attempted to raise a superstructure of morals upon the foundation of natural science, conceiving that there could be no better means of discovering the true principles and rules of action, than by contemplating our own nature, and the nature of the world around us. As the result of these inquiries, he wrote a treatise on the passions. After some time spent in Italy, whither he went in pursuit of knowledge, he returned again to Paris, and from thence he went to Holland, with a view of raising a new system of philosophy. Here he chose retirement, as the best means of forwarding the plans which he hoped to execute. He employed himself in investigating a proof from reason, independently of revelation, of the fundamental principles of religion, and published "Philosophical Meditations on the First Philosophy." At the same time he pursued his physical inquiries, and published a treatise "On Meteors." He paid considerable attention to medicine, anatomy, and chemistry; and wrote also an astronomical treatise on the system of the world, which he suppressed, upon hearing of the vile and infamous treatment that Galileo had met with for his discussions on the same subject. See Galileo.

The Cartesian philosophy was first taught in the schools of Deventer, 1633: it attracted many zealous admirers, and excited against him a host of opponents. The system of Des Cartes obtained so much credit in Great Britain, that the inventor was invited to settle in England, as well by the king as by some of the principal nobility. This invitation he would probably have accepted, had not the civil wars prevented Charles I. from being able to render the philosopher all the patronage which he had formerly tendered him. At this period he was forced into many disputes, in the course of which, as well as by his collateral conduct, he displayed an eager desire to be considered the father of a sect, and discovers more jealousy and ambition than became a philosopher.

During Des Cartes's residence in Holland, he went occasionally to his native country, where, in 1643, he published an abstract of his philosophy, under the title of "Philosophical Specimens." He was promised, on one of these visits, an annual pension of 3000 livres, which he never received. He was now invited by Christina, Queen of Sweden, to visit Stockholm. That learned princess had read with delight his treatise "On the Passions," and was earnestly desirous to be instructed by him in the principles of philosophy. Des Cartes arrived at Stockholm in 1649, where he received a most friendly and respectful reception from the enlightened queen, who urged him to settle in her kingdom, and assist her in establishing an academy of sciences. He had, however, been scarcely four months in that severe climate, when, in his visits to the sovereign, whom he instructed in the principles of philosophy, he caught a cold, which brought on an inflammation in his lungs, that put a period to his life, in 1650. His remains were interred in the cemetery for foreigners, and a long eulogium inscribed on his tomb: but in 1666 his bones were transported to France, and placed, with all the circumstances of pomp, in the church of St. Genevieve. Such was the life of this great man: his writings and system require a more detailed account.

On the subject of logic, he says, nothing is ever to be admitted as true, which is not certainly and evidently known to be so, and which cannot be possibly doubted. In proving any truth, the ideas are always to be brought forward in a certain order, beginning from things the most simple, and advancing by regular steps to those which are more complex and difficult. With regard to metaphysics, Des Cartes says, that since man is under the influence of prejudice, he ought, once in his life, to doubt of every thing; even whether sensible objects have a real existence; and also of the truth of mathematical axioms. The first principle of the Cartesian philosophy is this, "I think, therefore I am:" this is the foundation of Des Cartes's metaphysics: that on which his physics is built is, "That nothing exists but substances." Substance he makes of two kinds; the one that thinks, the other is extended: so that actual thought and actual extension make the essence of substance. The essence of matter being thus fixed in extension, Des Cartes concludes that there is no vacuum, nor any possibility of it in nature, but that the universe is absolutely full: by this principle mere space is quite excluded; for extension being implied in the idea of space, matter is so too.

Des Cartes defines motion to be the translation of a body from the neighbourhood of others that are in contact with it, and considered as at rest, to the neighbourhood of other bodies; by which he destroys the distinction between motion that is absolute or real, and that which is relative or apparent. He maintains, that the same quantity of motion is always preserved in the universe, because God must be supposed to act in the most constant and immutable manner: and hence also he deduces his three laws of motion.

Upon these principles Des Cartes explains mechanically how the world was formed, and how the present phenomena of nature came to arise. He supposes that God created matter of an indefinite extension, which he separated into small square portions or masses, full of angles; that he impressed two motions on this matter; the one, by which each part revolved about its own centre; and another, by which an assemblage or system of them turned round a common centre. From whence arose as many different vortices, or eddies, as there were different masses of matter thus moving about common centres.

The consequence of these motions in each vortex, according to Des Cartes, is as follows: the parts of matter could not thus move and revolve amongst one another, without having their angles gradually broken: and this continual friction of parts and angles must produce three elements: the first of these, an infinitely fine dust formed of the angles broken off; the second, the spheres remaining, after all the angular parts are thus removed; and those particles not yet rendered smooth and spherical, but still retaining some of their angles, and hamous parts, form the third element.

Now the first or subtilest element, according to the laws of motion, must occupy the centre of each system, or vortex, by reason of the smallness of its parts; and this is the matter which constitutes the sun and the fixed stars above, and the fire below. The second element, made up of spheres, forms the atmosphere, and all the matter between the earth and the fixed stars: in such sort, that the largest spheres are always next the circumference of the vortex, and the smallest next its centre. The third element, formed of the irregular particles, is the matter that composes the earth, and all terrestrial bodies, together with comets, spots in the sun, &c.

He accounts for the gravity of terrestrial bodies from the centrifugal force of the ether revolving round the earth: and upon the same general principles he pretends to explain the phenomena of the magnet, and to account for all the other operations in nature.

Of this great man many eulogia have been published, by persons very capable of appreciating his worth and his talents. We shall mention the opinion entertained of him by two or thee of our own countrymen.

Dr. Barrow, in his "Opuscula," observes, that Des Cartes was doubtless a very ingenious man, and a real philosopher, and one who seems to have brought those assistances to that part of philosophy relating to matter and motion, which perhaps no one had done before; namely, a great skill in mathematics; a mind habituated, both by nature and custom, to profound meditation; a judgment exempt from all prejudices and popular errors, and furnished with a good number of certain and select experiments; a great deal of leisure; an entire disengagement, by his own choice, from the reading of useless books, and the avocations of life: with an incomparable acuteness of wit, and an excellent talent of thinking clearly and distinctly, and of expressing his thoughts with the utmost perspicuity.

Dr. Halley, in a paper concerning optics, affirms that Des Cartes was the first, who, in modern times, discovered the laws of refraction, and brought dioptrics to a science. And Dr. Keil says, that Des Cartes was so far from applying geometry and observations to natural philosophy, that his whole system is but one continued blunder, on account of his negligence in that point; which he could easily prove, by showing that his theory of the vortices, upon which his system is founded, is absolutely false, for that Newton has shewn that the periodical times of all bodies that swim in vortices must be directly as the squares of their distances from the centre of them; but it is evident, from observations, that the planets, in moving round the sun, observe a law quite different from this; for the squares of their periodical times are always as the cubes of their distances: and therefore, since they do not observe that law, which of necessity they must, if they swim in a vortex, it is a demonstration, that there are no vortices is which the planets are carried round the sun.

CARTHAMUS, in botany, English *bastard saffron*, a genus of the Syngenesia Polygamia Æqualis class and order.—Natural order of Compositæ, or compound flowers, and division of Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx ovate, imbricate with scales, which at the end are subovate-foliaceous. There are ten species, of which C. tinctorius, officinal bastard saffron, is an annual plant; it is two feet and a half high, dividing upwards into many branches, with ovate-pointed sessile leaves. The flowers grow single at the extremity of each branch, the heads are large, inclosed in a scaly calyx. It flowers in July and August. It grows naturally in Egypt and in some of the warm parts of Asia.

CARTILAGE, in anatomy, a body approaching much to the nature of bones. See ANATOMY.

Cartilage has so much induration, as to require the exertion of some force to bend it; and in a morbid state it frequently becomes ossified. Bone, on the other hand, is, in the first stages of its growth, cartilaginous; it sometimes becomes so from disease. A cartilaginous matter exists in the hardest bones, and forms their basis: from which the other ingredients, the gelatine and earthy matter, may be removed. Cartilages are solid, but easily cut: they are elastic, dense, white, and semi-transparent. They cover the articulated extremities of bones, and sometimes form distinct parts. The matter of cartilage has been examined by Mr Hatchett, who considers it as indurated albumen.

CARTILAGINOUS *fishes*, those with cartilaginous instead of bony skeletons: they constitute an order of fishes, answering to the Chondropterygious and Branchiostegious of Linnæus. See CHONDROPTERYGIOUS.

CARTON, or CARTOON, in painting, a design drawn on strong paper, to be afterwards traced through, and transferred on the fresh plaster of a wall, to be painted in fresco.

In Italian, whence the term seems to be derived, cartone, or cartoni, signifying large paper, denotes several sheets of paper pasted on canvas, on which large designs are made, whether coloured, or with chalks only. Of these cartoons there are many by Dominichino Leonardo da Vinci, Andrea Mantegna, Michael Angelo, &c.—but the most celebrated performances of this kind are the cartoons of Raphael, or Raffaello Sanzio Da Urbino, which are seven in number, and form only a small part of the sacred historical designs, executed by this famous artist while engaged in the chambers of the Vatican, under the auspices of Pope Julius II. and Leo X. As soon as they were finished they were sent to Flanders, to be copied in tapestry, for adorning the pontifical apartments; but the tapestries were not conveyed to Rome till after the decease of Raphael, and probably not before the dreadful sack of that city in 1527, under the pontificate of Clement VII.—when Raphael's scholars having fled from thence, none were left to enquire after the original cartoons, which lay neglected in the store-rooms of the manufactory. The revolution that happened soon after in the Low Countries prevented their being noticed during a period, in which works of art were wholly neglected. These seven, however, escaped the wreck of the others, which were torn in pieces, and of which some fragments remain in different collections. These were purchased by Rubens for Charles I. but they had been much injured. In this state they also fortunately escaped being sold in the royal collection, by the disproportionate appraisement of these seven at 300*l.*; and the nine pieces, which were the triumph of Julius Cæsar, by Andrea Mantegna, appraised at 1000*l.* The cartoons seem to have been little noticed, till King William III. built a gallery for the purpose of receiving them at Hampton court. After having suffered much from the damps of the situation in which they were placed, they were removed by order of his present Majesty, King George III. to the Queen's Palace at Buckingham House, and from thence to the Castle at Windsor. His Majesty is entitled to a tribute of respect and applause for his care in preserving these precious treasures. They have been long deservedly held in high estimation throughout Europe, by all authors of refined taste, and by all the admirers of the art of design, for their various and matchless merit, particularly with regard to the invention, and to the noble expression of such a variety of characters, countenances, and attitudes as they are differently affected and suitably engaged, in every composition.

CARTOUCHE, in architecture, and sculpture, an ornament representing a scroll of paper. It is usually a flat member, with wavings, to represent some inscription, device, cypher, or ornament of armoury. They are, in architecture, much the same as modillions; only these are set under the cornice in wainscotting, and those under the cornice at the eaves of a house.

Cartouche, in the military art, a case of wood, about three inches thick at the bottom, girt with marlin, holding about four hundred musket balls, besides six or eight balls of iron, of a pound weight, to be fired out of a howitzer, for the defence of a pass, &c.

A cartouche is sometimes made of a globular form, and filled with a ball of a pound weight; and sometimes it is made for the guns, being of ball of half or quarter pound weight, according to the nature of the gun, tied in form of a bunch of grapes, on a tompion of wood, and coated over.

CARTRIDGE, in the military art, a case of paste board or parchment, holding the exact charge of a fire arm. Those for muskets, carabines, and pistols, hold both the powder and ball for the charge: and those of cannon and mortars are usually in cases of pasteboard or tin, sometimes of wood, half a foot long, adapted to the calibre of the piece.

Cartridge *box*, a case of wood or turned iron, covered with leather, holding a dozen musket cartridges. It is worn upon a belt, and hangs a little lower than the right pocket hole.

CARTS, *laws relating to*. Carts for the carriage of any thing, to and from any place where the streets are paved within the bills of mortality, shall contain six inches in the felly: the name of the owner must be on some conspicuous part, and his name entered with the commissioners of the hackney coaches, under the penalty of 40*s*. and any person may seize and detain such cart till the penalty is paid. On changing property, the names are to be altered, and new entries made. Every driver of a cart riding upon it, without having a person on foot to guide it, shall forfeit 20*s*. if he is the owner, and 10*s*. if he is the servant only.

CARUM, in botany, English *caraway*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: fruit ovate, oblong, striated; involucre, one-leaved; petals keeled, inflex-emarginate. There is but one species, *viz.* C. carui, common caraway, a biennial plant; it has a taper root like a parsnip, but much smaller, running deep into the ground, sending out many small fibres, and having a strong aromatic taste. It is particularly cultivated in Essex.

CARUNCULA, in anatomy, a term denoting a little piece of flesh, and applied to several parts of the body: thus, Caruncula lacrymalis, a little eminence situated in the larger angle, or canthus of the eye, where there are also sometimes hairs and certain little glands.

CARUS, in midicine, a sudden deprivation of sense and motion, affecting the whole body.

CARYATIDES, or Cariates, in architecture, a style of columns or pilasters, invented by the Greeks, under the figure of women, dressed in long robes, after the manner of the Carian people, and serving instead of columns, to support the entablature. The caryatides should always have their legs pretty close to each other, and even across, or one athwart the other; their arms laid flat to their bodies, or to the head; and as little spread as possible: when they are insulated, they should never have any great weight to support; and they ought always to appear in characters proper to the place they are used in.

CARYOCAR, in botany, a genus of the Polyandria Tetragynia class and order. Essential character: calyx five-parted; petals five; styles usually four; drupe with four nuts, reticulated with furrows. There is but one species, *viz.* C. nuciferum, a tall tree, with ternate leaves. Native of Berbice and Essequebo.

CARYOPHYLLÆUS, in natural history, a genus of the Vermes Intestina. Body round; mouth dilated and fringed. One species, *viz.* C. piscium, which inhabits the intestines of various fresh water fish, particularly the carp, tench, and bream. The body is of a clay colour, about an inch long, rounded at the hind part and broader before.

CARYOPHYLLUS, in botany, English *clove-tree*, a genus of the Polyandria Monogynia class and order. Natural order of Hesperideæ. Myrti, Jussieu. Essential character: corolla four-petalled; calyx four-leaved, duplicate; berry one-seeded, inferior. One species, *viz.* C. aromaticus, clove-tree, rises to the height of a common apple-tree, but the trunk generally divides at about four or five feet from the ground into three or four large limbs which grow erect, and are covered with a thin smooth bark, which adheres closely to the wood: the leaves are like those of the bay-tree, and are placed opposite on the branches. The flowers are produced in loose bunches at the end of the branches; they are small, white, and have a great number of stamens, which are much longer than the petals. The flowers are succeeded by oval berries, which are crowned by the calyx, divided into four parts, spreading flat on the top of the fruit: it is the young fruit, beaten from the trees before they are half grown, which are the cloves used all over Europe. It is found in all the Moluccas, in many of the South Sea islands, and in New Guinea.

CARYOTA, in botany, a genus of the Monoecia Polyandria class and order. Natural order of Palms. Essential character: male, calyx common; corolla tripartite; stamens very many: female, calyx as in the male; corolla tripartite; pistil one; berry dispermous. There are two species. C. urens is a lofty palm-tree; the trunk is very large, covered with a sort of cinereous crust, which is quite smooth. The flowers are in long pendulous spikes, on which they grow in pairs. The corolla, which is sometimes bipartite, but commonly tripartite, is at first green, then red or purple, and finally yellow. C. mitis is about fifteen feet in height, a most beautiful plant, growing in the woods of Cochinchina.

CASCADE, a steep fall of water from a higher into a lower place. They are either natural, as that of Trivoli, &c. or artificial, as those of Versailles, &c. and either falling with gentle descent, as those of Sceaux; or in form of a buffet, as at Trianon; or down steps, in form of a perron, as at St. Cloud; or from basin to basin, &c.

CASE, among grammarians, implies the different inflections or terminations of nouns, serving to express the different relations they bear to each other, and to the things they represent. There is great diversity among grammarians, with regard to the nature and number of cases; they generally find six, even in most of the modern languages, which they call the nominative, genitive, dative, accusative, vocative, and ablative; but this seems in compliance with their own ideas of the Greek and Latin, which they transfer to their own languages. The termination is not the sole criterion of a case; for though some authors reckon five cases of nouns in the Greek, and six in Latin, yet several of these cases are frequently alike: as the genitive and dative singular of the first and fifth declensions of the Latin; the dative and ablative plural of all the declensions, &c.; the genitive and dative dual of the Greek, &c. The English, and many other modern languages, express the various relations, not by changes in the terminations, as the ancients, but by the apposition of articles. Grammarians, however, admit of three cases in the English nouns; *viz.* the nominative, possessive, and objective. The nominative expresses simply the name of a thing, or the subject of the verb; the possessive expresses the relation of property or possession; and the objective expresses the object of an action, or of a relation, and follows a verb active or a preposition.

Case, among printers, denotes a sloping frame, divided into several compartments, containing a number of types or letters of the same kind. From these compartments the compositor takes out each letter as he wants it, to compose a page or form. Thus they say, a case of pica, of Greek, &c. Earl Stanhope, who has made great improvements in the printing-press, has contrived a case, which is said to be much more convenient to the workmen than those in common use.

Case *hardening*, a method of preparing iron, so as to render its outer surface hard, and capable of resisting any edged tool. The process of case-hardening, which is, in truth, a superficial conversion of iron into steel, depends on the cementation of it with vegetable or animal coals. We have seen small articles of iron converted into steel, by heating it in a crucible with pieces of leather, horn, &c. The whole must be raised to a great heat by means of a forge, furnace, &c. See Iron.

Case-*shot*, in the military art, musket ball, stones, old iron, &c. put into cases, and shot out of great guns.

CASERNS, in fortification, lodgings built in garrison towns, generally near the rampart, or in the waste places of the town, for lodging the soldiers of the garrison. There are usually two beds in each casern for six soldiers to lie, who mount the guard alternately; the third part being always on duty.

CASH, in the commercial style, signifies the stock of money which a merchant, trader, or banker, has at his disposal, in order to trade.

CASHEW *nut*, the fruit of the acajou tree, reckoned by Linnæus a species of anacardium. See Anacardium.

CASHIER, a person who is entrusted with the cash of some public company.

CASI, in the Persian policy, one of the two judges under the nadab, who decide all religious matters, grant all divorces, and are present at all public acts, having deputies in all the cities of the kingdom. See the article NADAB.

CASING *of timber work*, among builders, is the plastering a house all over on the outside with mortar, and then striking it while wet, by a ruler, with the corner of a trowel, to make it resemble the joints of free-stone. Some direct it to be done upon heart laths, because the mortar would, in a little time, decay the sap laths; and to lay on the mortar in two thicknesses, *viz.* a second before the first is dry; this process is commonly called rough-casting.

CASSAVA, in chemistry, a species of starch prepared from the roots of the jatropha manihat, an American plant. They are peeled and pressed, and the juice that is forced out is a deadly poison, and employed by the Indians to poison their arrows. It deposits, however, a white starch, which, when properly washed, is perfectly innocent, and when dried, is used in the preparation of bread.

CASSIA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx pentaphyllous; petals five; the three superior anthers sterile; the three inferior beaked; legume. There are 51 species, of which C. diphylla, two-leaved cassia, is a shrub with a round stem; two semi-orbiculate, obtuse, striated leaves on a short petiole; stipules covering the whole branches. It is an annual. Native of the West Indies. Some of the cassias are, however, very tall trees, as the C. fistula, Alexandrian purging cassia, cassia stick tree, or pudding pipe tree, which is 50 feet high, with a large trunk dividing into many branches. Native of both Indies. C. senna, Egyptian cassia, or senna, the plant which produces the leaves commonly known in medicine by the name of senna, is an annual: it rises with an upright branching stalk, a foot high. It grows naturally in Persia, Syria, and Arabia, whence the leaves are brought, dried, and picked from the stalks, to Alexandria in Egypt, and being thence annually imported into Europe, it has the title Alexandrian added to it.

CASSIDA, in natural history, a genus of Coleopterous insects, which, according to Linnæus, have moniliform antennæ, that become rather thicker towards the end: thorax and wing-cases with a broad margin, the former flat, and forming a kind of shield, beneath which the head is concealed. There are about 90 species.

The rotundate figure of the body, gibbous back, and flattened surface beneath, are a strong criterion of this genus. The surface above is commonly smooth, and in some species glossy; eyes oval, and placed near each other; antennæ inserted between the eyes: scutel triangular and small; wing-cases same length as the abdomen; legs short, thighs compressed, shanks rounded, and the tarsi consisting of four joints. Many of the species are very beautiful when alive, some of which retain their brilliancy of colours in the height of perfection after death; in others, however, and those especially of a small size, these are altogether evanescent, their rich metallic or golden hues fading as the insect dies, and totally disappearing in the dried specimens. Cassidæ, immersed in spirit of wine alive, are observed to retain the splendour of those golden hues for years, in as high perfection as they appear in the living insect; but if taken out, and allowed to dry, these change colour, in the same manner as the insect would in dying without being steeped in spirits. For immediate observation, the true colours of the living insect may, however, be revived in the dried specimens at any time, by leaving them for the space of 15 or 20 minutes in warm water; the colours re-appearing while the insect is kept moist, and fading again as the insect dries.

The larvæ of the cassidæ are commonly found concealed on the under surface of the leaves of the plants on which they feed, and often hide themselves under a cover of their own excrements, which they support in the air above their bodies by means of their lateral spines, and the bristles at the extremity of their tail, to shelter themselves from the sun and rain. The larvæ cast their skins several times before they pass into the pupa state. The perfect female insect deposits the eggs in regular order on the leaves of plants, and covers them with excrements to conceal them. The common English name of the insects of this tribe is the tortoise beetle. We have only an inconsiderable number of the species indigenous to this country, and those only of a small size: many of the large kinds, and those distinguished for their vivid hues and colours, are natives of South America.

CASSINE, in botany, a genus of the Pentandria Trigynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: calyx quinquepartite; petals five; berry trispermous. There are four species, of which C. Capensis, Cape cassine, or phillyrea, has a woody stalk, which in this country seldom rises more than six feet high, sending out many branches, covered with a purplish bark. The flowers are produced in roundish bunches from the side and at the end of the branches; they are white, and have five small petals spreading open; germ roundish, crowned by a bifid or trifid stigma. This shrub is a native of the Cape.

CASSINI (John Dominic,) an eminent astronomer, was born of noble parents, at a town in Piedmont in Italy, June 8, 1625. After laying a proper foundation in his studies at home, he was sent to continue them in a college of Jesuits at Genoa. He had an uncommon turn for Latin poetry, which he exercised so very early, that some of his poems were published when he was but 11 years old. At length he met with books of astronomy, which he read with great eagerness. Pursuing the bent of his inclinations in this way, in a short time he made so amazing a progress, that in 1650 the senate of Bologna invited him to be their public mathematical professor. Cassini was but 25 years of age when he went to Bologna, where he taught mathematics, and made observations upon the heavens, with great care and assiduity. In 1652 a comet appeared, which he observed with great accuracy; and he discovered that comets were not bodies accidentally generated in the atmosphere, as had been supposed, but of the same nature, and probably governed by the same law, as the planets. The same year he resolved an astronomical problem, which Kepler and Bulliald had given up as insolvable; *viz.* to determine geometrically the apogee and eccentricity of a planet, from its true and mean place. In 1653, when a church in Bologna was repaired and enlarged, he obtained leave of the senate to correct and settle a meridian line, which had been drawn by an astronomer in 1575. In 1657 he attended as an assistant to a nobleman, who was sent to Rome to compose some differences which had arisen between Bologna and Ferrara, from the inundations of the Po; and he shewed so much skill and judgment in the management of the affair, that in 1663 the Pope's brother appointed him inspector-general of the fortifications of the castle of Urbino; and he had afterward committed to him the care of all the rivers in the ecclesiastical state.

In the mean time he did not neglect his astronomical studies, and made several discoveries relating to the planets Mars and Venus, particularly the revolution of Mars upon his own axis; but the point he had chiefly in view was, to settle an accurate theory of Jupiter's satellites; which, after much labour and observation, he happily effected, and published it at Rome, among other astronomical pieces, in 1666.

Picard, the French astronomer, getting Cassini's tables of Jupiter's satellites, found them so very exact, that he conceived the highest opinion of his skill; and from that time his fame increased so fast in France, that the government desired to have him a member of the academy. Cassini however could not leave his station without leave of his superiors; and therefore the king, Lewis the XIVth, requested of the Pope, and the senate of Bologna, that Cassini might be permitted to come into France. Leave was granted for six years, and he came to Paris in the beginning of 1669, where he was immediately made the king's astronomer. When this term of six years was near expiring, the Pope and the senate of Bologna insisted upon his return, on pain of forfeiting his revenues and emoluments, which had hitherto been remitted to him: but the minister Colbert prevailed on him to stay, and he was naturalized in 1673; the same year also in which he was married.

The Royal Observatory of Paris had been finished some time, and Cassini was appointed to be the first inhabiter; which he took possession of in September, 1671, when he set himself with fresh alacrity to attend the duties of his profession. In 1672 he endeavoured to determine the parallax of Mars and the Sun; and in 1677 he proved that the diurnal rotation of Jupiter round his axis was performed in 9 hours 58 minutes, from the motion of a spot in one of his larger belts: also in 1684 he discovered four satellites of Saturn, besides that which Huygens had found out. In 1693 he published a new edition of his "Tables of Jupiter's Satellites," corrected by later observations. In 1695 he took a journey to Bologna, to examine the meridian line which he had fixed there in 1655; and he shewed, in the presence of eminent mathematicians, that it had not varied in the least during that 40 years. In 1700 he continued the meridian line through France, which Picard had begun, to the very southern limits of that country.

After our author had resided at the Royal Observatory for more than 40 years, making many excellent and useful discoveries, which he published from time to time, he died September the 14th, 1712, at 87 years of age; and was succeeded by his son James Cassini.

Cassini (James,) a celebrated French astronomer, and member of the several Academies of Sciences of France, England, Prussia, and Bologna, was born at Paris, Feburary 18,1677, being the younger son of John Dominic Cassini, above mentioned, whom he succeeded as astronomer at the Royal Observatory, the elder son having lost his life at the battle of La Hogue.

After his first studies in his father's house, in which it is not to be supposed that mathematics and astronomy were neglected, he was sent to study philosophy at the Mazarine college, where the celebrated Varignon was then professor of mathematics; from whose assistance young Cassini profited so well, that at 15 years of age he supported a mathematical thesis with great honour. At the age of 17 he was admitted a member of the Academy of Sciences; and the same year he accompanied his father in his journey to Italy, where he assisted him in the verification of the meridian at Bologna, and other measurements.

In 1712 he succeeded his father as astronomer royal at the Observatory. In 1717 he gave to the academy his researches on the distance of the fixed stars, in which he showed that the whole annular orbit of near 200 millions of miles diameter is but as a point in comparison of that distance. The same year he communicated also his discoveries concerning the inclination of the orbits of the satellites in general, and especially of those of Saturn's satellites and ring. In 1725 he undertook to determine the cause of the moon's libration, by which she shows sometimes a little towards one side, and sometimes a little on the other, of that half which is commonly behind or hid from our view.

In 1732 an important question in astronomy exercised the ingenuity of our author. His father had determined, by his observations, that the planet Venus revolved about her axis in the space of 23 hours: and M. Bianchini had published a work in 1729, in which he settled the period of the same revolution at 24 days 8 hours. From an examination of Bianchini's observations, which were upon the spots in Venus, he discovered that he had intermitted his observations for the space of three hours, from which cause he had probably mistaken new spots for the old ones, and so had been led into the mistake. He soon afterwards determined the nature and quantity of the acceleration of the motion of Jupiter at half a second per year, and of that of the retardation of Saturn at two minutes per year; that these quantities would go on increasing for 2000 years, and then would decrease again. In 1740 he published his "Astronomical Tables," and his "Elements of Astronomy;" which were very extensive and accurate works.

Although astronomy was the principal object of our author's consideration, he did not confine himself absolutely to that branch, but made occasional excursions into other fields. We owe also to him, for example, experiments on electricity, or the light produced by bodies by friction; experiments on the recoil of fire-arms; researches on the rise of the mercury in the barometer at different heights above the level of the sea; reflections on the perfecting of burning-glasses, and other memoirs.

After a long and laborious life our author, James Cassini, lost his life by a fall, in April 1756, in the 80th year of his age, and was succeeded in the Academy and Observatory by his second son, Cæsar François de Thury; who also distinguished himself in the sciences connected with astronomy; and, as well as his father and grandfather, published many valuable works. He died in 1784, of the small pox, and was succeeded by his only son count John Dominic Cassini.

CASSIOPEIA, in astronomy, a constellation of the northern hemisphere, situated opposite to the Great Bear, on the other side of the pole. See Astronomy.

In the year 1572, a remarkable new star appeared in this constellation, surpassing Sirius or Lyra in brightness and magnitude. It appeared even bigger than Jupiter, which, at that time, was near his perigee, and by some was thought equal to Venus, when she is in her greatest lustre; but in a month it began to diminish in lustre, and in about eighteen months entirely disappeared.

It alarmed all the astronomers of that age, many of whom wrote dissertations on it; among the rest, Tycho Brahe, Kepler, Maurolycus, Lycetus, Gramineus, &c. Beza, the Landgrave of Hesse, Rosa,

&c. wrote to prove it a comet, and the same which appeared to the Magi at the birth of Jesus Christ, and that it came to declare his second coming: they were answered on this subject by Tycho. Several astronomers are of opinion, that this star has a periodical return, which Keill and others have conjectured to happen every 150 years. Mr. Pigott adopts the same opinion; and he accounts for its not being noticed at the completion of every term, by its variable lustre at different periods, so that it may sometimes increase only to the ninth magnitude; and if this be the case, its period is probably much shorter.

CASSIUS, *precipitate of*, obtained from the muriate of gold by the means of tin. It is highly valued for the beauty of the colour which it gives to glass or enamel. It may be obtained by simply immersing a plate of tin in a dilute solution of muriate of gold: but the usual mode is to dissolve pure gold in a nitro-muriatic acid, composed of three parts of nitric acid and one of the muriatic. The tin is prepared by dissolving it, without heat, in an acid composed of two parts of nitric and one of muriatic acid, previously diluted with an equal weight of water. This solution being saturated, is diluted with one hundred parts of water, to which the solution of gold, in quantity equal to half the quantity of solution of tin, is added: the liquor becomes of a beautiful purplish red colour, and a precipitate subsides, which is to be washed and dried. This is the only preparation capable of giving a red colour to glass, which then serves as an imitation of the ruby.

CASSYTA, in botany, a genus of the Enneandria Monogynia class and order. Essential character: corol calycine, sexpartite; nectary of three truncate glands, surrounding the receptacle; interior filaments glanduliferous; drupe monospermous. There are but two species, of which C. filiformis is a plant which rises with taper succulent stalks, dividing into many slender succulent branches; these come out frequently by threes or fours at the same joint, afterward they send out side branches singly, without order, and become very bushy; the flowers come out on the side of the branches, having no calyx; the corolla is oval, white, with a small tincture of red, opening like a navel at the top, including the germ, stamen, style, and nectareous glands so closely, as not to be discovered till the corolla is cut open. This plant grows naturally in both Indies.

CAST, among the Hindoos, denotes a tribe or number of families of the same rank and profession. There are in India four principal casts: the first is called the cast of "Brahmins," from the mouth or wisdom, and deemed the most sacred. These are to teach the principles of religion, to perform its functions, and to cultivate the sciences. They are the priests, the instructors, and philosophers of the nation. The second order called "Chehteree," from arms or strength; to draw the bow, to fight, to govern: these are entrusted with the government and defence of the state. The third order called "Bice," from the belly or nourishment, are to provide the necessaries of life by agriculture and traffic; these are composed of husbandmen and merchants. The fourth class denominated "Sooder," from the feet or subjection; to labour, or serve, consisting of artisans, labourers, and servants. Besides these, there is a fifth class, denominated "Burrun Sunker," supposed to be the illicit union between persons of different casts: they are mostly dealers in petty articles of retail trade.

Cast *iron*. See Iron.

CASTILLEIA, in botany, so named in memory of Castilleius, a botanist of Cadiz, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx tubular, compressed; upper lip bifid, lower none; corol lower, lip trifid, with two glands between the segments; capsules two-celled. There are two species, C. fissifolia and C. integrifolia, both natives of New-Granada.

CASTING, in foundery, the running of a metal into a mould prepared for that purpose. See Foundery.

Casting, a term used for the quitting or throwing aside any thing from the body of an animal, by an effort of nature. Thus deer cast their horns, snakes their skins, lobsters their shells, hawks their feathers, annually. When birds cast their feathers, it is called moulting. A horse casts his hair in the spring, and sometimes in the autumn; also horses sometimes cast their hoofs.

Casting *of drapery*, among painters, denotes the distribution of the folds; and the drapery is said to be well cast, when the folds are distributed in such a manner, as to appear rather the result of mere chance than of art, study or labour. In that style of painting which is called "the grand," the folds of the draperies should be great, and as few as possible, because their rich simplicity is more susceptible of great lights. But it is an error to design draperies that are too heavy and cumbersome, for they ought to be suitable to the figures, with a combination of ease and grandeur. Order, contrast, and variety of stuffs and folds, constitute the elegance of draperies; and diversity of colours in those stuffs contributes extremely to the harmony of the whole in historic compositions.

CASTLE, in the sea language, is a part of the ship, of which there are two, the fore-castle being the elevation at the prow, or the uppermost deck, towards the mizen, the place where the kitchens are. Hind-castle is the elevation which reigns on the stern over the last deck, where the officers' cabins and places of assembly are.

CASTOR, the *beaver*, in natural history, a genus of Mammalia, of the order Glires. Generic character: upper fore-teeth truncated, and hollowed in a transverse angle; lower transverse at the top; four grinders in each jaw; tail long, scaly, and depressed; clavicles perfect. There are two species, of which the most worthy of notice is C. fiber. The colour of the beaver is generally of a deep chesnut; sometimes it has been seen entirely white; less rarely completely black; it is about three feet long in the body; its tail is about the length of one foot, and by its peculiarity distinguishes this animal from every other quadruped; it is of an oval form, and flat, with a slight convexity towards the base, destitute of hair, and completely covered with scaly divisions. The beaver was known to the ancients for its possession of that sebacious matter called castor, secreted by two large glands near its genitals and anus, and of which each animal has about two ounces; but they appear to have been unacquainted with its habits and economy; with that mental contrivance and practical dexterity, which, in its natural state, so strikingly distinguish it. Beavers are found in the most northern latitudes of Europe and Asia, but are most abundant in North America. In the months of June and July they assemble in large companies, to the number of two hundred, on the banks of some water, and proceed to the formation of their establishment. If the water be subject to risings and fallings, they erect a dam, to preserve it at a constant level; where this level is naturally preserved, this labour is superseded. The length of this dam is occasionally eight feet. In the preparation of it, they begin with felling some very high, but not extremely thick, tree on the border of the river, which can be made to fall into the water; and in a short time this is effected, by the united operation of many, with their fore-teeth, the branches being afterwards cleared by the same process. A multitude of smaller trees are found necessary to complete the fabric, and many of these are dragged from some distance by land, and formed into stakes, the fixing of which is a work of extreme difficulty and perseverance, some of the beavers with their teeth raising their large ends against the cross-beam, while others at the bottom dig with their fore-feet the holes in which the points are to be sunk. A series of these stakes, in several rows, is established from one bank of the river to the other, in connection with the cross-tree, and the intervals between them are filled up by vast quantities of earth, brought from a distance, and plashed with materials adapted to give it tenacity, and prevent its being carried off. The bank is formed at the bottom, of about the width of twelve feet, diminishing as it approaches the surface of the water to two or three; being thus judiciously constructed to resist its weight and efforts by the inclined plane instead of perpendicular opposition. These preparations of such immense magnitude and toil being completed, they proceed to the construction of their mansions, which are raised on piles near the margin of the stream or lake, and have one opening from the land, and another by which they have instant access to the water. These buildings are usually of an orbicular form, in general about the diameter of ten feet, and comprehending frequently several stories. The foundation walls are nearly two feet in thickness, resting upon planks or stakes, which constitute also their floors. In the houses of one story only, the walls, which in all cases are plastered with extreme neatness, both externally and within, after rising about two feet perpendicularly, approach each other, so as at length to constitute, in closing, a species of dome. In the application of the mortar to their habitations, the tails as well as feet of the beavers are of essential service. Stone, wood, and a sandy kind of earth, are employed in their structures, which by their compactness and strength completely preclude injury from winds and rain. The alder, poplar, and willow, are the principal trees which they employ;

and they always begin their operations on the trunk, at nearly two feet above the ground; nor do they ever desist from the process till its fall is completed. They sit instead of standing at this labour, and while reducing the tree to the ground derive a pleasure at once from the success of their toils, and from the gratification of their palate and appetite by the bark, which is a favourite species of food to them, as well as the young and tender parts of the wood itself.

For their support in winter ample stores are laid up near each separate cabin, and occasionally, to give variety and luxury to their repasts during a long season, in which their stores must have become dry and nearly tasteless, they will make excursions into the neighbouring woods for fresh supplies. Depredations by the tenants of one cabin on the magazines of another are unknown, and the strictest notions of property and honesty are universal. Some of their habitations will contain six only, others twelve, and some even twenty or thirty inhabitants; and the whole village or township contains in general about 12 or 14 habitations. Strangers are not permitted to intrude on the vicinity; but, amidst the different members of the society itself, there appear to prevail that attachment and that friendship, which are the natural result of mutual co-operation, and of active and successful struggles against difficulty. The approach of danger is announced by the violent striking of their tails against the surface of the water, which extends the alarm to a great distance; and, while some throw themselves for security into the water, others retire within the precincts of their cabins, where they are safe from every enemy but man.

The neatness as well as the security of their dwellings is remarkable, the floors being strewed over with box and fir, and displaying the most admirable cleanness and order. Their general position is that of sitting, the upper part of the body, with the head, being considerably raised, while the lower touches, and is somewhat, indeed, immersed in the water, This element is not only indispensable to them in the same way as to other quadrupeds, but they carefully preserve access to it even when the ice is of very considerable depth, for the purpose of regaling themselves by excursions to a great extent under the frozen surface. The most general method of taking them is by attacking their cabins during these rambles, and watching their approach to a hole dug in the ice at a small distance, to which they are obliged, after a certain time, to resort for respiration.

The flesh of the anterior part of their bodies resembles that of land animals in substance and flavour, while that of the lower possesses the taste, and smell, and lightness of fish.

The sexual union among these animals is connected with considerable individual choice, sentiment, and constancy. Every couple pass together the autumn and winter, with the most perfect comfort and affection. About the close of winter the females, after a gestation of four months, produce, in general, each, two or three young, and soon after this period they are quitted by the males, who ramble into the country to enjoy the return of spring; occasionally returning to their cabins, but no longer dwelling in them. When the females have reared their young, which happens in the course of a few weeks, to a state in which they can follow their dams, these also quit their winter residence and resort to the woods, to enjoy the opening bloom and renovated supplies of nature. If their habitations on the water should be impaired by floods, or winds, or enemies, the beavers assemble with great rapidity to repair the damage. If no alarm of this nature occurs, the summer is principally spent by them in the woods, and on the advance of autumn they assemble in the scene of their former labours and friendships, and prepare with assiduity for the confinement and rigours of approaching winter.

When taken young, the beaver may be tamed without difficulty, but exhibits few or no indications of superior intelligence. Some beavers are averse to that association which so strikingly characterises these animals in general, and satisfy themselves with digging holes in the banks of rivers, instead of erecting elaborate habitations. The fur of these is comparatively of little value. See Mammalia, Plate VII. fig. 1.

C. huidobrius, or the Chilese beaver. This is found principally in the deep lakes and rivers of Chili. Its tail differs from that of the former, in being lanceolated and hairy. It produces no castor, and possesses nothing of the art of architecture. It is courageous, and even savage in its disposition, and has the power of remaining under water for a very considerable time. Its fur is employed in the manufacture of hats, and of a species of cloth as soft as the finest velvet.

CASTOR-*oil*, in pharmacy, is extracted from the kernel of the fruit produced by the Ricinus Americanus, or oil nut, which grows in many parts of America, and is much cultivated in Jamaica. A gallon of nuts from this tree will produce about a quart of oil. It is either prepared by coction or cold drawn; that is, extracted from the bruised seeds. It is sent over to us in barrels; and it is reckoned the best which has least colour.

CASTRAMETATION, is the art of measuring or tracing out the form of a camp on the ground; yet it sometimes has a more extentive signification, by including all the views and designs of a general; the one requires only the knowledge of a mathematician, the other the experience of an old soldier. The ancients were accustomed to fortity their camps by throwing up entrenchments round them. The Turks, and other Asiatic nations, fortify themselves, when in an open country, with their waggons and other carriages. The practice of the Europeans is quite different; for the surety of their camp consists in the facility and convenience of drawing out their troops at the head of their encampment: for which reason, whatever particular order of battle is regarded as the best disposition for fighting, it follows, of course, that we should encamp in such a manner as to assemble and parade our troops in that order and disposition as soon as possible. It is therefore the order of battle that should regulate the order of encampment; that is to say, the post of each regiment in the line of battle should be at the head of its own encampment: from whence it follows, that the extent of the line of battle from right to left of the camp should be equal to the front of the troops in line of battle, with the same intervals in the camp as in the line. By this means every battalion covers its own tents, and they can all lodge themselves, or turn out in case of necessity at a minute's warning.

If the front of the camp is greater than the line, the troops must leave large intervals, or expose their flanks; if less, the troops will not have room to form with the proper intervals.

The front or principal line of the camp is commonly directed to face the enemy.

CASUALS, a term used by military men, in their regimental returns of the British army, signifying men that are dead, have been discharged, or have deserted.

CASUARINA, in botany, a genus of the Monœcia Monandria class and order. Natural order of Coniferæ. Essential character: male calyx of the ament; corol scalelets two-parted; female calyx of the ament; corol none; style bifid; strobile. There are five species, of which C. equisetifolia, horse-tail casuarina, is a very large spreading lofty tree; the leaves, or rather blanchlets hanging down in bunches from twelve to eighteen inches in length, like very long hair, or a horse's tail, all jointed from top to bottom like the equisetums, or horse tails, is a very remarkable character of this singular tree. It is a native of the East Indies and the South Sea Islands.

CAT. See Felis.

Cat, a ship usually employed in the coal trade; built very strong, and made to carry from four to six hundred tons. It is distinguished by a narrow stern, projecting quarters, and by having no ornamental figure on the prows.

Cat-*hook*, a strong hook fitted to the cat, to hook the ring of the anchor when it is to be drawn up or catted.

Cat-*o'nine tails*, an instrument, by which discipline is still maintained in the British navy and army, though, to the honour of other countries, it is said that corporal punishment has been abolished. This instrument is composed of nine pieces of line or chord, about half a yard long, fixed upon a piece of thick rope for a handle, and having three knots on each cord, with which the men who transgress the orders of their superiors are punished.

Cat's-*paw*, a light breeze of wind perceived at a distance, in a calm, by the impression made on the surface of the sea, which it sweeps very lightly, and then decays. The same term is given to a particular turn made in the bight of a rope, in order to hook a tackle on it.

Cat-*harpings*, in a ship, small ropes running in little blocks from one side of the shrowds to the other, near the deck. Their use is to force the shrowds and make them taught, for the more security and safety of the masts.

Cat-*heads*, two strong beams of timber, projected almost horizontally over the ship's-bows, on each side of the bowsprit. The cat-head serves to suspend the anchor clear of the bow, when it is necessary to let it go: it is supported by a sort of knee, which is generally ornamented by sculpture.

CATACAUSTIC *curves*, in the higher geometry, that species of caustic curves which are formed by reflection.

These curves are generated after the following manner. If there be an infinite number of rays, as A B, A C, A D, &c. (plate Miscellanies, fig. 6.) proceeding from the radiating point A, and reflected at any given curb B D H, so that the angles of incidence be still equal to those of reflection; then the curve B E G, to which the reflected rays B I, C E, D F, &c. are tangents continually, as in the points I, E, F, is called the catacaustic curve.

If the reflected I B be produced to K, so that A B = B K, and the curve K L be the evolute of the catacaustic B E G, beginning at the point K; then the portion of the catacaustic B E = A C — A B × C E — B I continually. Or if any two incident rays, as A B, A C be taken, that portion of the caustic that is evolved while the ray A B approaches to a coincidence with A C, is equal to the difference of those incident rays × the difference of the reflected rays. When the given curve is a geometrical one, the catacaustic will be so too, and always rectifiable. The catacaustic of a circle is a cycloid, formed by the revolution of a circle along a circle. Thus, A B D, fig. 7, being a semicircle exposed to parallel rays; then those rays which fall near the axis C B will be reflected to F, the middle point of B C; and those which fall at A, as they touch the curve only, will not be reflected at all; but any intermediate ray H I will be reflected to a point K, somewhere between A and F. And since every different incident ray will have a different focal point, therefore, those various focal points will form a curve line A E F in one quadrant, and F G D in the other, being the cycloid above-mentioned. And this figure may be beautifully exhibited experimentally by exposing the inside of a smooth bowl, or glass, to the sun beams, or strong candle light; for then this curve A E F G D will appear plainly delineated on any white surface placed horizontally within the same, or on the surface of milk contained in the bowl. The caustic of the common semi-cycloid, when the rays are parallel to the axis, is also a common cycloid, described by the revolution of a circle upon the same base. The caustic of the logarithmic spiral is the same curve, only set in a different position.

CATACHRESIS, in rhetoric, a trope which borrows the name of one thing to express another. Thus Milton, describing Raphael's descent from the empyreal heaven to paradise, says,

"Down thither, prone in flight,
He speeds, and thro' the vast ethereal sky
Sails between worlds and worlds."

CATACOMB, a grotto or subterraneous place of burial for the dead.

The term is particularly used in Italy, for a vast assemblage of subterraneous sepulchres, three leagues from Rome, in the Via Appia, supposed to be the sepulchres of the ancients. Others imagine these catacombs to be the cells wherein the primitive Christians hid themselves. Each catacomb is three feet broad, and eight or ten high, running in form of an alley or gallery, and communicating with one another.

Mr. Monro, in the Philosophical Transactions, gives it as his opinion, that the catacombs were the burial places of the first Romans, before the practice of burning the dead was introduced; and that they were dug in consequence of these opinions, that shades hate the light, and love to hover about the place where their bodies were laid.

CATACOUSTICS, an appellation given to the doctrine of reflected sounds. See ACOUSTICS.

CATALOGUE, a list or enumeration of the names of several books, men, or other things, according to a certain order.

CATALOGUE *of the stars*, is a list of the fixed stars, disposed in their several constellations with the longitudes and latitudes of each.

The most renowned composers of these catalogues are, 1. Ptolemy, who added his own observations to those of Hipparchus Rhodius, about the year of Christ 880. 2. Ulugh Beigh made a catalogue of the fixed stars in 1437. 3. Tycho Brahe determined the places of 777 stars for the year 1600. 4. William, Landgrave of Hesse, with his mathematicians, determined the places of 400 fixed stars. 5. In the year 1667, Dr. Halley, in the island of St. Helena, observed 350, not visible in our horison. And 6. J. Hevelius, adding his own observations to those of the ancients, and of Dr. Halley, made a catalogue of 1888. But the last and greatest is the Britannic catalogue, a performance the most perfect of its kind, compiled from the observations of the accurate Mr. Flamstead, who, with all the talents and apparatus requisite for such an undertaking, devoted himself to that work for a long series of years. It contains 2934 stars.

In 1782, M. Bode, member of the Royal

Academy of Sciences at Berlin, published a very extensive catalogue of the fixed stars, collected from the observations of Flamstead, Bradley, Hevelius, Tobias Mayer, De La Caille, Messier, La Monnier, D'Arquier, and other astronomers; in which the places of the stars, amounting in number to 5058, are given for the beginning of the year 1780. This catalogue, which is a very valuable work, though there is reason to apprehend that the same star is inserted more than once, is accompanied by a celestial atlas, or set of maps of the constellations, engraved in a very delicate and beautiful manner. In the catalogue already enumerated, the stars are classed in constellations In the following catalogues they succeed each other, according to the order in which they transit the meridian, without any regard to the constellation to which they belong; the name of the constellation being given, with a description of the stars' situation in it. The first catalogue of the stars, as we conceive, that was printed in this form, or in the order of their right ascensions, is that of M. de la Caille, given at the beginning of his Ephemerides for the ten years between 1755 and 1765, and printed in 1755. It contains the right ascensions and declinations of 307 stars, adapted to the beginning of the year 1750. In 1757 he published his "Astronomiæ Fundamenta," in which is a catalogue of the right ascensions and declinations of 398 stars, adapted likewise to the beginning of 1750. In 1763, the year immediately succeeding that of his death, the "Cœlum Australe Stelliferum" of the same author was published; and this contains a catalogue of the places of 1942 stars, all situated to the southward of the Tropic of Capricorn, and observed by the same indefatigable astronomer while he was at the Cape of Good Hope in 1751 and 1752. The places of these are given for the beginning of the year 1750. In the same year, the Ephemerides for the 10 years between 1765 and 1775, were published; in the introduction to which, the places of 515 zodiacal stars are given, all deduced from his own observations. The stars in this catalogue are rectified to the beginning of the year 1765. The Nautical Almanac for 1773 contains a catalogue of 380 stars, in right ascension, declination, longitude, and latitude, derived from the observations of the late Rev. Dr. Bradley, and adjusted to the beginning of the year 1760. It has been since, *viz.* in 1798, republished, with corrections, by Dr. Hornsby, in the first volume of Bradley's Observations. These make but a small part of what might have been deduced from the labours of that great man, if his representatives had not withheld the rest from the public. Mr. Francis Wollaston informs us, that Dr. Bradley had the whole British catalogue calculated to the year 1744, and that traces may be observed in it of his having examined almost every star in it. He adds, from satisfactory information, that Dr. Bradley observed the British catalogue twice through; first, with the old instruments of the Royal Observatory, previous to 1750, and afterwards with the new ones. The 380 stars above mentioned were carefully rectified for the year 1790 by Mr. G. Gilpin.

At the end of the first volume of "Astronomical Observations, made at the Royal Observatory at Greenwich," published in 1776, Dr. Maskelyne, the present Astronomer Royal, has given a catalogue of 34 principal stars, in right ascension and north polar distance, adapted to the beginning of the year 1770, and which, being the result of several years' repeated observations, made with the utmost care and the best instruments, may be presumed to be exceedingly accurate. In 1776, a work was published at Berlin, entitled "Recueil de Tebles Astronomiques," in which is contained a very large catalogue of stars from Hevelius, Flamstead, M. de la Caille, and Dr. Bradley, with their latitudes and longitudes for the beginning of 1800, with a catalogue of the southern stars of M. de la Caille, of double stars, of changeable stars, and of nebulous stars: a work very useful for the practical astronomer. To these may be added Dr. Herschel's catalogue of double stars, printed in the Philosophical Transactions for 1782 and 1783; M. Messier's nebulæ and clusters of stars, published in the "Connoissance des Temps," for 1784; and Dr. Herschel's catalogue of the same kind, given in the "Philosophical Transactions" for 1786. In 1789, Mr. Francis Wollaston published in folio, a "Specimen of a general Astronomical Catalogue, arranged in Zones of North Polar Distance, and adapted to January 1, 1792." In forming this catalogue, Mr. Wollaston has not made any use of those which precede Flamstead, except, in a small part, that of Hevelius: but all the stars in the British catalogue of 1725 are inserted, as well as those which are in the three latter catalogues of M. de la Caille; those of Dr. Bradley, in the Nautical Almanac for 1773; of M. Mayer; of Dr. Maskelyne;

the double stars of Dr. Herschel; M. Messier's nebulæ; and all those of Dr. Herschel, excepting his second and third classes; that is, all those which are capable of being discerned with any telescope inferior to his own. This work contains five distinct catalogues, *viz.* Dr. Maskelyne's new catalogue of 36 principal fixed stars; a general catalogue of all the stars in zones of north-polar distance; an index of the general catalogue; a catalogue of all the stars, in the order in which they pass the meridian; and a catalogue of zodiacal stars, in longitude and latitude.

CATANANCHE, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compound Flowers. Division, Semiflosculosæ. Cinarocephalæ, Jussieu. Essential character: receptacle chaffy; calyx imbricate; down awned from a five-bristled calycle. There are three species, of which C. *cærulea* puts forth many narrow hairy leaves, which are jagged on their edges like those of buckshorn plantain; but the leaves are broader, the jags deeper and at greater distances; these lie flat on the ground, turning their points upwards, which are very narrow. Between the leaves come out the flower stalks, which are in number proportionable to the size of the plant; for from an old thriving root there is frequently eight or ten, and young plants do not send out more than two or three; each of the peduncles are terminated with single heads of flowers, having a dry, silvery, scaly calyx, in which are included three or four florets; these are of a fine blue colour, with a dark spot at bottom, and in each the stamens, with their yellow summits, standing a little above the petals, make a pretty appearance. It is a native of the South of Europe.

CATAPLASM, an external topical medicine, of a soft consistence, and prepared of ingredients of different virtues, according to the intention of the physician. See PHARMACY.

CATARACT, in medicine and surgery, a disorder of the humours in the eye, by which the pupilla, that ought to appear transparent and black, looks opaque, grey, blue, brown, &c. by which vision is variously impeded, or totally destroyed.

CATARRH. See MEDICINE.

CATASTASIS, in poetry, the third part of the ancient drama, being that wherein the intrigue, or action, set forth in the epitasis, is supported, and carried on, and heightened, till it be ripe for the unravelling in the catastrophe.

CATASTROPHE, in dramatic poetry, the fourth and last part in the ancient drama, or that immediately succeeding the catastasis; or, the fifth act in modern tragedy.

CATCH *word*, among printers, that placed at the bottom of each page, being always the first word of the following page.

CATECHU, in chemistry, a substance obtained by decoction and inspissation from the wood of the mimosa catechu, a native of India, is a very powerful astringent, and contains a large proportion of tannin. It is almost wholly soluble in water, and in alcohol, but when acted upon by this, a portion of mucilage remains undissolved: the component parts are

Bombay catechu.

Tannin . . .	54.5
Extractive matter	34.0
Mucilage . . .	6.5
Residue . . .	5.
	100.0

Bengal catechu.

Tannin . . .	48.5
Extract . . .	36.5
Mucilage . . .	8.0
Residue . . .	7.
	100.0

CATEGORY, in logic, a series or order of all the predicates or attributes contained under any genus.

The school philosophers distribute all the objects of our thoughts and ideas into certain genera or classes, not so much, say they, to learn what they do not know, as to communicate a distinct notion of what they do know; and these classes the Greeks called categories, and the Latins predicaments.

Aristotle made ten categories; *viz.* substance, quantity, quality, relation, action, passion, time, place, situation, and habit, which are usually expressed by the following technical distich:

Arbor, sex, servos, ardore, refrigerat, ustos,
Ruri, cras, stabo, nec tunicatus ero.

CATENARIA, in the higher geometry, the name of a curve line formed by a rope hanging freely from two points of suspension, whether the points be horizontal or not. The nature of this curve was sought after in Galileo's time, but not discovered till the year 1690, when Mr. Bernoulli published it as a problem. Dr. Gregory, in 1697, published a method of investigation of the properties formerly discovered by Mr. Bernoulli and Mr. Leibnitz, together with some new properties of this curve. From him we take the following method of finding the general property of the catenaria.

1. Suppose a line heavy and flexible, the two extremes of which F and D, Plate II. Miscellanies, fig. 8, are firmly fixed in those points; by its weight it is bent into a certain curve F A D, which is called the catenaria.

2. Let B D and $b\ c$ be parallel to the horizon, A B perpendicular to B D, and D c parallel to A B, and the points B b infinitely near to each other. From the laws of mechanics, any three powers in equilibrio are to one another as the lines parallel to the lines of their direction, (or inclined in any given angle) and terminated by their mutual concourses; hence if D d express the absolute gravity of the particle D d, (as it will if we allow the chain to be every way uniform) then D c will express that part of the gravity that acts perpendicularly upon D d; and by the means of which this particle endeavours to reduce itself to a vertical position; so that if this lineola $d\ c$ be constant, the perpendicular action of gravity upon the parts of the chain will be constant too, and may therefore be expressed by any given right line. Further, the lineola D c will express the force which acts against that conatus of the particle D d, by which it endeavours to restore itself in a position perpendicular to the horizon, and hinders it from doing so. This force proceeds from the ponderous line D A drawing according to the direction D d; and is, *cæteris paribus*, proportional to the line D A which is the cause of it. Supposing the curve F A D, therefore, as before, whose vertex is A, axis A B, ordinate B D, fluxion of the axis D C = B b, fluxion of the ordinate $d\ c$, the relation of these two fluxions is thus; *viz.* $d\ c$: D d :: a : D A curve, which is the fundamental property of the curve, and may be thus expressed (putting A B = x and B D = y and A D = c

$$\dot{y} = \frac{a\dot{x}}{c}.$$

CATERPILLAR, in natural history: the larvæ of butterflies are universally known by the name of caterpillars, and are extremely various in their forms and colours, some being smooth, others beset with either simple or ramified spines, and some are observed to protrude from their front, when disturbed, a pair of short tentacula or feelers, somewhat analagous to those of a snail. A caterpillar, when grown to its full size, retires to some convenient spot, and securing itself properly by a small quantity of silken filaments, either suspends itself by the tail, hanging with its head downwards, or else in an upright position, with the body fastened round the middle by a number of filaments. It then casts off its caterpillar-skin, and commences crysalis, in which state it continues till the butterfly is ready for birth, which, liberating itself from the skin of the chrysalis, remains till its wings, which are first short, weak, and covered with moisture, are fully extended; this happens in about a quarter of an hour, when the animal suddenly quits the state of inactivity to which it had been so long confined, and becomes at pleasure an inhabitant of the air.

CATESBÆA, in botany, so called in honour of Mark Catesby, a genus of the Tetrandria Monogynia class and order. Natural order of Luridæ. Rubiaceæ, Jussieu. Essential character: corolla monopetalous, funnel-form, extremely long, superior; stamens within the mouth; berry polyspermous. There are but two species, of which C. spinosa, lily-thorn, rises with a branching stem to the height of twelve feet, covered with a pale russet bark; the branches come out alternately from the bottom to the top, with small leaves resembling those of the box-tree, in clusters all round the branches at certain distances; the flowers come out single from the sides of the branches, hanging downward, and are of a dull yellow colour; the berry is the size of a middling plum, hollow within, with small angular seeds. This shrub was discovered by Mr. Catesby near Nassau town, in Providence, one of the Bahama Islands. C. parviflora is a native of Jamaica.

CATHARTICS, in medicine, are the same with what are commonly called purgatives. See MEDICINE.

CATHEDRAL, a church wherein is a bishop's see or seat.

After the establishment of Christianity, the emperors, and other great men, gave large demesnes and other possessions for the maintenance of the clergy; on these were built the first places of worship, which were called cathedra, cathedrals, sees, or seats, from the bishop and his chief clergy's residence thereon.

A cathedral was originally different from what it is now, the Christians, till the time of Constantine, having no liberty to build any temple. By their churches they only meant their assemblies; and by their cathedrals, nothing more than consistories.

CATHETER, in surgery, a fistulous instrument, usually made of silver, or silk coated with caoutchouc, to be introduced into the bladder, to discharge the urine when suppressed. See SURGERY.

CATHETUS, in geometry, a line or radius falling perpendicularly on another line or surface: thus the catheti of a right angled triangle are the two sides that include the right angle.

CATOPTRICS, that part of optics that treats of reflex vision, and explains the laws and properties of reflection, chiefly founded upon this truth, that the angle of reflection is always equal to the angle of incidence; and from thence deducing the magnitudes, shapes, and situations, of the appearances of objects seen by the reflection of polished surfaces, and particularly plane, spherical, conical, and cylindrical ones. See OPTICS.

CATTLE. Under this term are comprehended horses and oxen of both sexes and of all ages; these we term black cattle: while sheep, goats, &c. come under the designation of small cattle. The whole tribe are granivorous, and may be very easily maintained without the aid of the plough, though it is certain that the produce of tilled land will pay better, when appropriated to the support of cattle, than common pastures, or even artificial grasses. The latter, such as clover, saintfoin, burnet, &c. are superior to common meadow hay, for the purposes of winter fodder; making the animals appear better in their coats, or hair, and causing them to fatten, and to endure fatigue, far beyond what they could undergo on common field grass, or its hay. We have thousands of cattle-markets, where beasts of all descriptions may be purchased, in every stage of condition, and in all their varieties. The great improvements made of late years in farming, added to our great increase of population, have rendered the business of feeding cattle of great importance.

CATTLE, *law relating to*. By a statute of Edward VI. no person shall buy any ox, &c. and sell the same again alive in the same market, or fair, on pain of forfeiting double the value thereof, half to the King, and half to him that shall sue. This is the act against forestalling, regrating, &c.

CATURUS, in botany, a genus of the Dioecia Triandria class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. There are two species: C. spiciflorus is a tree about twenty feet in height, with many branches diffused all round; the wood is white and close, with a thick, dusky, unctuous, inodorous bark, and a yellow pith within; the fruit is a round, yellowish-green, insipid berry, inclosing one round green seed. Native of the East Indies. C. scandens is a native of the woods of Cochin China.

CAVA, or VENA CAVA, in anatomy, a vein arising with a large sinus from the right auricle of the heart. See ANATOMY.

CAVALIER, in fortification, an elevation of earth, of different shapes, situated ordinarily in the gorge of a bastion, bordered with a parapet, and cut into more or less embrasures, according to the capacity of the cavalier.

CAVALRY, a body of soldiers that charge on horseback, and may properly be called the right arm of the army: they are of great service in disturbing the enemy by their frequent excursions, in intercepting convoys, and destroying the country. The cavalry is divided into squadrons, and encamp on the wings of the army.

CAUCALIS, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: corolla radiated, in the disc; male, petals inflex-emarginate; fruit hispid; with bristles; involucres entire. There are nine species. These plants are all annual, or at most biennial, and are seldom cultivated, except in botanic gardens. They will rise readily from seeds, where they are permitted to scatter, and will grow in any soil and situation.

CAVEAR, CAVEER, or CAVIARY, the spawn or hard roes of sturgeon, made into small cakes, an inch thick, and of an hand's breadth, salted and dried in the sun.

The French and Italians get the cavear from Archangel, but they seldom get it at the first hand, for they commonly buy it of the English and Dutch.

CAVEAT, in law, a kind of process in the spiritual courts, to stop the proving of a will, the granting letters of administration, &c. to the prejudice of another. It is also used to stop the institution of a clerk to a benefice. A caveat stands in force for three months.

The entering a caveat being at the instance of the party, is for the benefit of the ordinary, that he may do no wrong; it is a cautionary act for his better information, to which the temporal courts have no regard; therefore, if, after a caveat entered, the ordinary should grant administration, or probate of a will, it is not void by our law, though it is by the canon law; but our law takes notice of a caveat.

CAVERNOSE, among anatomists, an appellation given to several parts of the body on account of their spongy structure: thus the cavernosa corpora are two spongy bodies, made up of a number of small caverns or cells.

CAVETTO, in architecture, the reverse of a quarter round, being a concave moulding frequently used in the entablature.

CAVIA, the *cavy*, in natural history, a genus of Mammalia, of the order Glires. Generic character: two wedge-shaped front teeth; eight grinders; from four to five toes on the fore-feet, from three to five on the hind-feet; tail very short, or none; no clavicles. There are seven species, of which those that follow are most deserving attention.

C. cobaya, or the guinea pig. This animal is a native of South America, and found particularly in Brazil. It is tamed with great facility, and is inoffensive, timorous, and particularly cleanly; it does not, however, appear susceptible of strong attachments to its benefactors, nor is it remarkable for docility. It is one of the most prolific of animals, and Buffon calculates that, in twelve months only, one thousand might be produced from a single pair, as the female has been known to bring forth young when two months old only; and the time of gestation is only three weeks; and she will produce at least every two months. They are six or seven months before they arrive at their maturity of growth, but within the short period of twelve hours from their birth are nearly as alert and active as those fully grown, and therefore require parental assiduity only for a little time. Vegetables form their food, and on a great variety of these they will flourish and fatten: very succulent food of this description, however, is injurious, and with sow-thistles and cabbage, should be employed for them nourishment of more consistency, such as grain and bread. They drink but little, appear, after eating to ruminate, and are extremely apt to be affected by cold. They are in some places used as articles of food, and even considered as delicacies. They are uncommonly cleanly in their habitations, and are often to be seen smoothing and cleansing their fur with particular attention and perseverance. In contests they not only bite, but kick. It is a curious circumstance, if it may be depended upon as true, and it is stated by authentic reporters, that the male and female seldom sleep at the same time, but exercise over each other alternate vigilance. See Mammalia, Plate VII. fig. 2.

C. paca, or the spotted cavy, of Pennant, is clumsily formed; a native, like the former, of South America; is highly esteemed by the inhabitants of this quarter of the world for its food; is particularly fond of fruits and of sugar; and continuing in its hole during the day, devotes the night to activity and refreshment. See Mammalia, Plate VII. fig. 3.

C. capybara, or the river cavy, inhabits particularly the eastern parts of South America; and when full grown weighs about a hundred pounds; it lives not only upon vegetables, but also upon fish, which, as it swims and dives extremely well, it procures with facility, but which it brings to land before it devours; it is of a mild disposition, and easily familiarized by man; its pursuit of prey is generally engaged in by night; it frequents, principally, marshes and the banks of rivers. These animals are reported to associate only in pairs. The female produces only one young at a time. Their flesh is praised by some as exquisite, but others represent it as rank and fishy.

C. aguti, the long-nosed cavy. These animals move like hares, and grunt like pigs; their food consists of various fruits, and of nuts, which they will hide, and abstain from touching for many months; they breed with the rapidity of rabbits, no season checking their prolific tendencies; their flesh is very agreeable to the taste, and, even when they are old, acquires little or no toughness. They are caught by the Indians in Guinea, and other warm parts of South America, where alone they are to be met with in great numbers, sometimes being hunted down by their dogs, and frequently being taken in traps, to which they are allured by the accurate imitation of their peculiar sounds. They are nearly of the size of a hare; when pursued, they retreat to burrows or holes of trees, which, indeed, constitute their irregular and frequently changed abodes, and in which they are almost uniformly found alone; or the female with its young ones. They hold their food in the same manner as the squirrel; they make their excursions for food during the day, and may be easily domesticated, though not so completely as to exclude altogether their natural wildness. See Mammalia, Plate VII. fig. 4.

CAUKING, or CAULKING *of a ship*, is driving oakum, or the like, into all the seams of the plank of a ship, to prevent leaking and keep out the water.

CAULKING *irons*, are iron chissels for that purpose. Some of these irons are broad, some round, and others grooved. After the seams are stopped with oakum, it is done over with a mixture of tallow, pitch, and tar, as low as the ship draws water.

CAUL, in anatomy, a membranaceous part of the abdomen, covering the greatest part of the intestines.

CAULIFLOWERS, in gardening, a much esteemed species of *brassica*, or cabbage.

CAUSE, *causa*, that from whence any thing proceeds, or by virtue of which any thing is done: it stands opposed to effect. We get the ideas of cause and effect, says Mr. Locke, from our observation of the vicissitude of things, while we perceive some qualities or substances begin to exist, and that they receive their existence from the due application and operation of other beings. That which produces, is the cause, and that which is produced, the effect: thus, fludity in wax is the effect of a certain degree of heat, which we observe to be constantly produced by the application of such heat.

CAUSE, *first*, that which acts of itself, and of its own proper power or virtue: God is the only first cause in this sense.

CAUSES, *second*, are those which derive the power and faculty of action from a first cause; these are improperly called causes, as they do not, strictly speaking, act at all, but are acted on: of this kind are all those that we term natural causes.

CAUSES, *final*, are the motives inducing an agent to act; or the design and purpose for which the thing was done.

Lord Bacon says, that the final cause is so far from being serviceable, that it corrupts the sciences, unless it be restrained to human actions: however, continues he, final causes are not false, nor unworthy of inquiry in metaphysics: but their excursions into the limits of physical causes hath made a great devastation in that province; otherwise, when contained within their own bounds, they are not repugnant to physical causes.

CAUSEWAY, or CAUSEY, a massive construction of stones, stakes, and fascines; or an elevation of earth, well beaten; serving either as a road in wet marshy places, or as a mole to retain the waters of a pond, or prevent a river from overflowing the lower grounds.

CAUSTIC, CAUSTICITY, } a substance is said to be caustic, when it produces the same effect on the tongue as that of actual fire, that is, an immediate sensation of burning, followed with a slight disorganization of the surface actually in contact. Thus alkalies are called caustic when deprived of carbonic acid, because, when concentrated, they then burn and blister the tongue almost instantly. Caustic substances are also generally corrosive, or such as act upon organized matter, and decompose it with rapidity. The term caustic prefixed to the alkalies and earths, to distinguish the pure or decarbonated state, is now almost always omitted, as unnecessary, by the use of the term carbonate; thus, to the terms caustic potash, and mild potash, are substituted those of potash, and carbonate of potash, respectively. We also say lime, and the carbonate of lime. There is still some confusion with regard to the term soda among others; soda meaning in chemical language pure or caustic soda, but in commerce, and in common use, the mild or carbonate of soda.

CAUSTIC, *lunar*, the old name for nitrate of silver, melted and cast into cylindrical pieces about the size of small black-lead pencils, for the use of surgeons: and the solution of lunar caustic is the proportion of from 8 to 12 grains in an ounce of water, and has been found an excellent remedy in cases of ringworm, as it is called, that is, when the hair falls off in patches from the head.

CAUSTIC *curve*, in the higher geometry, a curve formed by the concourse or coincidence of the rays of light, reflected or refracted from some other curve. See CATACAUSTIC.

CAYENNE *pepper*. This is the levigated or ground pod of the plant commonly known to us by the name of capsicum. There are many varieties; but the principal are:—1. The berberry capsicum, much resembling that fruit in size and colour, though infinitely more glowing. It is perhaps the most pungent of all the vegetable simples with which we are acquainted. 2. The long-pod, which is extremely common, and generally grows as large as a man's middle finger. 3. The cockspur, which takes that name from its shape, and is highly pungent. 4. The caffree, which is round and wrinkled, and ordinarily about the size of a small medlar. All these may be raised from the seed on hot-beds, and planted out in June. They are biennials in their native climate; *viz.* in Cayenne, whence the pepper derives its name, and in every part of the torrid zone; but we cannot keep them through the winter. Cayenne is esteemed a stimulant, and commonly has a place among the sauces, &c. intended for the table.

CAYS, a term used by sailors to denote the little islands and rocks that are almost every where dispersed among the West India islands.

CAZEMATE, or CASEMATE, in fortification, a certain retired platform in the flank of a bastion, for the defence of the moat and face of the opposite bastion.

CEANOTHUS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: petals five, sacular, vaulted; berry dry, three-celled, three-seeded. There are six species, of which C. Americanus, American ceanothus, or New-Jersey tea, seldom rises more than three or four feet high in England, sending out branches on every side from the ground upward. These branches are ornamented with oval pointed leaves, having three longitudinal veins running from the foot-stalk to the point, and diverging in the broad part of the leaves from each other; at the extremity of each shoot the flowers are produced in close thick spikes, and are composed of five small petals of a clear white. These appear in July, making a pretty appearance during their continuance; for as every shoot is terminated by one of these spikes, the whole shrub is covered over with flowers, the branches growing very close to each other; and when the autumn proves mild, these shrubs often flower again in October.

CECROPIA, in botany, a genus of the Dioecia Diandria class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character, male; spathe caducous; ament imbricate, with turbinate scales; compressed-quadrangular; corolla none; female as in the male; germus imbricate: style one; stigma lacerated; berry one-seeded. There is but one species, *viz.* C. peltata, trumpet-tree, or snake-wood; this tree commonly rises to a considerable height, being seldom under forty feet in the most perfect state. The trunk and branches are hollow every where, and stopped from space to space with membranous septas, answering to so many light annular marks in the surface. The wood of this tree, when dry, is very apt to take fire by attrition: the native Indians always kindle their fires in the woods by rubbing a piece of it against some harder wood. The bark is strong and fibrous, and is frequently used for cordage. It is a native of South America, Jamaica, and other West India Islands.

CEDAR, comprehended by Linnæus among the junipers. See JUNIPER. Cedar-wood, which is of a fragrant smell and fine grain, is almost incorruptible, by reason of its bitterness, which renders it distasteful to worms. Historians tell us, that some of this timber was found in the temple of Apollo at Utica, 2000 years old. The cedars of Lebanon are famous as having been used by Solomon in building the temple at Jerusalem.

CEDRELA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Miscellaneæ. Meliæ, Jussieu. Essential character: calyx withering; corolla five-petalled, funnel-form, fastened by the base to the receptacle to one-third of its length; capsule woody, five-celled, five-valved; seeds imbricate downwards, with a membranaceous wing. There is but one species; *viz.* C. odorata, Barbadoes bastard cedar; rises with a straight stem to the height of 70 or 80 feet: while young the bark is smooth, and of an ash colour; but as it advances, the bark becomes rough, and of a darker colour. Toward the top it shoots out many side branches, garnished with winged leaves, composed of sixteen pair of leaflets, which are broad at their base, and are near two inches long, of a pale colour; these emit a rank odour in the summer season, so as to be very offensive. The fruit is oval, about the size of a partridge's egg, smooth, of a dark colour, and opens in five parts, having a five-cornered column standing in the middle, between the angles of which the winged seeds are closely placed, lapping over each other like the scales of fish. This tree is commonly known under the name of cedar in the British West India islands.

CEDROTA, in botany, a genus of the Octandria Monogynia class and order. Essential character: calyx six-parted; corolla none; germ superior, surrounded by a gland; style short. There is but one species; *viz.* C. Guianensis; this is a lofty tree, forty feet in height, and two in diameter, with a thick, unequal, wrinkled bark full of clefts, and is a heavy aromatic wood, which becomes light when dry. It grows in the great forest of Guiana, flowering in May.

CELARENT, in logic, a mode of syllogysm, wherein the major and conclusion are universal negative propositions, and the minor an universal affirmative. As

CE No man that is a hypocrite can be saved:

LA Every man, who with his lips only cries Lord, Lord, is a hypocrite:

RENT Therefore, no man, who with his lips only cries Lord, Lord, can be saved.

CELASTRUS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: corolla five-petalled, spreading; capsule triangular, trilocular; seeds calyptrated. There are twenty-two species. This genus consists of shrubs or small trees, with alternate leaves, and the flowers many together, on axillary subdichotomous peduncles. They are mostly natives of America and the Cape of Good Hope.

CELERITY, the swiftnes of any body in motion. See MECHANICS.

CELESTINE, in mineralogy, a species of the Strontian genus; it is divided by Werner into two sub-species; *viz.* the fibrous and the foliated: the colour of the former is intermediate between indigo blue and bluish grey, and sometimes passes into a milk white. It loses its colour in keeping. It is found massive and in plates, also crystallized: the fragments are splintery. It shews a tendency to prismatic distinct concretions, which appear to be parallel and conformable with the fibrous fracture. Specific gravity is 3.83. Its geognostic situation is very imperfectly known; it is imagined to occur in marl. It is found in France, and at Frankstown in Pennsylvania. The foliated celestine is milk white, which falls into blue: it occurs massive, and is crystallized in six-sided tables that intersect one another. It is found in Sicily, and in England, near Bristol: specific gravity 3.6, nearly, and the constituent parts are, according to Vauquelin,

Sulphate of strontian . .	91.42
Carbonate of lime . . .	8.33
Oxide of iron	0.25
	100,00

CELLEPORA, in natural history, a genus of the vermes zoophyta. Animal an hydra or polype: corol somewhat membranaceous, composed of round cells. There are eight species, of which we shall notice C. ramulosa, which is found in the Northern Ocean, very brittle, and much branched, and appearing as if composed of grains of sand. C. spongites has rows of tubular top-shaped cells, in single layers, the openings of which are margined. This species inhabits the Mediterranean and North seas: white, grey, or red, and marked on the under side of the cells with lines between each row; they are from two to five inches in diameter.

CELLULAR *substance*, in anatomy, or CELLULAR *membrane*, is the medium which connects and supports all the various parts and structures of the body. It is composed of an assemblage of fibres, and laminæ of animal matter, connected to each other, so as to form innumerable cells or small cavities, from which its name of cellular is derived. This substance pervades every part of the animal structure. By joining together the minute fibrils of muscle, tendons or nerve, it forms obvious and visible fibres; it collects these fibres into larger fasciculi; and by joining such fasciculi to each other, constitutes an entire muscle or nerve. It thus forms an investment common to the whole muscle, and bestows on each bundle of fibres, nay, on each fibre, down to the most minute threads, peculiar sheaths, delicate and tender in proportion to the subtilty of the fibre. It joins together the individual muscles, and is collected in their intervals. It surrounds each vessel and nerve in the body; often connecting these parts to each other by a firm kind of capsule; and in a looser form joining them to the neighbouring muscles, &c. When condensed into a firm and compact structure, it constitutes the various membranes of the body; which, by long maceration in water, may be resolved into a cellular texture. In the bones, it forms the basis and groundwork of their fabric; a receptacle, in the interstices of which the earth of bone is deposited. The only parts of the body in which the cellular texture seems to be wanting are, the proper substance of the brain, the crystalline lens, enamel of the teeth, and the insensible integuments of the body; *viz.* the epidermis, nails, and hair. As the cellular substance is entirely soluble in boiling water, it is ascribed by chemists to the peculiar modification of animal matter, termed gelatine. Its watery solution assumes, when cold, the appearance of jelly, and, after a particular mode of preparation, constitutes glue.

From the universal extent of this cellular texture, two conclusions may be drawn. 1. It forms the basis of the whole animal fabric in such a way, that, if we conceive every part removed, except this, the form of the whole would still be expressed in cellular substance. 2. It forms a connection and passage between all parts of the body, however remote in situation, or dissimilar in structure. For the cells of this substance every where communicate, as we may collect from facts of the most common and familiar occurrence. The air in emphysema spreads rapidly from the chest to the most remote parts of the body; it has been known in such a case to gain admission into the eye-ball.

CELOSIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Miscellaneæ. Amaranthi, Jussieu. Essential character: calyx three-leaved; leaflets similar to those of the five-petalled corolla; stamina conjoined at the base to the plated nectary; capsule gaping horizontally. There are fourteen species. Celosias, or cock's combs, are all herbaceous plants, and annual. The flowers are glomerate in spikes or panicles, some of which are fluted and shaped somewhat like the comb of a cock. Natives of the East Indies, China, Cochin China, and Japan.

CELSIA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: calyx five-parted; corolla rotated; filament bearded; caspule two-celled. There are four species. Natives of the Levant, Crete, the East Indies, and Peru.

CELTIS, in botany, English *lote*, or *nettle-tree*, a genus of the Polygamia Monoecia class and order. Natural order of Scabridæ. Amentaceæ, Jussieu. Essential character: Herm. calyx five-parted; corolla none; stamina five; styles two; drupe one-seeded: male, calyx six-parted; corolla none; stamina six. There are seven species, of which C. australis, European nettle-tree, or lote tree, with a black fruit, is about fifty feet in height, with slender branches, which have a smooth dark coloured bark with grey spots. The fruit is the size of a pea; it grows naturally in the south of France, where it is one of the largest trees. The wood of this tree is exceedingly hard, and when it arrives to any size, its hardness, toughness, and flexibility, entitle it to very important services. Its fine regular spreading head, of a cheerful green colour, renders this tree very proper for clumps in parks, groves, single trees, or avenues.

CEMENT *copper*. The copper procured from the sulphate by precipitation with iron is so called.

CEMENTATION, in the arts, a general method of forming steel from iron, by means of the application of charcoal. In a proper furnace, layers of bars of malleable iron, and layers of charcoal, are placed one upon another, the air excluded, the fire is raised to a great height, and kept up for eight or ten days. If after this the conversion of the iron into steel be complete, the fire is extinguished, and the whole is left to cool for six or eight days longer. Iron prepared in this manner is named blistered steel, from the blisters which appear on its surface. Copper is converted into brass by cementation with a powder of calamine and charcoal. The powder thus used is called cement powder.

CEMENTS and *lutes*. Under this article may be mentioned the receipts for preparing some of the most useful substances of this kind that are required in common chemical operations. The uses of lutes and cements are either to close the joinings of chemical vessels to prevent the escape of vapours and gases during the processes of distillation, sublimation and the like, or to protect vessels from the action of the fire, which might crack, or fuse, or calcine them; or sometimes to repair flaws and cracks, and for a variety of other smaller purposes.

From the vast variety of receipts for lutes and cements of different kinds, the following may be selected, which will answer most of the purposes of the experimental chemist. To prevent the escape of the vapours of water, spirit, and liquors not corrosive, the simple application of slips of moistened bladder will answer very well for glass, and paper with good paste for metal. Bladder, to be very adhesive, should be soaked some time in water moderately warm, till it feels clammy; it then sticks very well: if smeared with white of egg, instead of water, it adheres still closer. Another very convenient lute is linseed meal, moistened with water to a proper consistence, well beaten, and applied pretty thick over the joinings of the vessels. This immediately renders them tight, and the lute in some hours dries to a hard mass. Almond paste will answer the same purpose. The use of the above lute is so extensive, that no other is required in closing glass vessels in preparing all common distilled liquors; and it will even keep in ammonia, and acid gases, for a longer time than is required for most experimental purposes. It begins to scorch and spoil at a heat much above boiling, and therefore will not do as a fire-lute. It is still firmer, and dries sooner, when made up with milk, or lime-water, or weak glue. A number of very cohesive cements, impervious to water and most liquids and vapours, and extremely hard when once solidified, are made by the union of quick-lime with many of the vegetable or animal mucilaginous liquors. The variety of these is endless. We may first mention the following, as it has been extensively employed by chemists for centuries. Take some whites of eggs with as much water, beat them well together, and sprinkle in sufficient slaked lime to make up the whole to the consistence of thin paste. The lime should be slaked by being once dipped in water, and then suffered to fall into powder, which it will do speedily, with great emission of heat, if well burnt. This cement should be spread on slips of cloth, and applied immediately, as it hardens or sets very speedily. While hardening it may be of use to sprinkle over it some of the lime in fine powder. This cement is often more simply and as conveniently managed, by smearing slips of linen on both sides with white of egg, and when applied to the joining of the vessels, shaking some powdered lime over it; it then dries very speedily. Another lute of the same kind, and equally good, is made by using a strong solution of glue to the lime, instead of the white of egg: it sets equally soon, and becomes very hard. A mixture of liquid glue, white of egg, and lime, makes the *lut d'ane*, which is so firm, that broken vessels united with it are almost as strong as when sound. None of these lutes, however, will enable these vessels to hold liquids for any great length of time. Milk or starch, with lime, make a good but less firm lute. A very firm and singular lute of this kind is made by rubbing down some of the poorest skimmed-milk cheese with water, to the consistence of thick soup, and then adding lime, and applying as above: it answers extremely well. Lime and blood, with a small quantity of brick-dust, or broken pottery, stirred in, is used in some places as a very good water-cement for cellars and places liable to damp.

All the above-mentioned cements, with lime, become very hard by drying, insomuch that they cannot be separated from glass vessels without the help of a sharp knife and some violence; and hence delicate vessels and long thin tubes, cemented with it, are apt to break when the apparatus is taken down, and sometimes even by the mere force of contraction in setting. It is a great advantage, however, that they may be applied immediately to any accidental crack or failure of the lute already on, notwithstanding a stream of vapour is bursting through; and in large distillations it is of advantage always to have some of the materials at hand.

CENCHRUS, in botany, a genus of the Polygamia Monoecia class and order. Natural order of Grasses. Essential character: invol. laciniate, echinate, two flowered; calyx glume two flowered, one male, the other hermaphrodite; Herm. corolla glume awnless; stamina three; seed one: male, corolla glume awnless; stamina three. There are eleven species, all natives of both Indies.

CENSOR *of books*, is a body of doctors or others established in divers countries to examine all books before they go to the press, and to see they contain nothing contrary to faith and good manners.

In England, we had formerly an officer of this kind, under the title of licenser of the press; but since the revolution our press has been laid under no such restraint.

CENT, in commerce, an abridgement of centum, is used to express the profit or loss arising from the sale of any commodity. Thus we say, there is 10 *per cent.* profit, or 10 *per cent.* loss which is one-tenth profit, or one-tenth loss, upon the sale of the whole.

CENTAUREA, in botany, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of compound flowers. Cinarocephalæ, Jussieu. There are seventy-seven species, of which we shall only mention C. moschata, purple sweet centaury, which is an annual, and has been many years propagated in the English gardens, under the title of Sultan flower, or sweet Sultan. It was brought from the Levant, where it grows naturally in arable land among the corn; it sends up a round, channelled stalk, nearly three feet high, which divides into many branches, from the sides of which come out long naked peduncles, each sustaining a single head of flowers; they have a strong odour, so as to be very offensive to many people; they are purple, white, or flesh-coloured; there is also a variety with fistula flowers, and another with fringed flowers; but these degenerate in a few years, however carefully the seeds may be saved.

CENTER, in carpentry, an arch framed of wood, upon which a stone or brick arch is turned.

CENTER, or CENTRE, in geometry, a point equally distant from the extremities of a line figure, or body.

CENTER *of a circle*, a point in the middle of a circle, or circular figure, from which all lines drawn to the circumference are equal.

CENTER *of a conic section*, a point wherein the diameters intersect each other. In the ellipsis, this point is within the figure; and in the hyperbola, without.

CENTER *of a curve of the higher kind*, the point where two diameters concur. When all the diameters concur in the same point, Sir Isaac Newton calls it the general center.

CENTER *of an ellipsis*, the point where the transverse and conjugate diameters intersect each other.

CENTER *of gravitation and attraction*, in physics, that point to which the revolving planet or comet is impelled or attracted by the impetus of gravity.

CENTER *of gravity*, in mechanics, that point about which all the parts of a body do, in any situation, exactly balance each other. Hence, 1. If a body be suspended by this point as the center of motion, it will remain at rest in any position indifferently. 2. If a body be suspended in any other point, it can rest only in two positions, *viz.* when the said center of gravity is exactly above or below the point of suspension. 3. When the center of gravity is supported, the whole body is kept from falling. 4. Because this point has a constant endeavour to descend to the center of the earth; therefore, 5. When the point is at liberty to descend, the whole body must also descend, either by sliding, rolling, or tumbling down. 6. The center of gravity in regular uniform and homogeneal bodies, as squares, circles, &c. is the middle point in a line connecting any two opposite points or angles; wherefore, if such a line be bisected, the point of section will be the center of gravity.

To find the center of gravity of a triangle. Let B G (Plate III. Miscell. fig. 1,) bisect the base A C of the triangle A B C, it will also bisect every other line D E drawn parallel to the base, consequently the center of gravity of the triangle will be found somewhere in the line B G. The area of the triangle may be considered as consisting of an infinite number of indefinitely small parallelograms, D, E, b, a, each of which is to be considered as a weight, and also as the fluxion of the area of the triangle, and so may be expressed by $2\,y\,\dot{x}$, (putting B F $= x$, and F E $= y$) if this fluxionary weight be multiplied by its velocity x, we shall have $2\,y\,x\,\dot{x}$ for its momentum. Now put B G $= a$ and A C $= b$, then B G (a) : A C (b) :: B F (x) : D E $= \frac{bx}{a} = 2\,y$, therefore the fluxion of the weight $2\,y\,\dot{x} = \frac{b\,x\,\dot{x}}{a}$; and the fluxion of the momenta $2\,y\,x\,\dot{x} = \frac{b\,x\,x\,\dot{x}}{a}$, whence the fluent of the latter, *viz.* $\frac{b\,x^3}{3\,a}$ divided by the fluent of the former, *viz.* $\frac{b\,x^2}{2\,a}$ will give $\frac{2}{3}\,x$ for the distance of the point from B in the line B F, which has a velocity equal to the mean velocity of all the particles in the triangle D B E, and is therefore its center of gravity. Consequently the centre of gravity of any triangle A B C, is distant from the vertex B $\frac{2}{3}$ B G, a right line drawn from the angle B bisecting the base A C. And since the section of a superficial or hollow cone is a triangle, and circles have the same ratio as their diameters, it follows that the circle, whose plane passes through the center of gravity of the cone, is $\frac{2}{3}$ of the length of the side distant from the vertex of the said cone.

To find the center of gravity of a solid cone. As the cone consists of an infinite number of circular areas, which may be considered as so many weights, the center of gravity may be found as before, by putting B E $= x$ (fig. 2.) B G $= a$, the circular area D F E $= y$, and A G C $= b$; and from the nature of the cone, $a^2 : x^2 :: b : y = \frac{b\,x^2}{a^2}$: but $\dot{x}\,y = \frac{b\,x^2\,\dot{x}}{a^2} =$ fluxion of the weights; and $y\,x\,\dot{x} = \frac{b\,x^3\dot{x}}{a^2}$ = fluxion of the momenta, whence the fluent of the latter, *viz.* $\frac{b\,x^4}{4\,a^2}$, divided by the fluent of the former $\frac{b\,x^3}{3\,a^2}$ will give

$\frac{3}{4}x$ for the center of gravity of the part D B E F, consequently the center of gravity of the cone A B C G is distant from the vertex B $\frac{3}{4}$ of the side B G, in a circle parallel to the base.

To find the center of gravity in a parallelogram and parallelopiped, draw the diagonal A D and E G (fig. 3,) likewise C B and H F; since each diagonal A D and C B divides the parallelogram A C D B into two equal parts, each passes through the center of gravity: consequently the point of intersection, I, must be the center of gravity of the parallelogram. In like manner, since both the plane C B F H and A D G E divide the parallelopiped into two equal parts, each passes through its center of gravity, so that the common intersection I K is the diameter of gravity, the middle whereof is the center. After the same manner may the center of gravity be found in prisms and cylinders, it being the middle point of the right line that joins the center of gravity of their opposite bases.

The center of gravity of a parabola is found as in the triangle and cone. Thus, let B F in the parabola A B C (fig. 4) be equal to x, D E $= y$, then will $y\dot{x}$ be the fluxionary weight, and $yx\dot{x}$ the fluxion of the momenta; but from the nature of the curve we have $y = x^{\frac{1}{2}}$; whence $yx = x^{\frac{1}{2}} \dot{x}$, and $y x \dot{x} = x^{\frac{1}{2}} \dot{x} x$, whose fluent $\frac{2}{5}x^{\frac{5}{2}}$ divided $\frac{2}{3}x^{\frac{3}{2}}$ the fluent of $x^{\frac{1}{2}}\dot{x}$ will give $\frac{3}{5}x = \frac{3}{5}$B F for the distance of the center of gravity from the vertex B in the part of D B E; and so $\frac{2}{5}$ of B G is that center in the axis of the whole parabola A B C from the vertex B.

The center of gravity in the human body is situated in that part which is called the pelvis, or in the middle between the hips. For the center of gravity of segments, parabolics, conoids, spheroids, &c: we refer to Wolfius.

Center *of gravity of two or more bodies,* a point so situated in a right line joining the centers of these bodies, that, if this point be suspended the bodies will equiponderate and rest in any situation. In two equal bodies it is at equal distances from both: when the bodies are unequal, it is nearer to the greater body, in proportion as it is greater than the other; or the distances from the centers are inversely as the bodies. Let A (fig. 5,) be greater than B, join A B, upon which take the point C, so that C A : C B :: B : A, or that A × C A = B × C B; then is C the center of gravity of the bodies A and B. If the center of gravity of three bodies be required, first find C the center of gravity of A and B; and supposing a body to be placed there equal to the sum of A and B, find G the center of gravity of it and D; then shall G be the center of gravity of the three bodies A, B, and D. In like manner the center of gravity of any number of bodies is determined.

The sum of the products that arise by multiplying the bodies by their respective distances, from a right line or plane given in position, is equal to the product of the sum of the bodies multiplied by the distance of the center of gravity from the same right line or plane, when all the bodies are on the same side of it: but when some of them are on the opposite side, their products, when multiplied by their respective distances from it, are to be considered as negative, or to be subducted. Let I L, (fig. 6.) be the right line given in position, C the center of gravity of the bodies A and B; A *a*, B *b*, C *c*, perpendiculars to I L in the points *a*, *b*, and *c*: then if the bodies A and B be on the same side of I L we shall find $A + Aa + b \times Bb = \overline{A + B} \times Cc$. For drawing through C, the right line M N parallel to I L meeting A *a* in M, and B *b* in N, we have A : B :: B C : A C by the property of the center of gravity, and consequently A : B :: B N : A M, or $A \times AM = B \times BN$; but $A \times Aa + B \times Bb = A \times Cc + A \times AM + B \times Cc - B \times BN = A \times Cc + B \times Cc = \overline{A + B} \times Cc$. When B is on the other side of the right line I L (fig. 7,) and C on the same side with A, then $A \times Aa - B \times Bb = A \times Cc + A \times AM - B \times BN + B \times Cc = \overline{A + B} \times Cc$; and when the sum of the products of the bodies on one side of I L, multiplied by their distances from it, is equal to the sum of the products of the bodies multiplied by their distances on the other side of I L, then C *c* vanishes, or the common center of gravity of all the bodies falls on the right line I L.

Hence it is demonstrable, that when any number of bodies move in right lines with uniform motions, their common center of gravity moves likewise in a right line with an uniform motion; and that the sum of their motions, estimated in any given direction, is precisely the same as if all the bodies in one mass were carried on with the direction and motion of their common center of gravity.

Center *of an hyperbola,* a point in the middle of the transverse axis.

CENTER *of magnitude,* of any homogeneal body, the same with the center of gravity.

CENTER *of motion,* that point which remains at rest, while all the other parts of a body move about it. And this is the same in uniform bodies of the same matter throughout, as the center of gravity.

CENTER *of oscillation,* that point in a pendulum, in which, if the weight of the several parts thereof were collected, each vibration would be performed in the same time as when those weights are separate. This is the point from whence the length of a pendulum is measured, which, in our latitude, in a pendulum that swings seconds, is 39 inches and $\frac{1}{16}$.

The center of suspension is the point on which the pendulum hangs.

A general rule for finding the center of oscillation. If several bodies be fixed to an inflexible rod suspended on a point, and each body be multiplied by the square of its distance from the point of suspension, and then each body be multiplied by its distance from the same point, and all the former products, when added together, be divided by all the latter products added together, the quotient which shall arise from thence will be the distance of the center of oscillation of these bodies from the said point.

Thus if C F (fig. 8) be a rod on which are fixed the bodies A, B, D, &c. at the several points A, B, D, &c. and if the body A be multiplied by the square of the distance C A, and B be multiplied by the square of the distance C B, and so on for the rest; and then if the body A be multiplied by the distance C A, and B be multiplied by the distance C B, and so on for the rest; and if the sum of the products arising in the former case be divided by the sum of those which arise in the latter, the quotient will give C Q the distance of the center of oscillation of the bodies A, B, D, &c. from the point C.

To determine the center of oscillation of the rectangle R I H S (fig. 9) suspended on the middle point A of the side R I, and oscillating about its axis R I. Let R I = S H = a, A P = x, then will P $p = dx$ and the element or the area, consequently one weight $= a\,dx$ and its momentum $a\,x\,dx$. Wherefore $s\,a\,x^2\,dx : s\,a\,x\,dx = \frac{1}{3}a\,x^3 : \frac{1}{2}a\,x^2 = \frac{2}{3}x$, indefinitely expresses the distance of the center of oscillation from the axis of oscillation in the segment R C D I. If then for x be substituted the altitude of the whole rectangle R S = b, the distance of the center of oscillation from the axis will be found $= \frac{2}{3}b$.

The center of oscillation in an equilateral triangle S A H oscillating about its axis R I, parallel to the base S H, is found at a distance from the vertex A equal to $\frac{3}{4}$ A E the altitude of the triangle.

The center of oscillation in an equilateral triangle S A H oscillating about its base S H, is found at a distance from the vertex A = $\frac{1}{2}$ A E.

For the centers of oscillation of parabolas and curves of the like kind oscillating about their axes parallel to their bases, they are found as follows. In the apollonian parabola, the distance of the center of oscillation from the axis = $\frac{5}{6}$ A E.

In the cubical paraboloid, the distance of the center from the axis $\frac{7}{16}$ A E. In a biquadratic paraboloid, the distance of the center from the axis = $\frac{9}{13}$ A E.

CENTER *of percussion,* in a moving body, that point wherein the striking force is greatest, or that point, with which, if the body strikes against any obstacle, no shock shall be felt at the point of suspension.

The center of percussion, when the striking body revolves round a fixed point, is the same with the center of oscillation, and consequently may be determined by the same rule.

Hence a stick of a cylindrical figure, supposing the center of motion at the hand, will strike the greatest blow at a distance about two-thirds of its length from the hand.

The center of percussion is the same with the center of gravity, if all the parts of the striking body be carried with a parallel motion, or with the same celerity.

CENTER *of a parallelogram,* or *polygon,* the point in which its diagonals intersect.

CENTER *of a sphere,* a point in the middle, from which all lines drawn to the surface are equal. Hermes Trismegistus defines God an intellectual sphere, whose center is every where, and circumference no where.

CENTINEL, or CENTRY, in military language, is a private soldier, from the guard posted upon any spot of ground, to stand and watch carefully for the security of the said guard, or of any body of troops, or post, and to prevent any surprise from the enemy. All centinels are to be very vilant on their posts; neither are they to sing, smoke, or suffer any noise to be made near them. They are not to sit down, lay their arms out of their hands, or sleep; but keep moving about their posts during the two hours they stand, if the weather will allow of it. No centry to move more than 50 paces to the right, and as many to the left of his post; and let the weather be ever so bad, he must not get under any other cover but that of the centry box. No one to be allowed to go from his post without leave from his commanding officer; and to prevent desertion or marauding, the centries and videttes must be charged to let no soldier pass.

CENTRAL *forces*, the powers which cause a moving body to tend towards, or recede from, the center of motion.

If a body A (plate III. Miscel. fig. 10.) be suspended at the end of a string A C, moveable about a point C, as a centre, and in that position it receive an impulse in an horizontal direction, it will be thereby compelled to describe a circle about the central point. While the circular motion continues, the body will certainly endeavour to recede from the center, which is called its centrifugal force, and arises from the horizontal impetus. With this force it acts upon the fixed center-pin, and that, by its immobility, re-acts with an equal force on the body, by means of the string, and solicits it towards the center of motion; whence it is called the centripetal force; and when we speak of either or both indefinitely, they are called the central forces of the revolving body.

The doctrine of central forces makes a considerable branch of the Newtonian philosophy, and has been greatly cultivated by mathematicians, on account of its extensive use in the theory of gravity, and other physical and mathematical sciences.

In this doctrine it is supposed, that matter is equally indifferent to motion or rest; or that a body at rest never moves itself; and that a body in motion never of itself changes either the velocity or the direction of its motion; but that every motion would continue uniformly, and its direction rectilinear, unless some external force or resistance should affect it, or act upon it. Hence, when a body at rest always tends to move, or when the velocity of any rectilinear motion is continually accelerated or retarded, or when the direction of a motion is continually changed, and a curve line is thereby described, it is supposed that these circumstances proceed from the influence of some power that acts incessantly; which power may be measured, in the first case, by the pressure of the quiescent body against the obstacle which prevents it from moving, or by the velocity gained or lost in the second case, or by the flexure of the curve described in the third case; due regard being had to the time in which these effects are produced, and other circumstances, according to the principles of mechanics. Now the power or force of gravity produces effects of each these kinds, which fall under our constant observation near the surface of the earth: for the same power which renders bodies heavy, while they are at rest, accelerates their motion when they descend perpendicularly; and bends the track of the motion into a curve line, when they are projected in a direction oblique to that of their gravity. But we can judge of the forces or powers that act on the celestial bodies by effects of the last kind only. And hence it is, that the doctrine of central forces is of so much use in the theory of the planetary motions.

Sir Isaac Newton has treated of central forces in his Principia, and has demonstrated this fundamental theorem, *viz.* that the areas which revolving bodies describe, by radii drawn to an immoveable centre, lie in the same immoveable planes, and are proportional to the times in which they are described.

The theory of this species of motion is comprised in the following propositions. 1 When two or more bodies revolve at equal distances from the center of the circle they describe, but with unequal velocities, the central forces necessary to retain them will be to each other as the squares of their velocities. That is, if one revolves twice as fast as the other, it will require four times the retaining force the other does; if with three times the velocity, it will require nine times the force to retain it in its orb, &c.

2. When two or more bodies move with equal velocities, but at unequal distances from the center they revolve about, their central forces must be inversely as their distances. That is, by how many times greater the distance a body revolves at is from the center, so many times less force will retain it.

3. When two or more bodies perform their revolutions in equal times, but at different distances from the center they revolve about, the forces requisite to retain them in their orbs will be to each other

as the distance they revolve at from the center: for instance, if one revolves at twice the distance the other does, it will require a double force to retain it, &c.

4. When two or more bodies revolving at different distances from the centre are retained by equal centripetal forces, their velocities will be such, that their periodical times will be to each other as the square roots of their distances. That is, if one revolves at four times the distance another does, it will perform a revolution in twice the time that the other does; if at nine times the distance, it will revolve in thrice the time.

5. And, in general, whatever be the distances, the velocities, or the periodical times of the revolving bodies, the retaining forces will be to each other in a ratio compounded of their distances directly, and the squares of their periodical times inversely. Thus, for instance, if one revolves at twice the distance another does, and is three times as long in moving round, it will require two-ninths, that is, two-ninths of the retaining power the other does.

6. If several bodies revolve at different distances from one common center, and the retaining power lodged in that center decrease as the squares of the distances increase, the squares of the periodical times of these bodies will be to each other as the cubes of their distances from the common center. That is, if there be two bodies, whose distances, when cubed, are double or treble, &c. of each other, then the periodical times will be such, as that when squared only they shall also be double, or treble, &c.

7. If a body be turned out of its rectilineal course by virtue of a central force, which decreases as you go from the seat thereof as the squares of the distances increase; that is, which is inversely as the square of the distance, the figure that body shall describe, if not a circle, will be a parabola, an ellipsis, or an hyperbola; and one of the foci of the figure will be at the seat of the retaining power. That is, if there be not that exact adjustment between the projectile force of the body and the central power necessary to cause it to describe a circle, it will then describe one of those other figures, one of whose foci will be where the seat of the retaining power is.

8. If the force of the central power decreases as the square of the distance increases, and several bodies revolving about the same describe orbits that are elliptical, the squares of the periodical times of these bodies will be to each other as the cubes of their mean distances from the seat of that power.

9. If the retaining power decrease something faster as you go from the seat thereof (or, which is the same thing, increase something faster as you come towards it) than in the proportion mentioned in the last proposition, and the orbit the revolving body describes be not a circle, the axis of that figure will turn the same way the body revolves: but if the said power decrease (or increase) somewhat slower than in that proportion, the axis of the figure will turn the contrary way. Thus, if a revolving body, as D, (fig. 11) passing from A towards B, describe the figure A D B, whose axis A B at first points, as in the figure, and the power whereby it is retained decrease faster than the square of the distance increases, after a number of revolutions, the axis of the figure will point towards P, and after that towards R, &c. revolving round the same way with the body; and if the retaining power decrease slower than in that proportion, the axis will turn the other way.

Thus it is the heavenly bodies, *viz.* the planets, both primary and secondary, and also the comets, perform their respective revolutions. The figures in which the primary planets and the comets revolve are ellipses, one of whose foci is at the sun; the areas they describe, by lines drawn to the center of the sun, are in each proportional to the times in which they are described. The squares of their periodical times are as the cubes of their mean distances from the sun. The secondary planets describe also circles or ellipses, one of whose foci is in the center of their primary ones, &c.

From what has been said may be deduced the velocity and periodic time of a body revolving in a circle, at any given distance from the earth's center, by means of its own gravity. Put $g = 16\frac{1}{12}$ feet, the space described by gravity, at the surface, in the first second of time, *viz.* = A M; then putting $r =$ the radius A C; it is $AE = \sqrt{AB \times AM} = \sqrt{2gr}$ the velocity in a circle at its surface in one second of time; and hence, putting $c = 3.14159$ &c. the circumference of the earth being $2cr = 25,000$ miles, or 132,000,000 feet, it will be $\sqrt{2gr} : 2cr :: 1'' : c\sqrt{\frac{2r}{g}}$ $= 5078$ seconds nearly, or $1^h\ 24^m\ 38^s$, the periodic time at the circumference: also the velocity there, or $\sqrt{2gr}$ is $=26,000$ feet per second nearly. Then, since the force of gravity varies in the inverse duplicate ratio of the distance, by the rules laid down, it is $\surd R : \surd r :: v$ or $26,000 : 26,000 \sqrt{\frac{r}{R}} =$ V, the velocity of a body revolving about the earth at the distance R; and $\surd r^3 : \surd R^3 :: t$, or $5078'' : 5078 \sqrt{\frac{R^3}{r^3}}$ = T, the time of revolution in the same. So if, for instance, it be the moon revolving about the earth at the distance of 60 semi-diameters; then $R = 60\,r$, and the above expressions become $V = 26,000 \surd\frac{1}{60} = 3357$ feet per second, or $38\frac{1}{7}$ miles per minute, for the velocity of the moon in her orbit; and $T = 5078 \sqrt{\frac{R^3}{r^3}} =$ 2,360,051 seconds, or $27\frac{3}{10}$ days nearly, for the periodic time of the moon in her orbit at that distance.

Thus, also, the ratio of the forces of gravitation of the moon towards the sun and earth may be estimated. For one year, or $365\frac{1}{4}$ days, being the periodic time of the earth and moon about the sun, and $27\frac{3}{10}$ days, the periodic time of the moon about the earth, also 60 being the distance of the moon from the earth, and 23,920 the distance from the sun, in semi-diameters of the earth, it is

$$\frac{60}{27.3^2} : \frac{23920}{365.25^2} :: f \text{ or } 1 : \frac{23902}{60} \times \frac{27.3^2}{365.25^2} = 2\tfrac{2}{9};$$

that is, the proportion of the moon's gravitation towards the sun is to that towards the earth as $2\frac{2}{9}$ to 1 nearly.

Again, we may hence compute the centrifugal force of a body at the equator, arising from the earth's rotation. For the periodic time, when the centrifugal force is equal to the force of gravity, it has been shown above, is 5078 seconds; and 23 hours, 56 minutes, or 86,160 seconds, is the period of the earth's rotation on its axis; therefore, as $86,160^2 : 5078^2 :: 1 : \frac{1}{289}$, the centrifugal force required, which therefore is the 289th part of gravity at the earth's surface. See Simpson's Fluxions, vol. i.

Central *rule*, a rule discovered by Mr. Thomas Baker, whereby to find the center of a circle designed to cut the parabola in as many points, as an equation to be constructed hath real roots. Its principal use is in the construction of equations, and he has applied it with good success as far as biquadratics.

The central rule is chiefly founded on the property of the parabola, that if a line be inscribed in that curve perpendicular to any diameter, a rectangle formed of the segments of the inscript is equal to the rectangle of the intercepted diameter and parameter of the axis.

The central rule has the advantage over Des Cartes and De Latere's methods of constructing equations, in that both these are subject to the trouble of preparing the equation, by taking away the second term.

CENTRIFUGAL *force*, that force by which all bodies that move round any other body in a curve endeavour to fly off from the axis of their motion in a tangent to the periphery of the curve, and that in every point of it.

Mr. Huygens demonstrates, that this force is always proportional to the circumference of the curve in which the revolving body is carried round. The centrifugal force of any body is to the centripetal as the square of the arch which a body describes in a given time, divided by the diameter, to the space through which a heavy body moves, in falling from a place where it was at rest in the same time.

If any body swim in a medium heavier than itself, the centrifugal force is the difference between the specific weight of the medium and the floating body.

All moving bodies endeavour after a rectilinear motion, because it is the easiest, shortest, and most simple: whenever therefore they move in any curve, there must be something that draws them from their rectilinear motion, and detains them in their orbits; and were that force to cease, the moving body would go straight off in a tangent to the curve in that very point, and so would get still further and further from the focus, or center of its curvilinear motion.

It may be, that in a curve where the force of gravity in the describing body is continually variable, the centrifugal force may also continually vary in the same manner, and so that one may also supply the defect, or abate for the excess of the other, and consequently the effect be every where equal to the absolute gravity of the revolving body.

Centrifugal *Machine*, a curious machine for raising water by means of a centrifugal force, combined with the pressure of the atmosphere. This machine consists of a large tube of copper, &c. in the form of a cross, placed perpendicularly in the water, and resting at the bottom on a pivot. At the upper part of the tube is an horizontal cog-wheel, which touches the cogs of another in a vertical position; so that by the aid of a double winch, the whole machine is moved round with very great velocity. Near the bottom of the perpendicular part of the tube is a valve opening upwards; and near the two extremities, but on the contrary sides of the arms, or cross part of the tube, are two other valves opening outwards. These two valves are kept shut, by means of springs, till the machine is put in motion, when the centrifugal velocity of the water forces them open, and discharges itself into a cistern or reservoir placed there for that purpose. On the upper part of the arm are two holes, which are closed by pieces that screw into the metal of the tube. Before the machine can work, these holes must be opened, and water poured in through them, till the whole tube be full: by these means all the air will be forced out of the machine, and the water supported in the tube by means of the valve at the bottom. The tube being thus filled with water, and the holes closed by their screw-caps, it is turned round by the winch, when the water in the arms of the tube acquires a centrifugal force, opens the valves near the extremities of the arms, and flies out with a velocity nearly equal to that of the extremities of the said arms.

If the men who work the machine be supposed to turn the winch round in three seconds, the machine will move round its axis in one second; and, consequently, each extremity of the arms will move with a velocity of 18.8 feet in a second. A column of water, therefore, of three inches diameter, will issue through each of the valves with a velocity of 18.8 feet in a second; but the area of the aperture of each of the valves is 7.14 inches; which, being multiplied by the velocity in inches = 125.6, gives 1610.784 cubic inches, the quantity of water discharged through one of the apertures in one second; so that the whole quantity discharged in that space of time through both the apertures is = 3221.568 inches; or 193294.08 cubic inches in one minute. But 60812 cubic inches make a tun, beer-measure; consequently, if we suppose the centrifugal machine to revolve round its axis in one second, it will raise nearly 3 tuns 44 gallons in one minute; but this velocity is too great, at least to be maintained for any considerable time; so that, when this and other deficiencies in the machine are allowed for, two tuns are nearly the quantity that can be raised by it in one minute. As the water is forced up the perpendicular tube by the pressure of the atmosphere, it is evident that this machine cannot raise water above thirty-two feet high.

CENTRIPETAL *force*, that force by which a body is every where impelled, or any how tends towards some point as a center; such is gravity, or that force whereby bodies tend towards the center of the earth; magnetical attraction, whereby the load-stone draws iron; and that force, whatever it be, whereby the planets are continually drawn back from right-lined motions, and made to move in curves.

The greater the quantity of matter in any body is, the greater will be its centripetal force, all things else alike. If a body laid upon a plane revolve at the same time, and about the same center with that plane, and so describe a circle; and if the centripetal force, wherewith the body is drawn every moment towards the center, should cease to act, and the plane should continue to move with the same velocity, the body will begin to recede from the center about which the plane moved. See CENTRAL *forces*.

CENTRISCUS, in natural history, a genus of fishes, ranked among the branchiostegous order of Linnæus, but by Dr. Shaw among the Cartilagenei. Generic character: snout lengthened; body compressed, carinated beneath; ventral fins united. There are but three species; *viz.* the scutatus, scolopax, and the velitaris. All are found in the Indian seas, and the scolopax is likewise a native of the Mediterranean.

CENTROGASTER, in natural history, a genus of fishes of the order Thoracici. Generic character; head compressed, smooth; gill-membraned, mostly seven rayed; body depressed, smooth; fins spinous; ventral connected by a membrane, with four sharp spines, and six soft rays. There are four species.

CENTUNCULUS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rotaceæ. Lysimachiæ, Jussieu. Essential character: calyx four-cleft; corol four-cleft, spreading: stamina short; capsules one-celled, opening horizontally. There is but one species, *viz.* C. minimus, bastard pimpernel, is an annual, and a native of Italy, France, Germany, and Denmark—with us on Hounslow-heath, Ashford-common, near Hampton Court, Chiselhurst; &c. It flowers from June to August.

CEPHAELIS, in botany, a genus of the Pentandria Monogynia class and order: flowers in heads, involucred; corol tubular; stigma two-parted; berry two-seeded; receptacle chaffy. There are 12 species, found chiefly in the West Indies.

CEPHALANTHUS, in botany, *button wood*, *button tree*, or *pond dogwood*, a genus of the Tetrandria Monogynia class and order. Natural order of Aggregatæ. Rubiaceæ, Jussieu. Essential character: calyx common, none; proper superior, funnel form; receptacle globular, naked; seed one, lanuginous. There are five species, of which C. occidentalis, American button wood, is a shrub, which in this country is seldom higher than seven feet. The branches come out by pairs opposite at each joint; the ends of which are terminated by loose spikes of spherical heads, about the size of a marble, each of which is composed of many small flowers, of a whitish yellow colour, fastened to an axis in the middle; these appear in July, and in warm seasons are succeeded by seeds which sometimes ripen.

CEPHALIC *medicines* are remedies for disorders of the head.

CEPHALOPHORA, in botany, a genus of the Syngenesia Æqualis class and order: receptacle chaffy-fleshy; down simple; calyx ovate, imbricate. One species, found in Guinea.

CEPHEUS, in astronomy, a constellation of the northern hemisphere. See Astronomy.

CEPOLA, in natural history, the *band-fish*, a genus of fishes of the order of Thoracici. Generic character: head short; teeth curved, sharp; body very long and compressed; abdomen extremely short; gill membrane six-rayed. There are three species according to Gmelin, *viz.* 1. C. tænia, or livery band-fish, with red fins, very obtuse head and attenuated tail. This fish swims with great rapidity, and presents a beautiful spectacle by the undulating flexures of its body. It lives on the smaller kind of crabs and shell-fish; and as it frequents the shores, it is often used as a bait for other fishes. 2. C. rubescens, reddish band-fish; and 3. C. Trachyptera: both natives of the Mediterranean. Dr. Shaw mentions another species, *viz.* C. Hermanniæna.

CERAMBYX, in natural history, a genus of insects of the order Coleoptera. Antennæ setaceous; feelers four; thorax spinous or gibbous; shells linear. Of this very beautiful and finely variegated family, many hundred species have, by naturalists, been noticed and described. They have separated them into four divisions, *viz.* A. feelers equal, filiform; the subdivisions in this class are, *a.* jaw cylindrical, entire; in some the thorax has moveable spines, in others the thorax is margined; *b.* jaw obtuse, one-toothed; *c.* jaw bifid, horny; *d.* jaw bifid, membranaceous, thorax unarmed. B. feelers equal, capitate; thorax spinous. C. feelers equal, clavate; thorax unarmed. D. feelers unequal, the two fore-ones filiform, the hind-ones clavate. The larvæ of this genus resemble soft, oblong, slender worms, with a scaly head and six hard legs on the fore part: they bore through the inner parts of trees, pulverizing the wood, and are transformed into perfect insects in the cavities which they make: many of them diffuse a strong smell, perceivable at a great distance; and some when taken utter a sort of cry, produced by the friction of the thorax on the upper part of the abdomen and shells. The antennæ are deemed short when they are shorter than the body; moderate when of equal length with the body; and long when they exceed the body. In the division C. the species violaceus, so called from the colour of its body, is found chiefly in fir timber which has been felled some time, and which has not been stripped of its bark: it bores serpentine cavities between the bark and the wood, which are larger in diameter as the insect increases in size, filling the space it leaves behind with its excrement, which resembles saw-dust.

CERASTIUM, in botany, English *mouse-ear*, or *mouse-ear chickweed*, a genus of the Decandria Pentagynia class and order. Natural order of Caryophyllei. Essential character: calyx five-leaved; petals bifid; capsules unilocular, gaping at the tip. There are eighteen species. None of the mouse-ear chickweeds make much appearance, and are therefore only cultivated in botanic gardens. Some of them are common weeds in most parts of Europe; the smoother sorts are not disagreeable to cattle; the seeds are useful to birds.

CERATE. See Pharmacy and Wax.

CERATOCARPUS, in botany, a genus of the Monoecia Monandria class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: male, calyx one-leafed, bifid; corol none; female calyx one-leafed, keeled, permanent, two-horned; styles two: seeds single, compressed, inclosed in and covered by the calyx. There is but one species, *viz.* C. arenarius, is an annual branching plant, with very narrow leaves. Three male flowers, sessile in each division of the stems; females solitary, sessile in each axilla of the leaves. It has no proper pericarp, but the calyx when ripe becomes a sort of oblong-triangular compressed sheath, with a ridge on each side and two innocuous spines, diverging almost horizontally at the end. Within this is a single obovate seed, compressed, and at bottom very sharp-pointed, which does not drop from its covering. Native of Tartary.

CERATONIA, in botany, English *carob tree*, *St. John's bread*, a genus of the Polygamia Trioecia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: hermaphrodite; calyx five parted; corol none; stamens five; style filiform; legume coriaceous; many seeded; dioecous; male and female separate. There is but one species, *viz.* C. siliqua, the carob tree, which is a native of Syria, Palestine, Egypt, Cyprus, Candia, Sicily, Apulia, Spain, &c.

CERATOPETALUM, in botany, a genus of the Decandria Monogynia class and order. Calyx five-parted, permanent, bearing the stamina; petals five, pinnatifid; antheræ spurred; capsule covered in the bottom of the calyx; two celled. One species, a native of New Holland.

CERATOPHYLLUM, in botany, a genus of the Monoecia Polyandria class and order. Natural order of Inundatæ. Naiades, Jussieu. Essential character: male calyx many-parted; corol none; stamens sixteen to twenty; female, calyx many-parted; corolla none; pistils one; style none; seed one, naked. There are two species, *viz.* C. demersum, prickly-seeded horn wort; and C. submersum, smooth-seeded horn wort. They grow in ditches and slow streams, flowering in August and September in Europe; also in Japan. It is common in Jamaica, called there morass weed, and used to cover fish, &c. when carried to any distance.

CERBERA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; drupe one-seeded. There are five species, of which C. ahouai, oval-leafed cerbera, grows naturally in the Brazils, and also in the Spanish West Indies in plenty; and there are some of the trees growing in the British Islands of America. This tree is about ten feet high, sending out many crooked diffused branches, which toward the top has thick succulent leaves, about three inches long and near two broad, of a lucid green colour, full of a milky juice, as is every part of the tree. The flowers come out in loose bunches at the end of the branches; they are of a cream colour. It flowers in July, but never produces fruit in England. The wood of this tree is exceedingly offensive, and the kernels of the nuts are a most deadly poison.

CERCARIA, in natural history, a genus of the Vermes infusoria: worm invisible to the naked eye, pellucid, and furnished with a tail. There are 13 species, of which C. gyrinus is round, with a sharp pointed tail; found in animal infusions; white, gelatinous, forepart nearly globular. C. catellus; body three-parted, with a forked tail; is met with in waters where flowers have been kept; head moveable, affixed to the body by a point; abdomen not so wide, but twice as long as the head, and filled with intestines; tail shorter than the head and narrower than the abdomen, ending in two bristles, which it can unite and separate at pleasure; C. mutabilis, changeable, cylindrical, red or green, with a pointed slightly bifid tail; found in stagnant pools in such innumerable myriad, as to cover the whole surface with a sheet of green or red, giving it sometimes the appearance of being tinged with blood; varies its posture from a long cylindrical body, larger in the middle, to a nearly globular one; the extremities are pellucid.

CERCIS, in botany, English *Judas tree*, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx five-toothed, gibbous below; corol papilionaceous; standard short beneath the wings; legume. There are two species, *viz.* C. siliquastrum common Judas tree; and C. canadensis, Canada Judas tree, or red budding tree. These trees are usually planted with other flowering trees, for ornaments to pleasure gardens, and for their singular beauty deserve a place as well as most other sorts. The wood is also beautifully veined with black and green, and, taking a fine polish, may be converted to many uses.

CEREBELLUM, in anatomy, the hinder part of the brain. See ANATOMY.

CEREBRUM, in anatomy, denotes the brain, but more particularly applies to the anterior and larger portion of the brain, separated from the cerebellum by the tentorium. See ANATOMY.

CEREMONIES, *master of the*, an officer instituted by King James I. for the more honourable reception of ambassadors and strangers of quality; he wears about his neck a chain of gold, with a medal with the crown of Great Britain, having on one side an emblem of peace, with the motto, *Beati pacifici;* and on the other, an emblem of war, with *Dieu et mon droit;* his salary is three hundred pounds *per annum.*

CERINTHE, in botany, English *honey-wort,* a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: border of the corolla tube-bellied; throat pervious; seeds two, bilocular. There are two species, of which C. major, great honeywort, is about eighteen inches high, round, smooth, branching, and leafy. Leaves glaucous, becoming blue by age, without prickles, but ciliated about the edge, dotted with white. The tube of the corolla is yellow, but the border is purple: the toothlets very short and revolute. C. minor, small honeywort, is very nearly allied to the foregoing; the corolla five-cleft to one-third of the length, whereas that is only five-lobed at the edge. Annual when sown in the spring, but biennial when sown in autumn. Both these plants are natives of France, Italy, Switzerland, and Germany.

CERITE. See Cerium.

CERIUM, in chemistry, a new metal obtained from a fossil found in Sweden, to which has been given the name of Cerite. This fossil occurs disseminated or massive; it is of a flesh red colour, more or less deep, with sometimes a shade of yellow: it is semi-transparent: its fresh fracture has considerable lustre. It strikes fire with steel with difficulty: is not attracted by the magnet: its specific gravity is from 4.7 to 4.9. Exposed to a strong heat it does not melt, but loses 5 or 6 per cent. of weight, becomes friable, and acquires a bright yellow colour. With borax it forms a globule, greenish while hot, but colourless when cold. From 100 parts of it, the Swedish chemists obtained about 50 of oxide of cerium, 22 oxide of iron, 23 silex, and 5.5 carbonate of lime. According to Vauquelin's analysis, the proportions are, oxide of cerium 63, silex 17.5, oxide of iron 2, lime from 3 to 4, water 12. The pure oxide of cerium is extracted from the cerite, by dissolving this mineral in nitromuriatic acid, and, after saturating the clear solution with an alkali, precipitating by tartrate of potash. The precipitate, well washed, calcined, and digested in vinegar, is the oxide of cerium.

The oxide of cerium exists in different degrees of oxidizement. When precipitated from its acid solutions by the alkalies, it is white, but acquires a shade of yellow when dried in the air, and, when exposed to a continued heat, becomes of a brick red colour. The white, according to Vauquelin, is the one at the lower degree of oxidizement; but the difference in the proportion of oxygen is, he remarks, inconsiderable. Neither of them can be fused by heat. Borax determines their fusion: the globule, heated by the exterior flame of the blow-pipe, is of a blood-red colour, which, by cooling, becomes of a yellowish green, and, at length, colourless and transparent; or, if the proportion of oxide has been large, opaque and pearly.

The metal itself, in the trials which Vauquelin made with it, proved insoluble in any unmixed acid, and was dissolved with great difficulty in nitro-muriatic acid. Its oxide, however, combines with the acids easily, and the properties of its salts have been fully determined.

CEROPEGIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; follicles two, erect; seeds plumose; border of the corolla converging. There are six species, of which C. candelabrum is a twining plant, with slender stems, round, green, or reddish. Leaves opposite, ovate, thick, soft and smooth. The peduncle, and at first the flowers, hang down, but when open they erect themselves, and, being placed in a circle, have the appearance of a set of lamps suspended. The follicles or seed-vessels hang down. It is a native of the East Indies.

CERTHIA, the *creeper,* in natural history, a genus of birds of the order Picæ. Generic character: bill sharp-pointed, slender, and incurvated; nostrils small; tongue varying in shape; legs somewhat stout; toes three before and one behind, the latter large; claws long and hooked; tail of twelve feathers.

These birds are distinguished from humming birds, with which they have sometimes been confounded, by the circumstances of their being to be met with in every quarter of the world; by their bill universally terminating in a point; and by their feeding in a great degree, though not exclusively, on insects. There are no less than forty-nine species, of which the principal are,

C. familiaris, the tree-creeper of Albinus. This bird is scarcely larger than the crested wren, and is to be observed in various parts of Europe, but especially in England. It runs on the bark of a tree with extreme ease and rapidity, and the instant it perceives a human being near, it conceals itself on the opposite side of the trunk or branch, repeating this movement according to the corresponding movement of the person whose notice it wishes to avoid, and thus perpetually endeavouring, and almost in all cases with success, to evade the observation of its pursuer. It feeds almost solely on insects, which it finds in the hollows, and among the moss of trees.

C. Lotenia, or Loten's creeper, is a native of Ceylon and Madagascar. It builds its nest of the down of plants, and is subjected to the hostility of a spider in those countries, nearly as large as itself, which pursues it with extreme ardour, and delights in sucking the blood of its young.

C. cœrulea, or blue creeper, is an inhabitant of Cayenne, and is remarkable for the ingenuity it exhibits in the construction of its nest, by which it precludes any attack from the monkeys and snakes, as well as lizards, which abound in that country. This nest is suspended from some slender twig at the end of a branch, to which those animals dare not venture, as it would be too weak to support them. The entrance to the nest is towards the ground, and about a foot distant from the body of it, to which the bird climbs through a narrow neck of this extraordinary length.

C. sannio, or mocking creeper, is found in New-Zealand, has an agreeable note, and can so modulate its voice, as seemingly to imitate the notes of all birds: hence it is called the mocking creeper. See Plate IV. Aves, fig. 3.

CERTIFICATE, in law, a writing made in any court, to give notice to another court of any thing done therein. The clerks of the crown, assize, and the peace, are to make certificates into the King's Bench, of the tenor of all indictments, convictions, outlawries, &c.

CERTIORARI, a writ which issues out of the chancery, directed to an inferior court, to call up the records of a cause there depending, in order that justice may be done. And this writ is obtained, upon complaint that the party who seeks it has received hard usage, or is not like to have an impartial trial in the inferior court. A certiorari is made returnable either in the King's Bench, Common Pleas, or in Chancery.

It is not only issued out of the Court of Chancery, but likewise out of the King's Bench, in which last-mentioned court it lies, where the King would be certified for a record. Indictments from inferior courts, and proceedings of the quarter sessions of the peace, may also be removed into the King's Bench by a certiorari; and here the very record must be returned, and not a transcript of it; though usually in Chancery, if a certiorari be returnable there, it removes only a tenor of the record.

CERVICAL *nerves*, in anatomy, are eight pair of nerves, so called, as having their origin in the neck.

CERUMEN, is a viscid yellow-coloured liquid secreted by the glands of the auditory canal, which gradually becomes concrete by exposure to the air. It has an orange-yellow colour and a bitter taste. When slightly heated upon paper, it melts, and stains the paper like an oil; at the same time it emits a slightly aromatic odour. On burning coals it softens, emits a white smoke, which resembles that given out by burning fat; it afterwards melts, swells, becomes dark-coloured, and emits an ammoniacal and empyreumatic odour. A light coal remains behind. When agitated in water, cerumen forms a kind of emulsion, which soon putrefies, depositing at the same time white flakes. Alcohol, when assisted by heat, dissolves five-eighths of the cerumen; the three-eighths which remain behind have the properties of albumen, mixed however with a little oily matter.

Ether also dissolves this oily body; but it is much less bitter and much lighter coloured. When the albuminous part of cerumen is burnt, it leaves traces of soda and of phosphate of lime. From these facts, Vauquelin considers cerumen as composed of the following substances:

1. Albumen
2. An inspissated oil
3. A colouring matter
4. Soda
5. Phosphate of lime.

CERUSSE, or *white lead*, a substance compounded of the acetic acid and lead. It is formed by the metal plates of lead being exposed to the vapours arising from boiling vinegar, and the metal being oxydized by the action of the air, aided by the affinity of the acid. This has been regarded either as an oxide or a sub-carbonate of lead; though it appears probable that it should contain some acetic acid. It serves as the basis from which the more perfect salt, the sugar of lead of commerce, is formed; the cerusse, in fine powder, is boiled in distilled vinegar, the vinegar being poured off as it loses its acidity, and fresh qualities being successively added. The liquors thus procured are then evaporated nearly to the consistence of honey; and on cooling, masses are formed, consisting of a congeries of needle-like prisms. From the account given by Pontier of the manufacture of this salt, it appears that it is also formed by exposing plates of lead to the action of distilled vinegar and of the atmospheric air: the plates, as they are incrusted with oxide at the surface of the vinegar, are plunged to the bottom, until this oxide is dissolved, and are again raised to the surface. The acid is thus at length saturated, and, by evaporation, the solution is brought to crystallize.

CERVUS, the *deer*, in natural history, a genus of Mammalia of the order Pecora. The generic character: horns solid, and while the animal is young covered with a hairy skin, growing from the top, annual, branched and naked: eight front teeth in the lower jaw: no canine teeth. There are twelve species, of which we shall particularly notice the C. Aces, or the elk. This animal sometimes attains the height of seventeen hands, and the weight of twelve hundred and thirty pounds; but such cases are somewhat extraordinary. It is larger in Asia and America than in Europe. It abounds in the cold countries of Sweden, Siberia, and Canada, and in the last is called also the moose deer. Its principal food is derived from the boughs of the forest trees in these desolate regions, and the night is generally preferred for its repasts. Its manners are extremely gentle and inoffensive; it will however defend itself with great courage and dexterity, both with its horns and fore feet, and has been known, with a single blow from the latter, to destroy a wolf. Among the North American Indians the hunting of the elk is an employment of considerable interest and preparation. One party is occupied in surrounding a large tract of country near the lakes or rivers, and, by means of their dogs, in rousing the elks contained in it, who, finding all escape from danger impractible by land, press onwards to the water. Here, however, they are received by another party of enemies, whose canoes, extending in a crescent form, inclose a considerable space, and reach from shore to shore, and who destroy their victims by clubs and lances. They are often taken also by snares, into which they are driven by the noises and alarms of the Indians, and in which they are inextricably entangled amidst slips of raw hides, or confined within so small a compass, that they become sure marks for the arrows of their adversaries. It is remarked of the elk, that when first dislodged, he drops on the ground for a few seconds, as if labouring under a complete prostration of strength, occasioned, probably, by the influence of fear. This is the moment invaluable to the hunter, who, if he miss this opportunity, frequently fails in every other, as the animal, after a very short pause, is roused to the most vigorous flight, which he continues, without suspension, for a progress of twenty or thirty miles.

In the bogs of Ireland, as well as in America, horns have been repeatedly dug up of an enormous size, which apparently belonged to an animal of the deer kind, but are far superior in dimensions to those of any animal now known by naturalists. Their length has sometimes been of eight feet, and the distance from the tip of one to that of another has extended to fourteen feet. These are justly considered as most curious specimens in the collection of natural productions, and the idea of their annual reproduction is well calculated to excite astonishment. Mammalia Plate VIII. fig. 1.

C. tarandus, or the rein deer. When full grown, this animal is about the height of four feet six inches, and both sexes are furnished with horns, those of the male, however, being much larger than the females. It is found more abundantly than any where else in Lapland and Norway. It is met with in the north of Asia so far as Kamschatka, and in America so far south as Canada. With the Laplander the rein deer is a complete substitute for the horse, the cow, the sheep, and the goat. He possesses two breeds of this animal, the wild and the tame. The former of these are by far the most vigorous, but are also often extremely obstinate and not a little ferocious, turning upon their drivers with dangerous, and sometimes fatal, fury. The tame rein deer, therefore, is almost universally preferred. It is trained when young to draw the sledge, which is the common vehicle of the country, which is made extremely light, and covered with the skin of a young deer. The deer is fastened to this carriage by a strap, which passes round his neck, and comes down between his legs, and is guided by a cord, tied round his horns, and held by the driver, whose cheering voice is perpetually exerted to encourage the animal on his progress, and who is furnished also with a goad for occasional applications. One of these deer has been known several times to draw its sledge and owner a journey of fifty miles without stopping; an exertion, however, which is almost uniformly fatal to it. To a progress of thirty miles without halting it is a competent, without any injury. The constant mode of travelling in Lapland in winter is by means of the deer and sledge. It is extremely speedy, yet at the same time inconvenient and dangerous, and can be accomplished only when the snow is frozen and glazed. The favourite food of this animal is a species of moss, which, in Lapland, covers the face of the country through large tracts, and to obtain which, in winter, the horns of the rein deer enable it to dig through the snow with great facility. The attention paid by the Laplander to these animals constitutes his principal occupation. In the rigour of winters they are sheltered and nursed by him; in the short summers they are led to the banks of the lakes and rivers, or to the tops of the mountains, where they may brouse on their favourite lichen; which, from the fulness and sweetness of the pasture, supplies all the richness and variety of his temperate banquets, fig. 2

C. elaphus, or the stag. This animal is found in nearly all the temperate climates of Europe and Asia. It is also found in North America, but attains its largest size in Siberia. From the branchiness of its horns, the elegance of its form and movements, and the strength of its limbs, it deservedly attracts particular admiration, and may be regarded as a principle embellishment of the forest. The stag is remarkable for a fine eye and an acute sense of smelling. Its ear, also, is exquisitely sensible, and musical sounds appear to possess over him the power of exciting complacency, if not rapture. His enemies not unfrequently employ the shepherd's pipe to decoy him to his destruction; and Mr. Playford, in his "Introduction to Music," states, that he once met a herd of twenty stags near Royston, which readily followed the tones of a violin and bagpipe, played by their conductors, but stopped whenever the music was suspended. Their whole progress from Yorkshire to Hampton-court was attended, and it was supposed extremely facilitated, by these sounds. The stag is simple and unsuspicious, and employs no arts to avoid detection or pursuit, until after having received considerable molestation. His food consists, in winter, of moss and bark; in spring, of the catkins of willow and hazel, and the flowers and buds of cornel; in summer, of the grain of rye and the tender shoots of the alder; in autumn, of the leaves of brambles, and the flowers of heath and broom. He eats with slowness, and ruminates with some considerable effort, in consequence of the distance between the first stomach and the mouth. In March, generally, he sheds his horns, which are not completely renewed till August. It will live to between thirty and forty years of age, and was, formerly, amidst the other vulgar errors of antiquity, supposed capable of attaining most extraordinary duration. The stag is supposed to have been introduced from France into England where it has latterly been made to give way to the fallow deer, an animal more gentle in its manners, and more valuable as food. In some parts of Scotland the stag is yet to be found in its original wild state.

C. dama, or the fallow deer. This animal is, in general, much smaller than the stag; but in Spain is nearly equally large: in France and Germany, it is rarely to be found, and it has never been known to have existed in America: it has the elegance of the stag, connected with a much more tractable disposition: it sheds its horns, which, as in the stag species, are peculiar to the male, every year; is stated to live to the age of twenty years, and arrives at its maturity in three: it is by no means fastidious in its food. Fig. 4.

C. capreolus, or the roe. This is the smallest of the animals of this class in Europe, and generally of a reddish-brown colour: it is graceful, sprightly, and courageous, particularly cleanly, and delighting in dry and mountainous situations: it leaves a strong scent behind it, but possesses such arts of defence, that, by various doublings, and intermixtures of past with present emanations from its body, it frequently baffles the most experienced dogs, and remains in a state of security while the full pack passes almost close by its retreat, distinguishing it neither by sight nor smell: it differs from the stag in the constancy of its attachments, and the parents and their young constitute a family, never associating with strangers: two fawns are generally produced by the female at a birth, one of each sex, which, living together, form a mutual and invincible attachment. When a new family is to be nursed, the former is driven off to provide for itself, but returns again after a certain interval to the mother, whose former affection is restored: a final separation speedily takes place, however, soon after this return, between the fawns of the season preceding the last and their dam, and the former remove to a distance, constituting a distinct establishment, and rearing an offspring of their own. When the female is about to bring forth, she secludes herself in some remote recess of the forest, from which she returns at the end of about ten days, with her fawns, just able slowly and weakly to follow her steps: in cases of danger, she hides them in a place deemed by her most secure from the enemy, and attracts the attention of the latter from them to herself; happy, by her own perils, or even destruction, to effect the security of her offspring. In winter these animals feed on brambles, broom, heath, and catkins; and in spring they eat the young wood and leaves of almost every species of trees, and are said to be so affected, as it were with intoxication, by the fermentation of this food in their stomachs, that they will approach men and other enemies, whom they generally shun with extreme care, without apprehension or suspicion. The flesh of these animals is excellent, though after two years of age that of the males is ill-flavoured and tough. Some roes have been found perfectly white, and in the forest of Lucia, in the duchy of Lunenburgh, a race of jet black roes is to be met with, in every other respect but this marked peculiarity of colour, (which is also stated to be an invariable distinction,) resembling the common roe.

Roes may be tamed to a certain degree, but never so as to be completely familiarized. The share of natural wildness which they ever retain is connected, especially in males, with much caprice, and even antipathy to particular individuals, whom they will assault with their horns, and afterwards violently trample on with their feet. The roe exists now in no part of Ireland, and, in Great Britain, only in a few districts of the Highlands.

C. axis, or spotted axis, is a most beautiful animal, marked with numerous spots: it is described by Pliny, and is said to have been sacred to Bacchus among the ancients. Fig. 3.

CERTIFICATION *of assize of novel disseisin,* a writ granted for the re-examination or review of a matter passed by assize before any justices; as where a man, appearing by his bailiff to an assize brought by another, hath lost the day, and having something more to plead for himself, as a deed of release, &c. which the bailiff did not or might not plead for him, desires a farther examination of the cause, either before the same justices or others, and obtaineth letters patent to that effect.

CERTIORARI, *writ of,* is an original writ, issuing out of the Court of Chancery of the King's Bench, directed, in the King's name, to the judges or officers of inferior courts, commanding them to certify or to return the records of a cause depending before them, to the end that the party may have the more sure and speedy justice before the King, or such justices as he shall assign to determine the cause.

A certiorari lies in all judicial proceedings in which a writ of error does not lie; and it is a consequence of all inferior jurisdictions erected by act of parliament, to have their proceedings returnable in the King's Bench.

In particular cases, the court will use their discretion to grant a certiorari, as, if the defendant be of good character, or if the prosecution be malicious, or attended with oppressive circumstances.

The Courts of Chancery and King's Bench may award a certiorari to remove the proceeding from any inferior courts, whether they be of ancient or newly created jurisdiction, unless the statute or charter which creates them exempts them from such jurisdiction.

CESARE, among logicians, one of the modes of the second figure of syllogisms; the minor proposition of which is an universal affirmative, and the other two universal negatives: thus,

CE No immoral books ought to be read:

SA But every obscene book is immoral:

RE Therefore no obscene book ought to be read.

CESSION, in law, an act by which a person surrenders and transmits to another person, a right which belonged to himself. Cession is more particularly used in the civil law for a voluntary surrender of a person's effects to his creditors, to avoid imprisonment.

CESSION, in the ecclesiastical law, is when an ecclesiastical person is created a bishop, or when a parson of a parish takes another benefice without dispensation, or being otherwise qualified. In both these cases their first benefices become void by cession, without any resignation; and to those livings that the person had, who was created bishop, the King may present, for that time, whosoever is patron of them; and in the other case the patron may present; but by dispensation of retainder, a bishop may retain some or all the preferments he was entitled to, before he was made bishop.

CESTRUM, in botany, *English bastard jasmine*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla funnel-form; stamens emitting a toothlet from their middle; berry unilocular. There are nine species, of which C. nocturnum, night smelling cestrum, is about seven feet high, covered with a greyish bark, and divides upward into many slender branches, which generally incline to one side; they are garnished with leaves placed alternately, nearly four inches long, and one and a half broad; the flowers are produced at the wings of the leaves, in small clusters, standing upon short peduncles, each sustaining four or five flowers, of an herbaceous colour. They appear in August, but are not succeeded by berries in this country: those which come from America are small, and are of a dark brown colour. It is a native of the island of Cuba.

CESTUI, a French word, signifying he or him, frequently used in our law-writings. Thus "cestui qui trust," a person who has lands, &c. committed to him for the benefit of another; and if such person does not perform his trust, he is compellable to it in Chancery. "Cestui qui vie," one for whose life any lands, &c. are granted. "Cestui qui use," a person to whose use any one is enfeoffed of lands or tenements. Formerly the feoffees to uses were deemed owners of the land, but now the possession is adjudged in cestui qui use.

CETE, in natural history, the seventh order of Mammalia, in the Linnæan system of animals, including the four genera; Monodon, or narval; Balæna, whale; Physeter, cachalot; and Delphinus, dolphin. The cetaceous tribe has one or more spiracles placed on the fore part of the skull; no feet; pectoral fins without nails, and tail horizontal. The cetaceous order of animals has nothing peculiar to fish, except living in the same element, and being endowed with the same powers of progressive motion, as those fishes which are intended to move with considerable velocity. The popular idea of cetaceous animals being fishes is so strongly impressed on the public mind, that it can never, perhaps, be entirely removed; for the critical observations of naturalists appear too abstruse to be generally examined, and of consequence to be commonly understood. The cetaceous tribes live in the same element as fishes, and, partaking somewhat of their external figure, will ever be considered as appertaining to that class of animals by the less informed portion of mankind.

Cetaceous animals, or, as Dr. Shaw expresses them, "fish-formed mammalia," have lungs, intestines, and other internal organs, formed on the same principle as in quadrupeds; and, indeed, on strict comparison, the principal differences that exist between them will not be found very considerable; one of the most material seems to consist in their want of posterior legs, the peculiar structure of the tail supplying that defect, this being extremely strong and tendinous, and divided into two horizontal lobes, but which has no internal bones. Like quadrupeds, they have a heart furnished with two auricles, and two ventricles, and their blood is warm and red: they breathe by their lungs, and not by means of gills, as in true fishes. In their amours they agree with quadrupeds; the female produces her young alive, which rarely happens among fishes, and she suckles them with her teats, as in the true mammalia. The structure of their brain, their sexual organs, stomach, and liver, resemble those of mammiferous animals. Their skin is smooth, or not covered with scales; and their tail is placed in a position the very reverse of fishes, in being always flat and horizontal, instead of vertical. The cetaceous animals, the cachalot and dolphin genera, have the mouth armed with conic teeth; the whales with horny laminæ in the upper jaw; and the narval with teeth, or tusks of enormous length. They are neither sanguinary nor ferocious. Their stomachs are large, and divided into chambers to the number of five, as in the whale and porpoise, or even seven, as in the narval. In the last particular they seem to constitute an intermediate link between carnivorous and herbivorous animals, approaching nearly to ruminating quadrupeds; but differ, in subsisting on animal food, as they live chiefly on actiniæ, medusæ, and other zoophytes, on crustaceous animals, and on small fish. See MONODON, BALÆNA, PHYSETER, and DELPHINUS.

CEYLANITE, in mineralogy, a species of the flint genus, of a dark indigo-blue, which passes into a bluish or greenish black. It recurs sometimes in rolled pieces, and angular pieces, and sometimes also crystallized. Specific gravity 3.76 to 3.79. It is found, in sand, with tourmalin and other fossils.

CHÆROPHYLLUM, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: invol. reflected, concave; petals heart-inflected; fruit oblong, even. There are ten species, of which C. bulbosum, tuberous chervil, is about five or six feet high, with reddish spots, smooth and even at top, swelling at the joints. Both umbels of unequal rays, the partial rather convex; petals white, obcordate, unequal; some florets of the disk abortive. It is a native of Germany, Austria, Switzerland and Norway; in hedges and by wood sides; flowering in June and July. C. silvestre, wild cicely or cow-weed, and C. temulum, wild chervil, rough cow-parsley, are both common weeds; the others are admitted only into botanic gardens, not being in use either for medicine or in the kitchen.

CHÆTODON, in natural history, a genus of fishes of the order Thoracici: generic character: head and mouth small; teeth close set, flexile, setaceous; gill membrane three, four, five, or six rayed; body broad, compressed, and generally faciated; dorsal and anal fin thick, fleshy, and scaly at the base. The fishes of this numerous genus are generally extremely beautiful, their colours remarkably vivid, and their variegations consisting chiefly of stripes, lines, bends, or spots; their body covered with strong scales, which are finally denticulated at the margin; the dorsal and anal fins are remarkably broad. According to Gmelin there are about 60 species. Dr. Shaw has enumerated and described still more. The latter has divided them into classes, of which the first is described as having a single dorsal fin, and even or rounded tail, or very slightly inclining to crescent-shaped in some few species; among the species of this class is C. plectorhenchus, or pleat-nose chætodon. See Plate III. Pisces, fig. 1. The species of the second class have a single dorsal fin, and forked or lunated tail: those of the third class have two dorsal fins.

CHAFF, in agriculture, the husky substance of corn, which is separated by threshing and winnowing. It also sometimes signifies the rind of corn; thus, barley that has a thick rind is said to be thick-chaffed; and it likewise implies straw, &c. cut small for the purpose of being given to horses and other cattle, mixed with corn. This substance, whether obtained by the dressing of grain or made from straw and other matters by cutting, is highly useful in the feeding of horses and many other animals, as saving much other more valuable food. Besides its advantage in the common feeding of animals, it is of vast utility in the fattening of different sorts of animals, where much luxuriant green food is given as a dry meat; as without some sort of material of this nature they never go on well.

CHAIN, a long piece of metal composed of several links or rings, engaged the one in the other. They are made of divers metals, some round, some flat, others square, some single, some double. A gold chain is one of the badges of the dignity of the Lord Mayor of London, and remains to the person after his being divested of that office, as a mark that he has passed the chair. It is also the badge of office of the sheriff, but only while in office.

Chain is also a string of gold, silver, or steel wire, wrought like a tissue, which serves to hang watches, tweezer-cases, and other valuable toys upon. The invention of these pieces of workmanship was derived originally from England, whence foreigners give them the name of chains of England.

In making these chains, a part of the wire is folded into little links of an oval form, the longest diameter about three lines, the shortest one. These, after they have been exactly soldered, are again folded into two, and then bound together and interwoven by means of several other little threads of the same thickness, some of which passing from one end to the other, imitate the warp of a stuff, and the others, which pass transversely, the woof; there are at least four thousand little links, in a chain of four pendants, so equally, and at the same time so firmly, connected, that the eye takes the whole to consist of one piece.

Chain, in surveying, a measure of length, made of a certain number of links of iron-wire, serving to take the distance between two or more places. Gunter's chain is of 100 such links, each measuring 7 $\frac{92}{100}$ inches, and consequently equal to 66 feet, or four poles. When you are to measure any line by this chain, you need have a guard to no other denomination than chains and links, which are to be set down with a full point between them. Thus, for instance, if the side of a close is found to be 10 chains 14 links, it must be set down thus, 10.14. But if the links be under 10, a cypher must be prefixed; thus 10 chains 7 links must be set down 10.07.

Then if the field be a square or parallelogram, if you multiply the length expressed in chains and links, by the breadth expressed in the same manner, and cut off five figures from the product, those towards the left hand will be acres; then multiply the separated figures by four, cutting off the same number of figures, and you will have the roods or quarters of an acre; and lastly multiply the remaining figures by 40, cutting off five as before, and you will have the square perches. See Surveying.

Chains, in a ship, those irons to which the shrouds of the masts are made fast to the chain walls.

Chain *walls*, in a ship, the broad timbers which are made jetting out of her sides, to which the shrouds are fastened and spread out, the better to secure the masts.

Chain *shot*, two bullets with a chain between them. They are used at sea to shoot down yards or masts, and to cut the shrouds or rigging of a ship.

Chain *pump*. See Pump.

CHALCEDONY, in mineralogy, a species of the flint genus; of which there are, according to Werner, two subspecies, *viz.* the common chalcedony and the carnelian: the colour of the former is grey in all its shades. It is commonly semi-transparent, harder than flint, brittle, difficultly frangible; and the specific gravity, according to Kirwan, is about 2.6. Infusible before the blow-pipe. It is found mostly in balls, in amygdaloid, also in angular pieces and veins, in porphyry and amygdaloid. The cubic variety occurs in Transylvania, and the other varieties in Iceland, the Feroe Islands, Silecia, Saxony, Siberia, Cornwall, Scotland, &c. It is susceptible of a fine polish, and is employed as an article of jewelry. It derives its name from Chalcedon, in Asia, where it was first found. Onyx is considered as the most valuable variety of this species, and, on account of its being capable of receiving a high polish, is very much prized. It is principally cut in bas relief work, and the finest specimens for that purpose are brought from the East Indies. The dendritic variety is named mocha stone, being brought, originally, as was supposed, from Mocha, on the Red Sea; but it is now generally understood that the word mocha is a corruption from the German word mocks, which signifies moss; and it is affirmed that no stone of the kind is found near Mocha.

The principal colour of the carnelian is blood red, of all degrees of intensity; from this it passes into milk-white, and also into a kind of yellow. Semi-transparent; and in many other of its characters it agrees with the common chalcedony. It is found accompanying agate, and, in general, has the same geognostic situation as chalcedony. The fine oriental varieties occur in rolled pieces. The most beautiful carnelian is brought from Arabia and Hindostan; it is also found in different parts of Europe, and is used for seals, bracelets, crosses, and other ornaments.

CHALCIS, in natural history, a genus of insects of the order Hymenoptera: mouth with a horny compressed jaw; feelers four, equal; antennæ short, cylindrical, fusiform; the first joint a little thicker; thorax gibbous, lengthened behind in the place of a scutel; abdomen rounded and slightly petiolate. There are eleven species.

CHALDRON, a dry English measure, consisting of thirty-six bushels, heaped up according to the sealed bushel kept at Guildhall, London; but on ship-board, twenty-one chaldrons of coals are allowed to the score.

CHALK, in natural history, a species of Calk, which see.

Chalk, where it is found at all, is the preponderating substance, and may therefore be considered as characterizing a peculiar species of mineral formation. It is perhaps the most recent of all the varieties of calcareous carbonates; it occurs in strata for the most part nearly horizontal, alternating with thin layers of flint nodules, and with the same irregularity dispersed through its substance; it contains in abundance the relics of marine organized bodies, such as echinites, glossopetræ, pectinites, &c. and also not unfrequently the hard parts of amphibious and land animals, as the heads and vertebræ of crocodiles, and teeth of elephants. Chalk hills never rise to a higher elevation than three or four hundred feet, and are at once distinguishable by the smooth regularity of their outline, and their remarkable tendency to form cup-shaped concavities. Ridges of chalk, in England at least, are always bordered by parallel ranges of sand or sand stone, beneath, and alternating with which are situated the beds of fullers-earth. Chalk hills are also singularly characterized by their dryness and their verdure: the most porous sand-stone is scarcely so deficient in springs of water, and yet, except upon almost perpendicular descents, the white surface of the chalk is uniformly covered with fine turf or wood.

The chalk hills in England occupy a greater extent than in any other country; they run in a direction nearly from east to west, parallel to each other, and separated by ranges of sand-stone, and low tracts of gravel and clay. The most northern and loftiest range of chalk commences at the promontory of Flamborough-head, in Yorkshire, and proceeds westward for nearly twenty miles. In the county of Lincoln are some fragments of a ridge near Grantham. Two ridges traverse the midland countries, and reach as far west as the borders of Oxfordshire: these ridges are no where so conspicuous as in the county of Bedford, where they approach near to each other, being only separated by the Woburn and Ampthill range of sand-stone. The country south of the Thames also contains two ridges, the one commencing at the North and South Foreland, passing through the north of Kent, the middle of Surry, and the north of Hampshire, and including the North Downs of Banstead, Epsom, &c.: the other, commencing near Hastings and at the lofty promontory of Beachy-head, passes through Sussex and the south of Hampshire, into Dorsetshire, including the South Downs. The north part of France also abounds in chalk: it is besides met with in some of the Danish islands in the Baltic, and in Poland.

The uses of chalk are very extensive: the more compact kinds are used as building stone, and are burnt to lime (nearly all the buildings in London being cemented with chalk-mortar:) it is also largely employed in the polishing of metals and glass, in constructing moulds to cast metal in, by carpenters and others as a material to mark with, and by starch-makers and chemists to dry precipitates on, for which it is peculiarly qualified, on account of the remarkable facility with which it absorbs water.

Chalk *stones*. It is well known that concretions occasionally make their appearance in joints long subject to gout. These concretions, from their colour and softness, have received the name of chalk-stones. They are usually small, though they have been observed of the size of an egg. It had long been the opinion of physicians, that these concretions were similar to the urinary calculi. See Calculi.

Of course, after the discovery of uric acid by Scheele, it was usual to consider the gouty chalk-stones as collections of that acid. They were subjected to a chemical analysis by Dr. Wollaston in 1797, who found them composed of uric acid and soda. Gouty concretions are soft and friable. Cold water has little effect upon them; but boiling water dissolves a small portion. If an acid be added to this solution, small crystals of uric acid are deposited on the sides of the vessel. These concretions are completely soluble in potash, when the action of the alkaline solution is assisted by heat. When treated with diluted sulphuric or with muriatic acid, the soda is separated; but the uric acid remains, and may be separated by filtration. The liquid, when evaporated, yields crystals of sulphate or muriate of soda, according to the acid employed. The residuum possesses all the characters of uric acid.

When uric acid, soda, and a little warm water, are triturated together, a mass is formed, which, after the surplus of soda is washed off, possesses the chemical properties of gouty concretions.

CHALLENGE, in law, is an exception made to jurors, who are returned to a person on a trial.

This challenge is made either to the array, or to the polls: to the array, when exception is taken to the whole number of jurors impannelled; and to the polls, when an exception is made to one or more of the jury as not indifferent.

Challenge to the jurors is likewise divided into challenge principal or peremptory, and challenge for cause; that is, upon cause or reason alledged. Challenge principal, is what the law allows without any cause alledged, or further examination: as, a prisoner arraigned at the bar for felony may challenge peremptorily the number allowed him by law, being twenty, one after another, alleging no further cause than his own dislike: and the jurors, so challenged, shall be put off, and new ones taken in their places.

In cases of treason, the number of thirty-five jurors may be peremptorily challenged, without shewing any cause: and more, both in treason and felony, may be challenged, shewing cause.

If those who prosecute for the king challenge a juror, they are to assign the cause; and if the cause alleged be not a good one, the inquest shall be taken. When the king is party, if the other side challenge any juror above the number allowed, he ought to show cause of his challenge immediately, while the jury is full, and before they are sworn. This was supposed to be law with regard to challenges made for the crown, but in the memorable state trials of 1794, the crown lawyers challenged without shewing cause, declaring that they were not bound to shew reason till the whole pannel was gone through, and then only in case that a sufficient number of jurors were not left. This was the case, and the consequence was, that the persons whom they had challenged were then taken, against whom it was ascertained there was no cause of challenge whatever. Challenge to the array is in respect of the partiality or default of the sheriff, coroner, or other officer, that made the return; and it is then twofold. First, principal challenge to the array, which, if it be made good, it is a sufficient cause of exception, without leaving any thing to the judgment of the triers; as, if the sheriff be of kindred to either party, or if any of the jurors be returned at the nomination of either of the parties. Secondly, challenged to the array for favour, which being no principal challenge, must be left to the discretion and conscience of the triers. As where either of the parties suspect that the juror is inclined to favour the opposite party. Principal challenge to the polls, is where cause is shewn, which, if found true, stands sufficient of itself, without leaving any thing to the triers; as, if the juror be under the age of 21, it is a true cause of challenge.

CHALYBEATE. See MINERAL WATERS.

CHAMA, in natural history, a genus of Vermes Testacea. Animal a tethys: shell bivalve, rather coarse; hinge with a callous gibbosity, obliquely inserted in an oblique hollow; anterior slope closed: about 25 species, of which we shall notice only the C. gigas: shell plaited, with arched scales: posterior slope gaping, with crenulate margins. It inhabits the Indian ocean, and is sometimes so small as not to measure an inch in length; sometimes far exceeds all other testaceous productions, having been found of the weight of 532 pounds, and the fish or inhabitant so large as to furnish 120 men with food, and strong enough to cut asunder a cable and lop off men's hands; shell lucid, white, sometimes rosy, varied with yellow, red, and white: posterior aperture ovate, with a tumid crenate circumference; margin toothed; hinge armed with a tooth besides the callus.

CHAMÆLEON, in botany, a genus of the Syngenesia Segregata class and order. Calyx six or eight flowered, imbricate, many-leaved; calycle one-flowered, many-leaved; florets tubular, all hermaphrodite; receptacle naked; seeds covered with a calycle growing to them; one species, a native of the South of Europe.

CHAMÆROPS, in botany, *dwarf palm*, or *palmetto*. Essential character: hermaphrodite; calyx three-parted; corolla three petalled; stamina six; pistils three; drupes three, one-seeded: males, dioecous, as in the hermaphrodite. There are three species, of which C. humilis, dwarf fan palm, never rises with an upright stem; the foot stalks of the leaves rise immediately from the head of the root, and are armed on each side with strong spines; they are flat on their upper surface, and convex on their under side: from between the leaves comes out the spadix or club, which sustains the flowers; this is covered with a thin spathe or hood, which falls off when the bunches open and divide. It grows naturally in Italy, Sicily, and Spain, particularly in Andalusia, where, in the sandy land, the roots spread and propagate so fast, as to cover the ground in the same manner as fern in England.

CHAMBERLAIN, an officer charged with the management and direction of a chamber.

There are almost as many kinds of chamberlains as chambers, the principal of which are as follow:

CHAMBERLAIN, *Lord, of Great Britain*, the sixth great officer of the crown; to whom belongs livery and lodging in the king's court; and there are certian fees due to him from each archbishop or bishop, when they perform their homage to the king: and from all peers at their creation, on doing their homage. At the coronation of every king, he is to have forty ells of crimson velvet for his own robes. This officer, on the coronation day, is to bring the king his shirt, coif, and, wearing clothes; and after the king is dressed, he claims his bed, and all the furniture of his chamber, for his fees: he also carries, at the coronation, the coif, gloves, and linen, to be used by the king on that occasion; also the sword and scabbard, the gold to be offered by the king, and the robes royal and crown: he dresses and undresses the king on that day, waits on him before and after dinner, &c. To this officer belongs the care of providing all things in the House of Lords, in the time of the Parliament: to him also belongs the government of the palace of Westminster: he disposes likewise of the sword of state, to be carried before the king, to what lord he pleases.

The office of Lord Great Chamberlain of England is hereditary; and where a person dies siezed in fee of this office, leaving two sisters, the office belongs to both, and they may execute it by deputy, but such deputy must be approved of by the king, and must not be of a degree inferior to a knight. To the Lord Chamberlain the keys of Westminster Hall, and the Court of Requests, are delivered upon all solemn occasions. He goes on the right hand of the sword, next the king's person. The Gentleman Usher of the Black Rod, Yeoman Usher, &c. are under his authority.

Chamberlain, *Lord of the Household*, an officer who has the oversight and direction of all the officers belonging to the king's chambers, except the precinct of the king's bed-chamber.

He has the oversight of the officers of the wardrobe at all his Majesty's houses, and of the removing wardrobes, or of beds, tents, revels, music, comedians, hunting, messengers, &c. retained in the king's service. He moreover has the oversight and direction of the serjeants at arms, of all physicians, apothecaries, surgeons, barbers, the king's chaplains, &c. and administers the oath to all officers above stairs.

Chamberlain *of London*, keeps the city money, which is laid up in the chamber of London: he also presides over the affairs of masters and apprentices, and makes free of the city, &c. His office lasts only a year, but the custom usually obtains to re-choose the same person, unless charged with any misdemeanor in his office.

CHAMBERS, (Ephraim,) author of the dictionary of sciences, called the "Cyclopædia." He was born at Milton, in the county of Westmoreland, where he received the common education for qualifying a youth for trade and commerce. When he became of a proper age, he was put apprentice to Mr. Senex, the globe-maker, a business which is connected with literature, especially with geography and astronomy. It was during Mr. Chamber's residence with this skilful artist, that he acquired that taste for literature which accompanied him through life, and directed all his pursuits. It was even at this time that he formed the design of his grand work, the Cyclopædia; some of the first articles of which were written behind the counter. To have leisure to pursue this work, he quitted Mr. Senex, and took chambers at Grey's Inn, where he chiefly resided during the rest of his life. The first edition of the Cyclopædia, which was the result of many years intense application, appeared in 1728, in 2 vols. folio. The reputation that Mr. Chambers acquired by the execution of this work procured him the honour of being elected F. R. S. November 6, 1729. In less than ten years time, a second edition became necessary; which accordingly was printed, with corrections and additions, in 1738: and this was followed by a third edition the very next year.

Mr. Chambers's close and unremitting attention to his studies at length impaired his health, and obliged him occasionally to take a country lodging, but without much benefit; he afterwards visited the south of France, but still with little effect; he therefore returned to England, where he soon after died, at Islington, May 15, 1740, and was buried at Westminster Abbey.

After the author's death, two more editions of his Cyclopædia were published. The proprietors afterwards procured a supplement to be compiled, by Mr. Scott and Dr. Hill, but chiefly by the latter, which extended to two volumes more; and the whole has since been reduced into one alphabet, in four volumes, by Dr. Rees, forming a very valuable body of the sciences.

A new edition of the same work, or rather a new work under the title of the "New Cyclopædia," is now publishing by the same learned Editor. This work, of which Dr. Rees has published already nine volumes, will probably extend to thirty volumes quarto. It will, when complete, be unquestionably the most comprehensive body of science ever presented to the world.

CHAMELEON. See Lacerta.

CHAMPION, a person who undertakes a combat in the place or quarrel of another; and sometimes the word is used for him who fights in his own cause.

It appears that champions, in the just sense of the word, were persons who fought instead of those, that, by custom, were obliged to accept the duel, but had a just excuse for dispensing with it, as being too old, infirm, or being ecclesiastics, and the like. Such causes as could not be decided by the course of common law were often tried by single combat; and he who had the good fortune to conquer was always reputed to have justice on his side. Champions, who fought for interest only, were held infamous: these hired themselves to the nobility, to fight for them in case of need, and did homage for their pension.

When two champions were chosen to maintain a cause, it was always required that there should be a decree of the judge to authorize the combat: when the judge had pronounced sentence, the accused threw a gage or pledge, originally a glove or gauntlet, which being taken up by the accuser, they were both taken into safe custody, till the day of battle appointed by the judge.

Before the champions took the field, their heads were shaved to a kind of crown or round, which was left at the top: then they made an oath, that they believed the person who retained them to be in the right, &c. They always engaged on foot, and with no other weapon than a club and a shield, which weapons were blessed in the field by the priest, with a world of ceremonies; and they always made an offering to the church, that God might assist them in the battle.

The action began with railing, and giving each other ill language; and at the sound of a trumpet, they went to blows. After the number of blows or encounters expressed in the cartel, the judges of the combat threw a rod into the air, to advertise the champions that the combat was ended. If it lasted till night, or ended with equal advantage on both sides, the accused was reputed the victor. If the conquered champion fought in the cause of a woman, and it was a capital offence, the woman was burnt, and the champion hanged. If it was the champion of a man, and the crime capital, the vanquished was immediately disarmed, led out of the field, and hanged, together with the party whose cause he maintained. If the crime was not capital, he not only made satisfaction, but had his right hand cut off: the accused was close confined in prison, till the battle was over.

Champion *of the king*, a person whose office it is, at the coronations of our kings, to ride armed into Westminster-hall, while the king is at dinner there, and, by the proclamation of a herald, make challenge to this effect, viz. "That if any man shall deny the king's title to the crown, he is there ready to defend it in single combat, &c." Which done, the king drinks to him, and sends him a gilt cup, with a cover, full of wine, which the champion drinks, and has the cup for his fee. This office is hereditary.

CHANCE, in a general sense, a term applied to events not necessarily produced as the natural effects of any proper foreknown cause. We certainly mean no more in saying that a thing happened by chance, than that its cause is unknown to us: for chance itself is no natural agent or cause; it is incapable of producing any effect, and is no more than a creature of man's own making; for the things done in the corporeal world are really done by the parts of the universal matter, acting and suffering, according to the laws of motion established by the author of nature.

Chance is also confounded with fate and destiny.

Chances, *doctrine of*, in mixed mathematics, a subject of great importance, especially as applied to the doctrine of life annuities, assurance, &c. in a great commercial country like this. The writers on this branch of science have been comparatively few. In our own language the principal treatises are, a large quarto by De Moivre, and a very small work by the celebrated Mr. Thomas Simpson, in which, however, there are some problems never before attempted, or, at least, never before communicated to the public. In the year 1753, Mr. Dodson rendered this subject more accessible to persons not far advanced in analytical studies, by publishing, in his second volume of the "Mathematical Repository," a number of questions, with their several solutions, with an express reference to the doctrine of life annuities. We shall give his first problem.

Suppose a round piece of metal, equally formed, having two opposite faces, one white, the other black, be thrown up, in order to see which of those faces will be uppermost after the metal has fallen to the ground, when, if the white face appears uppermost, a person is to be entitled to 5*l.* it is required to determine, before the event, what chance or probability that person has of receiving the 5*l.* and what sum he may expect should be paid to him in consideration of his resigning his chance to another.

Solution. Since there is nothing in the form of the metal that can incline it to shew one face rather than the other, and since it must shew one, it will follow, that there is an equal chance for the appearance of either face, or there is one chance out of two for the appearance of the white face, and consequently the probability of it may be expressed by the fraction $\frac{1}{2}$; if, therefore, any other person should be willing to purchase his chance, he must give for it the half of 5*l.* or 2*l.* 10*s.* This is one of the most simple cases: before, however, we proceed, it may be proper to give some definitions introductory to the doctrine.

Def. 1. The probability of an event is the ratio of the chance for its happening to all the chances for its happening or failing: thus, if out of six chances for its happening or failing, there were only two chances for its happening, the probability in favour of such an event would be in the ratio of two to six; that is, it would be a fourth proportional to 6, 2, and 1, or $\frac{1}{3}$. For the same reason, as there are four chances for its failing, the probability that the event will not happen will be in the ratio of 4 to 6, or, in other words, it will be a fourth proportional to 6, 4, and 1, or $\frac{2}{3}$. Hence, if the fractions expressing the prbabilities of an event's both happening or failing be added together, they will always be found equal to unity. For let a be the number of chances for the event's happening, and b the number of chances for its failing, the probability in the first case being $\frac{a}{a+b}$, and in the second case $\frac{b}{a+b}$, their sum will be $= \frac{a+b}{a+b} = 1$. Having therefore determined the probability of any event's either happening or failing, the probability of the contrary will always be obtained by subtracting the fraction expressing such probability from unity.

Def. 2. The expectation of an event is the present value of any sum or thing, which depends either on the happening or on the failing of such an event. Thus, if the receipt of one guinea were to depend on the throwing of any particular face on a die, the expectation of the person entitled to receive it would be worth 3*s.* 6*d.*; for since there are six faces on a die, and only one of them can be thrown to entitle the person to receive his money, the probability that such a face will be thrown being $\frac{1}{6}$ (according to Def. 1.) it follows, that the value of his interest before the trial is made, or, which is the same thing, that his expectation is equal to one-sixth of a guinea, or 3*s.* 6*d.* Were his receiving the money to depend on his throwing either of two faces, his expectation would be equal to two-sixths of a guinea, or 7*s.* And, in general, supposing the present value of the money or thing to be received to be A, the probability of the event's happening to be denoted by a, and of its failing by b, the expectation will be either expressed by $\frac{Aa}{a+b}$, or by $\frac{Ab}{a+b}$, according as it depends either on the event's happening, or on its failing.

Def. 3. Events are independent, when the happening of any one of them does neither increase nor lessen the probability of the rest. Thus, if a person undertook with a single die to throw an ace at two successive trials, it is obvious (however his expectation may be effected) that the probability of his throwing an ace in the one is neither increased nor lessened by the result of the other trial.

Theor. The probability that two subsequent events will both happen, is equal to the product of the probabilities of the happening of those events considered separately.

Suppose the chances for the happening and failing of the first event to be denoted by b, and those for its happening only to be denoted by a. Suppose, in like manner, the chances for the second event's happening and failing to be denoted by d, and those for its happening only by c; then will the probability of the happening of each of those events, separately considered, be (according to Def. 1) $\frac{a}{b}$ and $\frac{c}{d}$ respectively. Since it is necessary that the first event should happen before any thing can be determined in regard to the second, it is evident that the expectation on the latter must be lessened in proportion to the improbability of the former. Were it certain that the first event would happen, in other words, were $a = b$, or $\frac{a}{b} = 1$, the expectation on the second event would be $= \frac{c}{d}$. But if a is less than b, and the expectation on the second event is restrained to the contingency of its having happened the first time, that expectation will be so much less than it was on the former supposition as $\frac{a}{b}$ is less than unity. Hence we have $1 : \frac{a}{c} :: \frac{c}{d} : \frac{ac}{bd}$ for the true expectation in this case.

Cor. By the same method of reasoning it will appear, that the probability of the happening of any number of subsequent events is equal to the "product of the probabilities of those events separately considered," and therefore, if a always denote the probability of its happening, and b the probability of its happening and failing, the fraction $\frac{a^n}{b^n}$ will express the probability of its happening n times successively, and (by Def. 1) the fraction $\frac{\overline{b-a}|^n}{b^n}$ will express the probability of its failing n times successively.

Rem. It should be observed, that in some instances the probability of each subsequent event necessarily differs from that which preceded it, while in others it continues invariably the same through any number of trials. In the one case the probabilities are expressed, as in the theorem, by fractions, whose numerators and denominators continually vary; in the other they are expressed, as in the corollary, by one and the same invariable fraction. But this perhaps will be better understood by the following examples.

1. Suppose that out of a heap of counters, of which one part of them are white and the other red, a person were twice successively to take out one of them, and that it were required to determine the probability that these should be red counters. If the number of the white be 6, and the number of the red be four, it is evident, from what has already been shown, that the probability of taking out a red one the first time will be $\frac{4}{10}$: but the probability of taking it out the 2d time will be different; for since one counter has been taken out, there are now only nine remaining; and since, in order to the 2d trial, it is necessary that the counter taken out should have been a red one, the number of those red ones must have been reduced to 3. Consequently, the chance of drawing out a red counter the 2d time will be $\frac{3}{9}$, and the probability of drawing it out the first and 2d time will (by this theorem) be $\frac{4 \times 3}{10 \times 9} = \frac{2}{15}$.

2. Suppose next, that with a single die a person undertook to throw an ace twice successively: in this case the probability of throwing it the first does not in the least alter his chance of throwing it the second time, as the number of faces on the die is the same at both trials. The probability, therefore, in each will be expressed by the same fraction, so that the probability, before any trial is made, will, by the preceding corollary, be $\frac{1}{6} \times \frac{1}{6} = \frac{1}{36}$. On these conclusions depend all the computations, however complicated and laborious, in the doctrine of chances. But this, perhaps, will be more clearly exemplified in the two following problems, which will serve to explain the principles on which every other investigation is founded on this subject.

Prob. 1. To determine the probability that an event happens a given number of times, and no more, in a given number of trials.

Sol. 1. Let the probability be required of its happening only once in two trials, and let the ratio of its happening to that of its failing be as a to b. Then, since the event can take place only by it happening the first, and failing the second time, the probability of which is $\frac{a}{a+b} \times \frac{b}{a+b} = \frac{ab}{\overline{a+b}|^2}$, or by its failing the first and happening the second time, the probability of which is $\frac{ba}{\overline{a+b}|^2}$, the sum of these two fractions, or $\frac{2ab}{\overline{a+b}|^2}$, will be the probability required.

2. Let the probability be required of its happening only twice in three trials. In this case, the event, if it happens, must take place in either of three different ways: 1st, by its happening the first two, and failing the third time, the probability of which is $\frac{aab}{\overline{a+b}|^3}$; 2dly, by its failing the first, and happening the other two times, the probability of which is $\frac{baa}{\overline{a+b}|^3}$; or, 3dly, by its happening the first and third, and failing the second time, the probability of which is $\frac{aba}{\overline{a+b}|^3}$. The sum of these fractions, therefore, or $\frac{3baa}{\overline{a+b}|^3}$, will be the required probability. By the same method of reasoning, the probability of its happening only once in three trials, or, which is the same thing, of its failing twice in three trials, may be found equal to $\frac{3bba}{\overline{a+b}|^3}$.

3. Let the probability of the event's happening only once in four trials be required. In this case it must either happen the first and fail in the three succeeding trials; or happen the second and

fail in the first, third, and fourth trials; or happen the third, and fail in the first, second, and fourth trials; or happen the fourth, and fail in the first, second, and third trials. The probability of each of these being $\frac{ab^3}{\overline{a+b}|^4}$, the required probability will be $\frac{4ab^3}{\overline{a+b}|^4}$; and for the same reason, the probability of its happening three times and failing only once in four trials will be $\frac{4ba^3}{\overline{a+b}|^4}$.

4. Let the probability be required of its happening twice and failing twice in four trials: here the event may be determined in either of six different ways: 1st, by its happening the first and second, and failing in the third and fourth trials; 2dly, by its happening the first and third, and failing the second and fourth trials; 3dly, by its happening the first and fourth, and failing the second and third trials; 4thly, by its happening the second and third, and failing the first and fourth trials; 5thly, by its happening the second and fourth, and failing the first and third trials; or, 6thly, by its happening the third and fourth, and failing the first and second trials. Each of these probabilities being expressed by $\frac{a^2b^2}{\overline{a+b}|^4}$, it follows that the sum of them, or $\frac{6a^2b^2}{\overline{a+b}|^4}$ will express the probability required.

By proceeding in the same manner, the probability in any other case may be determined. But if the number of trials be very great, these operations will become exceedingly complicated, and therefore recourse must be had to a more general method of solution.

Supposing n to be the whole number of trials, and d the number of times in which the event is to take place, the probability of the event's happening d times successively, and failing the remaining $n\ d$ times, will be $\frac{a^d}{\overline{a+b}|^d} \times \frac{b^{n-d}}{\overline{a+b}|^{n-d}} = \frac{a^d \,.\, b^{n-d}}{\overline{a+b}|^n}$. But as there is the same probability of its happening any other d assigned trials and failing in the rest, it is evident that this probability ought to be repeated as often as d things can be combined in n things, which, by the known rules of combination, are $= \frac{n}{1} \times \frac{n-1}{2} \times \frac{n-2}{3}$ continued to d terms; the general rule therefore will be $\frac{a^d \,.\, b^{n-d}}{\overline{a+b}|^n}$ multiplied into $n \times \frac{n-1}{2} \times \frac{n-2}{3} \times \frac{n-3}{4}$ continued to d terms.

Ex. Supposing a person with six dice undertakes to throw two aces, and no more; or, which is the same thing, that he undertakes with one die to throw an ace twice, and no more, in six trials; it is required to determine the probability of his succeeding, a being in this case $= 1$, $b = 5$, $n = 6$, and $d = 2$, the above expressions will become $= \frac{5^4}{6^6}$, multiplied into $6 \times \frac{5}{2} = \frac{625 \times 15}{46656} = \frac{1}{5}$ very nearly. Hence, since there is only one chance for his succeeding, while there are four for his failing, the odds against him will be as four to one.

Prob. 2. To determine the probability that an event happens a given number of times in a given number of trials, supposing, as in the former problem, the probability of its happening each time to that of its failing to be in the ratio of a to b.

Sol. It will be observed that this problem materially differs from the preceding, in as much as the event in that problem was restrained, so that it should happen neither more or less often than a given number of times, while in this problem the event is determined equally favourable by its happening either as often or oftener than a given number of times, so that in the present case there is no further restriction than that it should not fall short of that number.

1. Let the probability be required of an event happening once at least in two trials. If it happens the first and fails the second time, or fails the first and happens the second time, or happens both times, the event will have equally succeeded. The probability in the first case is $\frac{ab}{\overline{a+b}|^2}$, the probability in the second is $\frac{ba}{\overline{a+b}|^2}$, and the probability in the third is $\frac{aa}{\overline{a+b}|^2}$; hence the

probability required will be $= \frac{2ab+aa}{\overline{a+b}|^2}$.

2. Let the probability be required of its happening once in three times. Provided it has happened once at least in the first two trials, the event will have equally succeeded, whether it happens or fails in the third trial, and therefore $\frac{a^2+2ab}{\overline{a+b}|^2}$ will represent the probability in this case. But it may have failed in the first two and happened in the third trial, the probability of which is $\frac{bba}{\overline{a+b}|^3}$; adding this to the preceding fraction we have $\frac{\overline{a^2+2ab}\times\overline{a+b}+b^2a}{\overline{a+b}|^3}$ $=\frac{a^3+3a^2b+3ab^2}{\overline{a+b}|^3}$ for the probability required. In like manner the probability of its happening once at least in four trials will be $\frac{a^3+3a^2b+3abb}{\overline{a+b}|^3}+\frac{ab^3}{\overline{a+b}|^4}=\frac{a^4+6a^3b+6a^2b^2+4ab^3}{\overline{a+b}|^4}$, and the probability of its happening once at least in n times will be $=\frac{\overline{a+b}^n-b^n}{\overline{a+b}|^n}$. In other words, since the event must happen once at least, unless it fails every time, the probability required (by Def. 1) will always be expressed by the difference between unity and $\frac{b^n}{\overline{a+b}|^n}$.

3. Let the probability be required of an event's happening twice at least in three trials. In this case it will succeed, if it happens the first and second, and fails the third time, if it happens the first and third, and fails the second time, if it happens the second and third, and fails the first time, or if it happens each time successively. The first three probabilities are $\frac{3a^2b}{\overline{a+b}|^3}$ and the fourth is $\frac{a^3}{\overline{a+b}|^3}$; therefore the probability required will be $=\frac{a^3+3a^2b}{\overline{a+b}|^3}$. If the event is to happen twice at least in four times, the probability of its happening during the first three times has been already found. Let it be supposed to have happened only once in three times, the probability of which, by the preceding problem, in $\frac{3abb}{\overline{a+b}|^3}$; then will the probability of its happening the fourth, after having happened once in the three preceding, be $\frac{3a^2b^2}{\overline{a+b}|^4}$, and therefore the whole probability will be

$$\frac{a^3+3a^2b}{\overline{a+b}|^3}+\frac{3a^2b^2}{\overline{a+b}|^4}=\frac{a^4+4a^3b+6a^2b^2}{\overline{a+b}|^4}.$$

By proceeding in the same manner, it may be found that the probability of an event's happening twice at least in five trials, will be $=\frac{a^4+4a^3b+6a^2}{\overline{a+b}|^4}+\frac{a}{a+b}\times\frac{4ab^3}{\overline{a+b}|^4}$ $=\frac{a^5+5a^4b+10a^3b^2+10a^3b^2}{\overline{a+b}|^5}$. And if the probability of the event's happening thrice in 4, 5, 6, &c. trials be required, they may, by pursuing the same steps, be found $=\frac{a^4+4a^3b^2}{\overline{a+b}|^4}$, $\frac{a^5+5a^4b+10a^3b^2}{\overline{a+b}|^5}$ $\frac{a^6+6a^5b+15a^4b^2+20a^3b^3}{\overline{a+b}|^6}$, &c. respectively. Hence it follows, that if the binomial $\overline{a+b}|$ be raised to nth power, the probability of an event's happening at least d times in n trials will be $=$

$$\frac{a^n+na^{n-1}b+n.\frac{n-1}{2}a^{n-2}b^2\ \overline{(n+1-d)}}{\overline{a+b}|^n}$$

that is, the series in the numerator must be continued till the index of a becomes equal to d.

Cor. From this solution it appears that the series.

$$\frac{b^n+nb^{n-1}a+n.\frac{n-1}{2}b^{n-2}a^2 \text{ to } d \text{ terms,}}{\overline{a+b}|^n}$$

will express the probability of the event's not happening so often as d times in n trials.

Ex. Supposing a person with six dice undertakes to throw two aces or more in the first trial, what is the probability of his succeeding? In this case a, b, n, and d, being respectively equal to 1, 5, 6, and 2, the above expression will become $=$

$$\frac{1+30+15\times25+20\times125+15\times625}{6^6}$$

$=\frac{12281}{46656}$. Hence the odds against his succeeding will be as 34375 to 12281, or nearly as three to one.

We have already observed, that the doctrine of chances is particularly applicable to the business of life annuities and assurance. This depends on the chance of life in all its stages, which is found by the bills of mortality in different places. These bills exhibit how many persons upon an average out of a certain number born are left at the end of each year, to the extremity of life. From such tables the probability of the continuance of a life of any proposed age is known.

Example. To find the probability that an individual of a given age will live one year. Let A be the number in the tables of the given age, B the number left at the end of the year; then $\frac{B}{A}$ is the probability that the individual will live one year; and $\frac{A-B}{A}$ the probability that he will die in that time. In Dr. Halley's tables, out of 586 at the age of 22, 579 arrive at the age of 23; hence the probability that an individual aged 22 will live one year is $\frac{579}{586}$, or $\frac{83}{84}$ nearly; and $\frac{7}{586}$ or $\frac{1}{84}$ nearly is the probability that he will die in that time. See Mortality, *bills of*, &c.

Those who would enter more at large into this subject may be referred to the works already mentioned, or to the article Chances in the new Cyclopædia of Dr. Rees, a work that will be found in every library of general literature, and in which this subject is treated with great ability. Though we shall under the article Gaming refer again to the doctrine of chances, it may not be amiss to mention a deduction or two, drawn by the writer of the article just referred to, as the necessary consequences of mathematical reasoning. The first is: suppose a lottery consisting of 25,000 tickets, of which 20 are to be prizes of 1000*l.* and upwards; a person, to have an equal chance of one of those prizes, must purchase about 870 tickets, which at 20*l.* each is equal to 17,400*l.*

Again: suppose there are three prizes of 20,000*l.* and three of 10,000*l.* and a person out of 25,000 tickets has purchased 3000 of them to his own share, in hopes of gaining one of each of these capital prizes; still the chances against such an expectation will be nearly twelve to one. See Gaming.

Chance *medley*, in law, is the accidental killing of a man not altogether without the killer's fault, though without any evil intention; and is where one is doing a lawful act, and a person is killed thereby; for, if the act be unlawful, it is felony. The difference betwixt chance-medley and manslaughter is this: if a person cast a stone, which happens to hit one, and he dies; or if a workman, in throwing down rubbish from a house, after warning to take care, kill a person, it is chance-medley, and misadventure: but if a person throws stones on the highway, where people usually pass: or a workman throws down rubbish from a house, in cities and towns where people are continually passing; or if a man whips his horse in the street, to make him gallop, and the horse runs over a child and kills it, it is manslaughter; but if another whips the horse, it is manslaughter in him, and chance-medley in the rider. In chance-medley the offender forfeits his goods, but has a pardon of course.

CHANCELLOR, an officer supposed originally to have been a notary or scribe under the emperors, and named *cancellarius*, because he sat behind a lattice, called in Latin *cancellus*, to avoid being crowded by the people.

Chancellor, *Lord High, of Great Britain*, or *Lord Keeper of the Great Seal*, is the highest honour of the long robe, being made so *per traditionem magni sigilli. per dominum regem*, and by taking the oaths: he is the first person of the realm next after the king and princes of the blood in all civil affairs; and is the chief administrator of justice next the sovereign, being the judge of the court of chancery. All other justices are tied to the strict rules of law in their judgment; but the chancellor is invested with the king's absolute power to moderate the written law, governing his judgment purely by the law of nature and conscience, and ordering all things according to equity and justice. The Lord Chancellor not only keeps the King's great seal; but also all patents, commissions, warrants, &c. from the King, are, before they are signed, perused by him; he has the disposition of all ecclesiastical benefices in the gift of the crown under 20*l.* a year in the king's books; and he is speaker of the House of Lords. To him belongs the appointment of all justices of the peace throughout the kingdom.

He is the general guardian of all infants, idiots and lunatics; and has the general superintendence of all charitable uses in the kingdom.

Chancellor *of a cathedral*, an officer that hears lessons and lectures read in the church, either by himself or his vicar; to correct and set right the reader when he reads amiss; to inspect schools; to hear causes; apply the seal; write and dispatch the letters of the chapter; keep the books; take care that there be frequent preachings both in the church and out of it; and assign the office of preaching to whom he pleases.

Chancellor *of the duchy of Lancaster*, an officer appointed chiefly to determine controversies between the king and his tenants of the duchy land, and otherwise to direct all the King's affairs belonging to that court.

Chancellor *of the Exchequer*, an officer who presides in that court, and takes care of the interest of the crown.

He is always in commission with the Lord Treasurer, for the letting of crown-lands, &c. and has power, with others, to compound for forfeitures of lands upon penal statutes: he has also great authority in managing the royal revenues, and in matters relating to the first fruits.

Chancellor *of the order of the garter, and other military orders*, is an officer who seals the commissions and mandates of the chapter and assembly of the knights, keeps the register of their proceedings, and delivers acts thereof under the seal of their order.

Chancellor *of an university*, is he who seals the diplomas, or letters of degrees, provision, &c. given in the university. The Chancellor of Oxford is usually one of the prime nobility, chosen by the students themselves in convocation. He is their chief magistrate; his office is *durante vita*, to govern the university, preserve and defend its rights and privileges, convoke assemblies, and do justice among the members under his jurisdiction Under the Chancellor is the Vice-Chancellor, who is chosen annually, being nominated by the Chancellor, and elected by the university in convocation: he is always the head of some college, and in holy orders. His proper office is, to execute the Chancellor's power, to govern the university according to her statutes, to see that officers and students do their duty, that courts be duly called, &c. When he enters upon his office, he chooses four Pro-Vice-Chancellors out of the heads of the colleges, to execute his power in his absence. The Chancellor of Cambridge is also usually one of the prime nobility, and in most respects the same as that in Oxford, only he does not hold his office *durante vita*, but may be elected every three years. Under the chancellor there is a Commissary, who holds a court of record for all privileged persons and scholars under the degree of Master of Arts, where all causes are tried and determined by the civil and statute law, and by the custom of the university. The Vice-Chancellor of Cambridge is chosen annually by the Senate, out of two persons nominated by the heads of the several colleges and halls.

CHANCERY, the grand court of equity and conscience, instituted to moderate the rigour of the other courts that are bound to the strict letter of the law.

In Chancery are two courts; one ordinary, being a court of common law; the other extraordinary, being a court of equity. The ordinary or common law court is a court of record. Its jurisdiction is to hold plea upon a *scire facias*, to repeal and cancel the King's letters patent, when made against law, or upon untrue suggestions; and to hold plea on all personal actions, where any officer of this court is a party; and of executions on statutes, or of recognizances in nature of statutes; and by several acts of Parliament, of divers other offences and causes; but this court cannot try a cause by a jury, but the record is to be delivered by the Lord Chancellor into the King's Bench, to be tried there, and judgment given thereon. And when judgment is given in this common law part of Chancery upon demurrer, or the like, a writ of error is returnable into the King's Bench; but this hath not been practised for many years. From this court also proceed all original writs, commissions of charitable uses, bankrupts, sewers, idiots, lunatics, and the like: and for these ends this court is always open.

The extraordinary court is a court of equity, and proceeds by the rules of equity and good conscience. This equity consists in abating the rigour of the common law, and giving a remedy in cases where no provision, or not sufficient provision, had been made by the ordinary course of law. The jurisdiction of this court is of vast extent. Almost all causes of weight and moment, first or last, have their determination here. In this court relief is given in the case of infants, married women, and others not capable of acting for themselves. All frauds, for which there is no remedy at law, are cognizable here; as also all breaches of trust, and unreasonable or unconscionable engagements. It will compel men to perform their agreements; will remove mortgageors and obligors against penalties and forfeiture, on payment of principal, interest, and costs; will rectify mistakes in conveyances; will grant injunctions to stay waste; and restrain the proceedings of inferior courts, that they exceed not their authority and jurisdiction. This court will not retain a suit for any thing under 10*l.* value; except in cases of charity, nor for lands under 40*s. per annum.*

CHANCRE, a venereal ulcer. Se SURGERY.

CHANGES, in arithmetic, the variations or permutations of any number of things, with regard to their position, order, &c. The method of finding out the number of changes, is by a continual multiplication of all the terms in a series of arithmetical progressionals, whose first term, and common difference, is unity, or 1; and last term the number of things proposed to be varied, *viz.* $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7$, &c. as will appear from what follows:

1. If the things proposed to be varied are only two, they admit of a double position, as to order of place, and no more.

Thus, $\left\{\begin{matrix}1 . 2\\ 2 . 1\end{matrix}\right\} = 2 = 1 \times 2.$

2. And if three things are proposed to be varied, they may be changed six several ways, as to their order of places, and no more.

For, beginning with 1, there will be .... 1 . 2 . 3 / 1 . 3 . 2
Next, beginning with 2, there will be .... 2 . 1 . 3 / 2 . 3 . 1
Again, beginning with 3, it will be .... 3 . 1 . 2 / 3 . 2 . 1

Which, in all, make 6, or 3 times 2; *viz.* $1 \times 2 \times 3 = 6$.

3. Suppose 4 things were supposed to be varied, then they admit of 24 several changes, as to their order of different places.

For, beginnning the order with 1, it will be .... 1 . 2 . 3 . 4 / 1 . 2 . 4 . 3 / 1 . 3 . 2 . 4
Here are six different changes .... 1 . 3 . 4 . 2 / 1 . 4 . 2 . 3 / 1 . 4 . 3 . 2

And for the same reason there will be 6 different changes when 2 begins the order, and as many when 3 and 4 begin the order; which, in all, is $24 = 1 \times 2 \times 3 \times 4$. And by this method of proceeding it may be made evident, that 5 things admit of 120 several variations or changes, and 6 things of 720.

Thus, if it be required, in how many different ways seven persons may be placed at table, the answer is $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 = 5040$. The following table will shew the several variations and changes of any number of things up to 12.

The number of things to be varied.	How the variations are produced.	The different variations each of the proposed numbers can admit of.
1........	1 × 1	= 1
2........	1 × 2	= 2
3........	2 × 3	= 6
4........	6 × 4	= 24
5........	24 × 5	= 120
6........	120 × 6	= 720
7........	720 × 7	= 5040
8........	5040 × 8	= 40320
9........	40320 × 9	= 362880
10........	362880 × 10	= 3628800
11........	3628800 × 11	= 39916800
12........	39916800 × 12	= 479001600

They may thus be continued on to any assigned number. Suppose to 24, the number of letters in the alphabet, which will admit of 620448401733239439360000 several variations.

Since on 12 bells there would be, by the table, 479001600 changes: suppose 10 changes to be rung in a minute, that is 10×12, or 120 strokes in a minute, it would even then require upwards of 90 years to ring over all the changes on the 12 bells.

CHANGES *of quantities*, in algebra, the same with what is otherwise called combination. See COMBINATION.

CHANNEL, in hydrography, the deepest part of a river, harbour, strait, &c. which is most convenient for the track of shipping, also an arm of the sea running between an island and the main or continent, as the British Channel.

CHAOS, in natural history, a genus of insects, belonging to the order Zoophyta. The body has no covering; no joints; no external organs of sensation. There are five species, most obtained by fusion of different vegetables in water, and seen only by the aid of the microscope.

CHAPLAIN, an ecclesiastic, who officiates in a chapel. The King of Great Britain hath forty-eight chaplains in ordinary, usually eminent doctors in divinity, who wait four each month, preach in the chapel, read the service to the family, and to the King in his private oratory, and say grace in the absence of the clerk of the closet. Besides, there are twenty-four chaplains at Whitehall, fellows of Oxford or Cambridge, who preach in their turns, and are allowed thirty pounds *per annum* each. According to a statute of Henry VIII. the persons vested with a power of retaining chaplains, together with the number each is allowed to qualify, is as follows: an archbishop, eight; a duke or bishop, six; marquis or earl, five; viscount, four; baron, knight of the garter, or lord chancellor, three; a duchess, marchioness, countess, baroness, the treasurer and comptroller of the king's house, clerk of the closet, the king's secretary, dean of the chapel, almoner and master of the rolls, each of them two; chief justice of the King's Bench, and warden of the Cinque Ports, each one. All these chaplains may purchase a license or dispensation, and take two benefices with cure of souls. A chaplain must be retained by letters testimonial under hand and seal; for it is not sufficient that he serve as chaplain in the family.

CHAPLET, in architecture, a small ornament, carved into round beads, pearls, olives, and pater-nosters, as is frequently done in baguettes.

CHAPPE, in heraldry, the dividing an escutcheon by lines drawn from the centre of the upper edge to the angles below into three parts, the sections on the sides being of a different metal or colour from the rest.

CHAPTER, in ecclesiastical policy, a society or community of ecclesiastics belonging to a cathedral or collegiate church.

It was in the eighth century that the body of canons began to be called a chapter. The chapter of the canons of a cathedral were a standing council to the bishop, and, during the vacancy of the see, had the jurisdiction of the diocese. In the earlier ages, the bishop was head of the chapter; afterwards abbots and other dignitaries, as deans, provosts, treasurers, &c. were preferred to this distinction. The deans and chapters had the privilege of choosing the bishops in England, but Henry VIII. got this power vested in the crown; and as the same prince expelled the monks from the cathedrals, and placed secular canons in their room, those he thus regulated were called deans and chapters of the new foundation; such are, Canterbury, Winchester, Ely, Carlisle, &c.

CHARA, in botany, a genus of the Monoecia Monandria class and order. Natural order of Inundatæ. Naiades, Jussieu. Essential character: male calyx and corolla none; anther before the germ, underneath. Female, calyx four-leaved; corolla none; stigmas five-cleft; seed one. There are four species, of which C. tomentosa, brittle chara, or stone wort, is always flesh-coloured when alive, and when dry it becomes ash-coloured; stem twisted, brittle, and gritty in the mouth, like coralline; low and creeping in marshes where there is little water. In summer, this plant abounds in oblong berries, growing yellow when ripe, having small black seeds in them. It is an annual, flowering from June to October.

CHARACTER, in a general sense, denotes any mark whatever, serving to represent either things or ideas; thus, letters are characters, types, or marks of certain sounds; words, of ideas, &c.

Characters are of infinite advantage in almost all sciences, for conveying in the most concise and expressive manner an author's meaning; however, such a multiplicity of them, as we find used by different nations, must be allowed to be a very considerable obstacle to the improvement of knowledge; several authors have therefore attempted to establish characters that should be universal, and which each nation might read in their own language; and, consequently, which should be real, not nominal or arbitrary, but expressive of things themselves; thus, the universal character for a horse would be read by an Englishman *horse*, by a Frenchman *cheval*, by the Latins *equus*, by the Greeks, ιππος, &c.

The first who made any attempts for an universal character in Europe were, Bishop Wilkins and Dalgarme: Mr. Leibnitz also turned his thoughts that way; and Mr. Lodwic, in the Philosophical Transactions, gives a plan of an universal character, which was to contain an enumeration of all such single sounds as are used in any language. The advantages he proposed to derive from this character were, that people would be enabled to pronounce truly and readily any language that should be pronounced in their hearing; and lastly, that this character would serve as a standard to perpetuate the sounds of every language whatsoever.

CHARACTER is also used, in several of the arts, for a symbol, contrived for the more concise and immediate conveyance of the knowledge of things. We shall here subjoin the principal of them.

Characters *used in Algebra and Arithmetic.*

a, b, c, d, &c. the first letters of the alphabet, are the characters of given quantities; and *z, y, x,* &c. the last letters, are the characters of quantities sought. See the article Algebra.

m, n, r, s, t, &c. are characters of indeterminate exponents both of ratios and of powers: thus, x^m, y^n, z^r, &c. denote undetermined powers of different kinds; $m\,x$, $n\,y$, $r\,z$, different multiples or submultiples of the quantities *x, y, z,* according as *m, n, r,* are either whole numbers or fractions.

$+$ is the sign of the real existence of the quantity it stands before, and is called an affirmative or positive sign. It is also the mark of addition, and is read plus, or more; thus $a + b$, or $3 + 5$, implies *a* is added to *b*, or 3 added to 5.

— before a single quantity is the sign of negation or negative existence, shewing the quantity to which it is prefixed to be less than nothing. But between quantities, it is the sign of subtraction, and is read minus, or less; thus, $a - b$, or $8 - 4$, implies *b* subtracted from *a*, or 8 after 4 has been subtracted.

$=$ is the sign of equality, though Des Cartes and some others use this mark ∝; thus, $a = b$ signifies that *a* is equal to *b*. Wolfius and some others use the mark $=$ for the indentity of ratios.

$\times$ is the sign of multiplication; shewing that the quantities on each side the same are to be multiplied by one another, as $a \times b$ is to be read *a* multiplied into *b*; 4×8, the product of 4 multiplied into 8. Wolfius and others make the sign of multiplication a dot between the two factors; thus, 5 . 4 signifies the product of 5 and 4. In algebra the sign is commonly omitted, and the two quantities put together; thus *b d* expresses the product of *b* and *d*. When one or both of the factors are compounded of several letters, they are distinguished by a line drawn over them; thus, the factum of $a + b - c$ into *d*, is wrote $d \times \overline{a + b - c}$.) Leibnitz, Wolfius, and others, distinguish the compound factors by including them in a parenthesis; thus $(a + b - c\ d.)$

$\div$ is the sign of division; thus, $a \div b$ denotes the quantity *a* to be divided by *b*. In algebra the quotient is often expressed like a fraction; thus, $\frac{a}{b}$ denotes the quotient of *a* divided by *b*. Wolfius makes the sign of division two dots; thus, 12 : 4 denotes the quotient of 12 divided by $4 = 3$. If either the divisor or dividend, or both, be composed of several letters, for example, $a + b \div c$, instead of writing the quotient like a fraction, $\frac{a+b}{c}$, Wolfius includes the compound quantities in a parenthesis; thus, $(a + b) : c$.

⊚ is the character of involution: ɑu is the character of evolution.

7 or ⊏ are signs of majority; thus *a* 7 *b* expresses that *a* is greater than *b*.

∠ or ⊐ are signs of minority; and when we would denote that *a* is less than *b*, we write *a* ∠ *b*, or *a* ⊐ *b*.

∽ is the character of similitude used by Wolfius, Leibnitz, and others: it is used in other authors for the difference between two quantities, while it is unknown which is the greater of the two.

:: is the mark of geometrical proportion disjunct, and is usually placed between two pair of equal ratios, as 3 : 6 :: 4 : 8, shews that 3 is to 6 as 4 is to 8.

∺ the mark of geometrical proportion continued, implies the ratio to be still carried on without interruption, as, 2, 4, 8, 16, 32, 64 ∺ are in the same uninterrupted proportion.

$\surd$ is the character of radicality, and shews, according to the index of the power that is set over it, or after it, that the square, cube, or other root, is extracted, or to be extracted; thus, $\surd 16$, or $\surd^2 16$, or $\surd (2)\ 16$, is the square root of 16, $\sqrt[3]{25}$, the cube root of 25, &c. This character sometimes affects several quantities, distinguished by a line drawn over them; thus $\surd\,\overline{b + d}$ denotes the sum of the square roots of *b* and *d*. When any term or terms of an equation are wanting, they are generally supplied by one or more asterisms; thus, in the equation

$$\left.\begin{matrix} y^2 + py + \frac{1}{4}p^2 + q \\ - py - \frac{1}{2}p^2 \end{matrix}\right\} = 0,$$ the term $\pm\, py$ vanishing is marked with an asterism, as $y^2 * - \frac{1}{4}p^2 + q$.

Characters used in astronomy.

Characters of the planets.

♄ Saturn	☉ Sun	☾ Moon
♃ Jupiter	♀ Venus	⊕ Earth
♂ Mars	☿ Mercury.	

Of the signs.

♈ Aries	♌ Leo	♐ Sagittarius
♉ Taurus	♍ Virgo	♑ Capricornus
♊ Gemini	♎ Libra	♒ Aquarius
♋ Cancer	♏ Scorpio	♓ Pisces.

Of the aspect.

☌ or S. Conjunction	△ Trine
SS. Semisextile	Bq. Biquintile
✱ Sextile	Vc. Quincunx
Q. Quintile	☍ Opposition
□ Quartile	☊ Dragon's head
Td. Tredecile	☋ Dragon's tail.

Of time.

A. M. *ante meridiem*, before the sun comes upon the meridian.

O. or N. noon.

P. M. *post meridiem*, when the sun is past the meridian.

Characters, used in the arithmetic of infinites.

. the character of an infinitesimal or fluxion; thus $\dot{x}$, $\dot{y}$, &c. express the fluxions or differentials of the variable x and y; and two, three, or more dots denote second, third, or higher fluxions. M. Leibnitz, instead of a dot, prefixes the letter d to the variable quantity, in order to avoid the confusion of dots in the differencing of differentials. See Calculus Differentialis.

Characters in Medicine and Pharmacy.

℞ recipe	q. s. a sufficient quantity
ā, āā, or ana, of each alike	ß, or *ss*, half of any thing
℔ a pound or a pint	cong. congius, a gallon
℥ an ounce	coch. cochleare, a spoonful
ʒ a drachm	
℈ a scruple	
gr. grains	M. manipulus, a handful
P. a pugil	
P. Æ. equal quantities	q. pl. as much as you please
S. A. according to art	P. P. pulvis patrum, the Jesuit's bark.

Characters used in music, and of musical notes, with their proportions, are as follow:

character of a large	8	minim .... $\frac{1}{2}$
		crotchet .... $\frac{1}{4}$
a long	4	quaver .... $\frac{1}{8}$
a breve	2	semiquaver .... $\frac{1}{16}$
a semibreve	1	demisemiquaver $\frac{1}{32}$

♯ character of a sharp note: this character, at the beginning of a line or space, denotes that all the notes in that line are to be taken a semitone higher than in the natural series; and the same affects all the octaves above or below, though not marked: but when prefixed to any particular note, it shows that note alone to be taken a semitone higher than it would be without such character.

♭ or *b*, character of a flat note: this is the contrary to the other above, that is, a semitone lower.

♮ character of a natural note: when in a line or series of artificial notes, marked at the beginning ♭ or ♯, the natural note happens to be required, it is denoted by this character.

𝄞 character of the treble cliff.

𝄡 character of the mean cliff.

𝄢 bass cliff.

2, or $\frac{2}{4}$, or $\frac{4}{8}$, characters of common duple time: signifying the measure of two crotchets to be equal to two notes, of which four make a semibreve.

C ₵ ↀ characters that distinguish the movements of common time, the first implying slow, the second quick, and the third very quick.

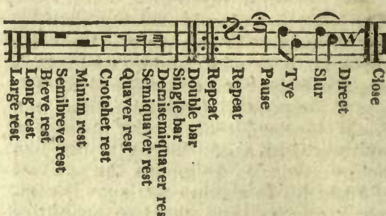
$\frac{1}{2}$, $\frac{3}{2}$, $\frac{3}{4}$, $\frac{3}{8}$, $\frac{3}{16}$, characters of simple triple time, the measure of which is equal to three semibreves, or to three minims.

$\frac{6}{4}$, or $\frac{6}{8}$, or $\frac{6}{16}$, characters of mixed triple time, where the measure is equal to six crotchets or six quavers.

$\frac{9}{4}$, or $\frac{9}{8}$, or $\frac{9}{16}$, or $\frac{9}{1}$, or $\frac{9}{2}$, characters of compound triple time.

$\frac{12}{4}$, $\frac{12}{8}$, $\frac{12}{16}$, or $\frac{12}{1}$, or $\frac{12}{2}$, characters of that species of triple time called the measure of twelve times.

Characters of the rests or pauses of time.



Characters, *numeral*, used to express numbers, are either letters or figures. The Arabic character, called also the common one, because it is used almost throughout Europe in all sorts of calculations, consists of these ten digits, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0.

The Roman numeral characters consist of seven majuscule letters of the Roman alphabet, *viz.* I, V, X, L, C, D, M. The I denotes one, V five, X ten, L fifty, C a hundred, D five hundred, and M. a thousand.

The I repeated twice makes two, II; thrice, three, III; four is expressed thus, IV. as I before V or X takes an unit from the number expressed by these letters. To express six, an I is added to a V, VI; for seven, two, VII; and for eight, three, VIII; nine is expressed by an I before X, thus, IX.

The same remark may be made of the X before L or C, except that the diminution is by tens; thus XL denotes forty, XC ninety, and LX sixty. The C before D or M diminishes each by a hundred.

The number five hundred is sometimes expressed by an I before a C inverted, thus IƆ; and instead of M, which signifies a thousand, an I is sometimes used between two C's the one direct, and the other inverted, thus CIƆ. The addition of C and Ɔ before or after, raises CIƆ by tens, thus CCIƆƆ expresses ten thousand, CCCIƆƆƆ a hundred thousand. The Romans also expressed any number of thousands by a line drawn over any numeral less than a thousand; thus, $\overline{V}$ denotes five thousand, $\overline{LX}$ sixty thousand; so likewise $\overline{M}$ is one million, $\overline{MM}$ is two millions, &c.

The Greeks had three ways of expressing numbers: first, every letter, according to its place in the alphabet, denoted a number, from α, one, to ω, twenty-four. 2. The alphabet was divided into eight units, α one, β two, γ three, &c. into eight tens, ι ten, κ twenty, λ thirty, &c. and eight hundreds, ρ one hundred, σ two hundred, τ three hundred, &c. 3. Ι stood for one, Π (πεντε) five, Δ (δεκα) ten, Η (κατον) a hundred, Χ (χιλια) a thousand, Μ (μυρια) ten thousand; and when the letter Π inclosed any of these except Ι, it showed the inclosed letter to be five times its value; as |Δ| fifty, |Η| five hundred, |Χ| five thousand, |Μ| fifty thousand.

The Hebrew numerals consisted of their alphabet divided into nine units; thus, א one, ב two, &c.: nine tens; thus, י ten, כ twenty, &c.; nine hundreds; thus, ק one hundred, ר two hundred, &c.: and ך five hundred, ם six hundred, ן seven hundred, ף eight hundred, ץ nine hundred. They expressed thousands by the word אלף, with the other numerals prefixed to signify the number of thousands: thus, אלףם, two thousand, גאלףים, three thousand.

Characters upon tomb-stones.

S. V. Siste viator, *i. e.* Stop traveller.

M. S. Memoriæ sacrum, *i. e.* Sacred to the memory.

Character, in law, if a person apply to another for the character of a third person, and a good character as to his solvency be given, yet if, in consequence of this opinion, the party asking the question suffer loss through the person's insolvency, no action lies against him who gave the character, if it were fairly given. But if a man assert what he knows to be false, and thereby draws his neighbour into a loss, it is actionable. But if the party giving credit also knew that the party credited was in bad circumstances, an action will not lie.

Characters, in botany, the description of the genera of plants, so termed by Linnæus; hence the generic character of any plant, and the definition of the genus, are synonymous terms. The term character is not extended by that author to the species of plants, because he never gives the complete description of any species; but only enumerates those characters or circumstances in which it differs from all the other species of the same genus. This observation sufficiently illustrates the different methods which are observed in the Genera and Species Plantarum. In the former work, all the parts of the flower and fruit from which the characters of the genera are derived are accurately and completely described; in the latter, such striking circumstances only of the stem, leaves, buds, roots, &c. are mentioned, as sufficiently distinguish the species in question from every other of that genus to which it belongs.

In general, characters, or characteristical marks, according to the idea of systematic writers, are certain external signs, obvious in the appearance of natural bodies, by means of which they are distinguished from one another. These signs being collected, and expressed by proper words, lay the foundation at once for definition, distribution, and denomination, the three grand parts of practical botany. The characteristic mark of each genus is to be fixed from the figure, situation, connection, number, and proportion of all the parts. Any part of a body, considered either in itself or with relation to others, is found to possess all the properties just enumerated. Characters, therefore, may be drawn from all the parts, to define the difference of bodies; thus the leaf, stem, flower, and its parts, in plants; the foot, wing, fin, in animals; all differ in their figure, situation, number, and proportion, and exhibit characters proper for distinction. Experience shows that one part, or property of a part, varies more than another; in constituting a method, therefore, those parts and properties are to be selected which vary least. Thus the parts of flowers in vegetables, the feet, fins, beaks, in animals, are more fixed, with respect to the above mentioned properties. Again, the figure and number of these parts are more apt to vary than their situation, connection, and proportion; the characters, therefore, are, if possible, to be taken from these last.

Artificial character.—The artificial character, otherwise called accidental, and, by Linnæus, factitious, is drawn indiscriminately from different parts of the plant, and admits of fewer or more characteristical marks than are absolutely necessary for distinguishing the classes, genera, and species. Linnæus, who particularly applies all the characters just enumerated to the distribution of the genera, establishes for a criterion of the artificial character, that it can never distinguish the genera in a natural order; being calculated merely for discriminating such as arrange themselves under the same artificial order. To the head of artificial characters is referred, by Linnæus, the description of the genera, in the methods of Tournefort, Ray, Rivinus, Boerhaave, and most of the other systematic botanists. The classical characters only, in the sexual method, are deemed artificial: the generical, as exhausting the description of the parts of fructification, its author considers as true natural characters.

Linnæus's idea of an artificial character is well expressed by Ray, when he says, that no more characteristical marks of the genera are to be collected, than are found absolutely necessary for determining the genus with certainty and precision.

Essential character.—The essential character discriminates one plant from another by means of a single mark, so striking and particular, as to distinguish the plant in which it is found from every other at first sight. It serves, says Linnæus, to distinguish such genera as arrange themselves under the same natural order. The essential character of the classes and genera, by the consent of all the modern systematic botanists, ought to be drawn from one of the seven parts of fructification; that of the species from any of the other parts, as the stem, leaf, root, buds, &c.

Natural character.—This character includes the two former, and collects all the possible marks of plants. It is useful, says Linnæus, in every method; lays the foundation of the systems; remains unchanged, although new genera be daily discovered; and is capable of emendation by the detection of new species alone, which afford an opportunity of excluding such characteristical marks as are totally superfluous. He adds, that the Genera Plantarum first introduced these characters into the science.

CHARADRIUS, or the *plover*, in natural history, a genus of birds of the order Grallæ. Generic character: bill straight, and in general about the length of the head; nostrils linear; three toes, and all placed forward. There are twenty-six species, of which the most interesting are the following.

C. pluvialis, or the golden plover. This species inhabits Great Britain during the whole of the year, frequenting particularly the Grampian Hills and the mountains of the Hebrides. Their length is about ten inches and a half. They make a shrill noise like that of a whistle, by the imitation of which they are easily decoyed within reach of the gun.

C. himantopus, or long legged plover, is occasionally to be found in England, though now but rarely. It is common in Egypt, where its food consists of flies. It is most characteristically designated, as the length of its legs is most extraordinary.

C. hiaticula, or ringed plover, arrives in England in the spring, and leaves it in autumn. During the summer these birds frequent the coast. They run with great rapidity, and often for a considerable time mingle short flights and rapid runnings, till at length they avoid the danger pursuing them, by retreating to some cleft or hole, or flying off completely. It is observed to use various stratagems to attract attention from its young. The female builds no nest, and lays her eggs upon the ground.

C. morinellus, or the dotterel. This species abounds in various parts of England, particularly in Cambridgeshire. They are migratory, and appear often in flocks of eight or ten. They are supposed to breed in the mountains of Cumberland, as they appear there in May, and are not seen there after the breeding season. In June they become extremely fat in Lincolnshire and Derbyshire, and are highly esteemed for their flavour and delicacy. They abound in Sweden, Russia, and Siberia, and from their extraordinary stupidity fall an easy prey to the clumsiest stratagem of the fowler. See Plate IV. Aves, fig. 4 and 5.

CHARCOAL, is wood burnt through, and suddenly extinguished by being covered with fresh earth. It is perhaps one of the most durable substances with which we are acquainted, not being decomposed either by the air or the water. It is of great use in many processes where a strong heat is required: it is an antiseptic; but very dangerous as fuel in confined places. In chemistry, the terms carbon and charcoal were long confounded, and supposed to mean the same thing; but the experiments by Morveau and others have pointed out the precise distinction. See CARBON.

When charcoal is prepared in the usual way, by exposing wood in close vessels to a red heat, it always contains a portion of hydrogen. For if a quantity of this charcoal be exposed to a strong heat in a retort of porcelain, iron, or coated glass, a great quantity of gas is obtained. The gas which comes over first is a mixture of carbonic acid and heavy inflammable gas; but the proportion of carbonic acid diminishes, and at last it ceases to come over at all; yet the inflammable gas continues as copious as ever. The evolution of these gases was long ascribed by chemists to the water which charcoal usually contains, and which it is known to absorb from the atmosphere with considerable avidity. If that were the case, the proportion of inflammable gas ought to diminish at the same rate with the carbonic acid; the hydrogen of the one being equally derived from the decomposition of water with the oxygen of the other. But as the evolution of inflammable gas continues after that of carbonic acid has ceased, it is scarcely possible to deny, that the hydrogen which thus escapes constituted a component part of the charcoal.

If, therefore, we consider the experiments of Morveau on the combustion of the diamond as decisive, we must conclude that common charcoal is composed of three ingredients, namely, carbon, hydrogen, and oxygen. It is of course a triple compound.

When common charcoal is exposed for an hour, in a close crucible, to the strongest heat of a forge, it ceases to emit gas; and no temperature is sufficient to expel gas from charcoal thus treated. Desormes and Clement have endeavoured to demonstrate, that by this treatment common charcoal is deprived of the whole of its hydrogen. The same chemists tried the combustion of charcoal obtained from a variety of other substances exposed to the heat of a forge, as pitcoal, animal substances, and various vegetable substances, and found the products exactly the same. Hence they conclude that charcoal is in all cases the same, provided it be exposed to a heat strong enough; and they conclude too, that by this strong heat the whole hydrogen of common charcoal is expelled.

These facts enable us to conclude, that there are two species of charcoal, namely, common and prepared charcoal. The first contains three ingredients, carbon, hydrogen, and oxygen; the second is deprived of a portion of its hydrogen and oxygen. It consists chiefly of carbon and oxygen united; but it still retains a small portion of hydrogen, and is not, therefore, strictly speaking, a pure oxyde of carbon, though it approaches very nearly to such an oxide.

CHARGE, in gunnery, the quantity of gunpowder and ball wherewith a gun is loaded for execution. The rule for charging large pieces in war are, that the piece be first cleaned or scoured withinside: that the proper quantity of powder be next driven in and rammed down; care however being taken, that the powder in ramming be not bruised, because that weakens its effect: that a little quantity of paper, hay, lint, or the like, be rammed over it, and that the ball or shot be intruded. If the ball be red-hot, a tampion or trencher of green wood, is to be driven in before it. The weight of the powder necessary for a charge is commonly in a subduple proportion to that of the ball.

CHARGE, in heraldry, is applied to the figures represented on the escutcheon, by which the bearers are distinguished from one another; and it is to be observed, that too many charges are not so honourable as fewer.

CHARGED, in heraldry, a shield carrying some impress or figure, is said to be charged therewith; so also when one bearing, or charge, has another figure added upon it, it is properly said to be charged.

CHART, or *hydrographical map*, in navigation, is a representation, in plano, of a part, or of the whole, of the water on the surface of the globe, and the adjacent coast. There are various kinds of charts, as Globular, Plane, Mercator's, &c.

CHART, *globular*, is a projection, so called from the conformity it bears to the globe itself. This projection was proposed by Senex, in which the meridians are inclined, the parallels equidistant and curvilinear, and the rhomb-lines real spirals, as on the surface of the globe. From this last property, it is evident it can be of very little use in navigation; as a map, however, it has its advantages.

Construction of Charts.

1. *Of the plane chart.*—The number of degrees of latitude which the chart is intended to contain, and the extent from east to west being fixed upon, a line is to be drawn near the side or end of a sheet of paper, in length equal to the whole length of the chart from north to south; and this line is to be divided into degrees, and numbered accordingly. From each end of this line perpendiculars are to be drawn, and made equal to the intended extent of the chart from east to west, and their extremities are to be joined by a straight line. If the chart is to commence at or near the equator, and to extend only a few degrees of latitude, the divisions of the parallels may be equal to those of the meridian; but if the chart begins at any considerable distance from the equator, it will conduce to accuracy, to make the length of each degree of the parallel equal to the co-sine of the mean latitude, the radius being 60 minutes; or the extreme parallels may be divided according to the above proportion, and in that case it will become a reduced chart. Meridians and parallels are there to be drawn at convenient distances.

A scale is now to be made of stiff paper or pasteboard, equal in length to the extent of the chart from east to west, and divided and numbered accordingly. By this scale, the positions of those places contained within the limits of the chart are very easily laid down, by placing the divided edge of the scale over the latitude of the given place; and under the given longitude, a mark being made will represent the position of the place on the chart.

A compass is to be inserted in any convenient place of the chart, an arrow shewing the direction of the flood tide or current. The times of high water at full and change are to be marked in their proper places, expressed in Roman characters; sounding and quality of the ground at bottom, the leading marks to avoid dangers, &c.

II. *Of a Mercator's chart.*—A Mercator's chart, for any given portion of the surface of the globe, is constructed as follows: the limit of the proposed chart is first to be determined; that is, the number of degrees of latitude and longitude which it is to contain, and the degree of latitude and longitude of its commencement. Find the meridional parts answering to each degree of latitude, within the intended limits of the chart, and take the difference between each, and that corresponding to the least degree of latitude in the chart; and reduce these differences to degrees by dividing by 60.

A parallel, representing that of the least latitude, is to be drawn; upon which the number of degrees in the proposed difference of longitude, from a scale of equal parts, is to be laid off, and divided into degrees, and smaller portions of, if convenient, and numbered at each fifth or tenth degree. From each end of this parallel a perpendicular is to be drawn, and made equal to the difference of the meridional parts of the extreme latitudes taken from the divided parallel; and the ends of these meridians are to be joined by a straight line, which will represent the other extreme parallel, and which is to be divided and numbered in the same manner as the first drawn parallel; the meridians are then to be divided into degrees, and numbered at every fifth or tenth degree. Take the meridional difference of latitude between the beginning of the chart, and the next fifth or tenth degree of latitude from the divided parallel, and lay it off from the first parallel on each of the scale meridians, and join these points by a straight line. In like manner the meridional difference of latitude, answering to each successive interval of five or ten degrees, is to be taken from the first drawn parallel and laid off, and the corresponding parallels are to be drawn and numbered accordingly, and the intermediate spaces are to be subdivided. If the chart is upon a large scale, the meridional difference of latitude answering to each degree is to be laid off from the least parallel.

If the chart is intended to be upon a larger scale, equi-multiples of the intervals are to be taken, such as will answer to the proposed extent of the chart. A slip of strong paper is to be divided, and numbered in the same manner as the first drawn parallel. Now each place within the limits of the chart is to be laid down, by placing the slip of paper so, that its extreme points of division may be at the latitude of the given place on each meridian; then, under the longitude of the place, a mark is to be made, which will represent the position of that place. In like manner all the places on the coast are to be laid down and connected by observations made on the coast: or if no sketch had been previously made, the contour of the coast is to be drawn agreeable to the best charts. Meridians and parallels are to be drawn through every fifth or tenth degree of latitude and longitude, and extended to the coast.

A compass is to be inserted in some convenient part of the chart, and the points extended to the land: an anchor is to be drawn where there is good anchoring ground, and in places where it is safe only to stop a tide, an anchor without a stock is to be laid down. The soundings, the quality of the ground, the times of high water at full and change, &c. are to be marked in their proper places.

Charts, *manner of using.*—The principal use of a chart is, to find the course and distance between any two places within its limits, and to lay down the place of a ship on it, so that the position of the ship with respect to the intended port, the adjacent land, islands, &c. may be readily perceived.

To find the latitude of a place on the chart.

Rule.—Take the nearest distance between the given place and the nearest parallel of latitude, which being applied the same way on the divided meridian, from the point of intersection of the parallel and meridian, will give the latitude of the proposed place.

Example.—Required the latitude of Port Louis, in the isle of France. The least distance between Port Louis and the nearest parallel, being laid the same way on the meridian, from the extremity of that parallel, will reach to 20° 8′ S., the latitude required.

To find the course and distance between two given places on the chart.

Rule.—Lay the edge of a scale over the given places, and take the nearest distance between the centre of any of the compasses on the chart and the edge of the scale; move this extent along, so as one point of the compass may touch the edge of the scale, and the straight line joining the points may be perpendicular thereto; then will the other point shew the course; and the interval between the places being applied to the scale will give the required distance.

Example.—Required the course and distance from Cape St. André to Cape St. Sebastian, both in the island of Madagascar. The edge of a scale being laid over the two places, then, by moving the compass as directed, the course will be found to be N. E. ½ E., and the interval between them will measure 105 leagues.

The course and distance sailed from a known place being given, to find the ship's place on the Chart.

Rule.—Lay the edge of a scale over the place sailed from, parallel to the given course; then take the given distance from the scale on the chart, and lay it off from the given place by the edge of the scale, and it will give the point on the chart representing the place on the ship.

Example.—The correct course of a ship from Cape St. Maria, on the north side the entrance of the river La Plata, was N. E. by E. and the distance 238 leagues. Required the place of the ship on the chart. The edge of the scale being laid over Cape St. Maria, in a N. E. by E. direction, and the distance 238 leagues, laid off from Cape St. Maria by the edge of the scale, will give the place of the ship, which will be found to be in the latitude 28° 15′ S.

To find the longitude of a place on the Chart.

Rule.—Take the least distance between the given place and the nearest meridian, which being laid off on the equator, or divided parallel, from the point of intersection of the parallel and meridian, will give its longitude.

Example.—Required the longitude of Funchal in the island of Madeira. The least distance being taken between Funchal and the nearest meridian, and laid off from the intersection of that meridian with the divided parallel, will give 17° 6′ W., the longitude required.

To find the distance between two given places on the Chart.

1. When the given places are under the same meridian.

Rule.—Find the latitude of each; then the difference or sum of their latitudes, according as they are on the same, or on opposite sides of the equator, will be the distance required.

Example.—Required the distance between the nearest extremities of the islands of Grenada and Guadaloupe.

Latitude of southermost extremity of Guadaloupe	15° 52′ N.
Latitude of northermost extremity of Grenada - -	12° 14′ N.
Distance - - - - - -	3° 38′ = 218 M.

2. When the given places are under the same parallel.

Rule.—If that parallel is the equator, the difference, or sum of their longitudes is the distance between them. If not, take half the interval between the given places, lay it off on the meridian on each side of the given parallel, and the intercepted degrees will be the distance between the places. If the given parallel is near the north or south extremity of the chart, the following method may be used. Take an extent of a few degrees from that part of the meridian where the given parallel is the middle of the extent; then the number of extents, and parts of an extent, contained between the given places, being multiplied by the length of an extent, will give the required distance.

Example.—Required the distance between Cape Canton and Funchal, both lying nearly in the same parallel. By proceeding as directed above, the distance will be found to be 6° 44′, or 404 miles.

3. When the given places differ both in latitude and longitude.

Rule.—Find the difference of latitude between the given places, and take it from the equator or graduated parallel; then lay the edge of a scale over the given places, and move or slide one point of the compass along the edge of the scale, until the other point just touches a parallel. Now, the distance between the place where the point of the compass rested, and the point of intersection of the edge of the scale and parallel being applied to the equator, or divided parallel, will give the distance between the places in degrees and parts of a degree; which, multiplied by 60, will give the distance in miles.

Example.—Required the distance between Cape Finisterre and Porto Santo.

Take the difference of latitude between the given places, *viz.* 9° 54′, from the graduated parallel, and move one point of the compass along the edge of the scale, laid previously over these places, until the other point just touches a parallel: now the interval between the place where the point of the compass rested, and the point of intersection of the scale, and parallel, being applied to the divided parallel, will measure 11° 24′, or 684 miles.

CHARTA, *magna*, an ancient instrument, containing several privileges and liberties granted to the church and state by Edward the Confessor, together with others relating to the feudal laws of William the Conqueror, granted by Henry I. all confirmed by the succeeding princes. See Magna Charta.

CHARTER, in law, a written instrument or evidence of things acted between one person and another.

Charter-*party*, is a contract under hand and seal, executed by the freighter and the master or owner of the ship, containing the terms upon which the ship is hired to freight; the masters and owners usually bind themselves, the ship, tackle, and furniture, that the goods freighted shall be delivered (dangers of the sea excepted) well conditioned, at the place of the discharge; and they also covenant to provide mariners, tackle, &c. and to equip the ship complete and adequate to the voyage. The freighter stipulates to pay the consideration money for the freight; and penalties are annexed to enforce the reciprocal covenants. A charter-party is the same in the civil law as an indenture at common law: and is distinguished from a bill of lading, inasmuch as the former adjusts the term of the freight, and the latter ascertains the contents of the cargo.

Charters *of community*, were certain privileges, first obtained by violence or purchase, and afterwards freely bestowed by emperors, kings, and barons; whereby the inhabitants of towns and cities were enfranchised, all marks of servitude abolished, and these cities, &c. were formed into corporations and bodies politic, to be governed by a council and magistrates of their own nomination. The first person who conferred these privileges was Lewis the Gross in France, about the beginning of the twelfth century; and his example was soon very generally followed. These charters convey a very striking representation of the wretched condition of cities previous to the institution of communities, when they were subject to the judges appointed by the superior lords, of whom they held, and had scarcely any other law but their will.

Charter *of the forest*, is that wherein the laws of the forest are comprised and established. In the time of King John, and that of his son, Henry III. the rigours of the feudal tenures and the forest laws were so warmly maintained, that they occasioned many insurrections of the barons or principal feudatories, which at last produced this effect, that first King John, and afterwards his son, consented to the two famous charters of English liberties, *Magna Carta*, and *Carta de Foresta*. The latter, in particular, was well calculated to redress many grievances and encroachments of the crown, in the execution of forest law. This charter, as well as the other, was established, confirmed, and settled, in the reign of Edward I.

Charter *governments of the British colonies*, are in the nature of civil corporations, with the power of making by-laws for their own interior regulation, not contrary to the laws of England; and with such rights and authorities as are specially given them in their several charters of incorporation. The form of government is borrowed from that of England. They have a governor named by the King, (or in some proprietary colonies by the proprietor,) who is his representative or deputy. They have courts of justice of their own, from whose decision an appeal (as some say, in the nature of a reference by way of arbitration) lies to the King in council in England. Their general Assemblies, which are their House of Commons, together with their Council of State, being their Upper House, with the concurrence of the King, or his representative the Governor, make laws suited to their own emergencies. But it is particularly declared, by stat. 7 and 8 William III. c. 22. that all laws, by-laws, usages, and customs, which shall be in practice in any of the plantations, repugnant to any law made, or to be made, in the kingdom of Great Britain, relative to the said plantations, shall be utterly void and of none effect.

Cheat, in law, is one who defrauds, or endeavours to defraud another of his known right, by means of some artful device, contrary to the plain rules of common honesty. By the 30 Geo. II. all persons, who, knowingly or designedly, by false pretence or pretences, shall obtain from any person, money, goods, wares, or merchandises, with intent to cheat or defraud any person of the same, or shall knowingly tender or deliver any letter or writing, with or without a name subscribed thereto, or signed with a fictitious name, threatening to accuse any person of a crime punishable by law with death, transportation, pillory, or other infamous punishment, with intent to extort from him any money, or other goods, shall be deemed offenders against law and the public peace; and the court, before whom any such offender shall be tried, shall, on conviction, order him to be fined and imprisoned, or be put in the pillory, or publicly whipped, or to be transported for seven years.

CHECK, or Check *roll*, a roll or book, wherein is contained the names of such persons as are attendants and in pay to the King, or other great personages, as their household servants.

CHECKS, or *drafts on bankers*, are instruments, by means of which a creditor may assign to a third person, not originally party to the contract, the legal as well as equitable interest in a debt raised by it, so as to vest in such an assignee a right of action against the original debtor. These instruments are uniformly made payable to bearer, which constitutes a characteristic difference between them and bills of exchange; and the legislature has considered them in a more favourable point of view, by exempting them from the stamp duties. They are equally negotiable with bills. When given in payment, they are considered as cash; and, it is said, may be declared upon as a bill of exchange; and the moment this resemblance begins, they are governed by the same principles of law as bills of exchange. Checks payable on demand, or when no time of payment is expressed, are payable on presentment, without any indulgence or days of grace; but the presentment should be made within a reasonable time after the receipt, otherwise the party upon whom the check is drawn will not be responsible, and the person from whom the holder received it will be discharged. Therefore, where circumstances will allow of it, it is advisable for the holder of a check to present it on the same day it is received.

CHECKY, in heraldry, is when the shield, or a part thereof, as a bordure, &c. is chequered, or divided into chequers or squares, in the manner of a chess-board.

CHEEK, in anatomy, that part of the face situated below the eyes, on each side. See Anatomy.

Cheeks, among mechanics, are almost all those pieces of their machines and instruments that are double, and perfectly alike; as the cheeks of a mortar, which are made of strong wooden planks, of a semicircular form, bound with thick plates of iron, and fixed to the bed with four bolts; these cheeks rise on each side the mortar, and serve to keep it at what elevation is given it: the cheeks of a printing-press are its two principal pieces placed perpendicular and parallel to each other, and serving to sustain the three sommers, &c.

Cheeks, in ship-building, two pieces of timber, fitted on each side of the mast, at the top, serving to strengthen the mast there, and having holes in them, called hounds, through which the ties run to hoist the yards.

CHEESE is made from the curd formed by mixing rennet with milk, the quality of the cheese depending on that of the milk used on the occasion. Various processes are recommended, but to detail them would be a voluminous task; we shall, however, state, in as few words as the subject will admit, how cheese is usually made. The milk being previously warmed, is turned, by the mixture of rennet, into an apparently solid mass. This being cut across with a brass knife, (for iron is supposed by many to give a bad flavour,) occasions the curd to separate from the whey: the latter is given to pigs, or is sold as a beverage, while the former is put into a press made for the purpose, and all the whey is completely separated, falling through holes in the bottom of the press; while the curd is kept in by a coarse kind of cloth made principally for that purpose. The curd must be repeatedly cut into minute squares, and be as often subjected to the press. When mixed for the last time, salt is added: and if any colour is to be given, a small quantity of annatto, or other colouring matter, is put in; though this is sometimes done in the early stages of the manufacture. Many put in sage-leaves, or mix plain and various-coloured curds together, according to fancy; the goodness of the cheese will, however, always depend on the richness of the milk. When the cheese has been kept a proper time in the mould and will bear handling, it is taken out, and put on a shelf; carefully turning it every day, so that it may be dried alike; it is next rubbed with green nettles, &c. and by some with salt, under the opinion that these help to ripen it. Every county has some favourite recipe for the operation, and all alike claim the palm of pre-eminence: we may, perhaps, be correct in saying, that in each there are both excellent and execrable cheeses made. Cheshire, Gloucester, Wiltshire, and Stilton, seem to be the most approved, while, on the other hand, that made in Suffolk, being usually from skimmed or flitted milk, and, consequently, deprived of all the butyrous part, is considered proverbially poor.

As an article of diet, cheese cannot, on the whole, be accounted nourishing: that which is old, crumbling, and rich, is assuredly a powerful aid to digestion, and has been given with great success in cases where children have ate incautiously of crude fruits; but such as is dry, and of a sour taste, may be justly ranked among the minor poisons. The rennet which is used for turning the milk is nothing more than the stomach of a young calf, or of a pig, in which the gastric juices are preserved, by means of a handful or two of salt. A very small quantity of this preparation will suffice to many gallons of milk; and as the rennet-bag, as it is called, may be emptied, it may be once or twice replenished, though the liquor will not be so strong. Some dry the rennet-bag, after having been thus used, and throw a piece in to turn the milk. See Milk.

CHEIRANTHUS, in botany, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ (Cruciformes. Essential character: germ with a glandulous toothlet on each side; calyx closed, with two leaflets, gibbous at the base; seeds flat. There are twenty-two species, of which C. cheiri, common wall-flower, is about a foot high, with a woody stem; on walls it is seldom more than eight inches, with very tough roots and firm stalks; the leaves short and sharp-pointed; the flowers are well known, being one of those which have been cultivated for their fragrancy time immemorial in our gardens. C. incanus, stock gilliflower, is nearly the same height, shrubby, with spear-shaped leaves, which are frequently waved on their edges, and turn downward at the extremity; the side branches are each terminated by a loose spike of flowers, each having a woolly calyx, and four large roundish petals, indented at the end. These usually appear in May and June. The flowers of this sort vary in their colour; some are pale, and others of a deep red; the latter are generally most esteemed. If the seed be well chosen, frequently three parts in four of the plants will be doubled. C. annuus, annual stock gilliflower, or ten-week stock, is two feet high, with a round, smooth, stalk, dividing into many branches at top. The flowers are produced in loose spikes at the ends of the branches, and are placed alternately; the calyx is large, erect, and slightly cut into several acute parts at the top; the petals are large and heart-shaped. Of this sort there are, the red, purple, white, and striped; which are great ornaments in the borders of the flower garden in autumn.

CHELIDONIUM, in botany, a genus of the polyandria Monogynia class and order. Natural order of Rhœadeæ. Essential character: corolla four-petalled; calyx two-leaved; silique one-celled, linear. There are five species, of which C majus, common or great celandine, is from a foot to eighteen inches in height; cylindric, and a little hairy. The juice of the whole plant is saffron-coloured. It approaches to the class Tetradynamia in the cruciform shape of the corolla, and its silique, which, however, differs essentially in being one-celled. It is common in hedges, shady places, and uncultivated grounds, flowering from May to July. This species is naturalized in the United States, and its yellow proper juice is esteemed by the vulgar as efficacious in curing warts.

CHELONE, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Bignoniæ, Jussieu. Essential character: calyx five-parted; rudiment of a fifth filament between the upper stamens, capsule two-celled. There are five species, of which two, viz. C. glabra, white chelone, and C. obliqua, or rose-coloured snake head, grow naturally in most parts of North America. These species are about two feet high, with two leaves at each joint, standing opposite, without foot stalks. The flowers grow in a close spike at the end of the stalk, and have but one petal, which is tubular, and narrow at the bottom, something like the fox-glove flower.

CHELSEA *hospital*, a noble edifice, which was built by Charles II. on his restoration, and afterwards improved by his successor James II. Non-commissioned officers and private men, who have been wounded or maimed in the service, are entitled to the benefit of this hospital. There are in and out-pensioners belonging to the establishment, and the provisions of it extend to the militia under the following restrictions: serjeants who have served fifteen years, and corporals or drummers who have served twenty, may be recommended to the bounty. Sergeants on the establishment may likewise receive that allowance, with their pay in the militia. But serjeants, who have been appointed subsequent to the passing of the 26th of George III. are not entitled to it under twenty years' service.

CHEMISTRY. All the changes that take place in bodies,—whether by the operation of powers not under the direction of man, which are called natural phenomena; or of the same powers, modified in their direction by the exercise of our voluntary exertions, which constitute the processes of art,—are effected by motion. When the bodies from their size and distance from each other can be separately distinguished by our senses, the effects are referred to the division of philosophical science called mechanics: but when the minuteness of the bodies themselves, and of the spaces to which the individual actions are confined, are such that we cannot view and contemplate them separately, but are under the necessity of inferring the nature and causes of their motions from general results or phenomena, the changes are referrable to chemistry.

Chemistry, therefore, as a science, teaches us to estimate and account for the changes produced in bodies by motions of their parts, which are too minute to affect the senses individually: as an art, its practice consists in placing or applying bodies, with regard to each other, in such situations as are adapted to produce those changes.

In our investigation of the results of chemistry, we find ourselves, from the regular connection of the facts, enabled to fortel what will happen to certain bodies in certain circumstances; and the rules by which, from experience, we are capable of doing so, are called laws of nature, if they relate to bodies in general; but when they relate to particular descriptions of bodies, we form our expressions so as to refer the effects to the bodies themselves, under the name of qualities or properties. The discovery of these laws and properties must, in the first instances, be effected from the observation of natural events, and afterwards by instituting experiments for the express purpose of manifesting them. In these experiments we may either separate compounded bodies into their simpler parts, which is called analysis; or we may unite simple parts so as to form a compound body, which is called synthesis. And our reasonings concerning these facts will have a correspondent denomination. When we describe and explain the process of analysis, by which general results are deduced by separating effects from each other, the operation of the mind is distinguished by the same name; but when, from the general results, we show in what manner particular events are produced by combining bodies together, the method is distinguished by the term synthesis.

The synthetical method of teaching is undoubtedly the most luminous and clear, where the first principles or simple elements of our knowledge are known or admitted, as is the case in geometry. But in chemistry this method of teaching cannot, from our imperfect knowledge of the facts, be generally adopted, without admitting the simplicity of a variety of substances, concerning which there is just reason to doubt.

It is true, indeed, that such admissions are generally made with a previous notice or reservation of this uncertainty. But by the constant use of the supposed facts, along with others which are better established, the mind becomes habituated to mix hypothesis with facts; and the imaginary beauty of connected science must from time to time be destroyed by the appearance of new truths. The revolutions of chemical science have amply shown this; and the numerous imperfections which still remain, have left considerable latitude for the arrangement of materials in a system of chemistry. If the theory were in its commencement, a treatise on chemistry would be little more than a collection of receipts for processes; and even in the present state of the science, different authors of credit and respectability greatly differ in the disposal of their subjects. Operative chemistry usually precedes the theory in the earlier works. Some writers treat of compound bodies, and deduce their principles or component parts in the way of analysis: while others begin with the habitudes or powers by which the several changes are effected. But it must be confessed, nowithstanding the magnitude of the discoveries which have been really made, and the elevated pretensions of a few theorists, that the practical science is still in its infancy. Every one of the phenomena is sufficiently complicated as to be referrible to various topics of consideration; and to which of these in a general way our attention shall be first directed, is in many cases a matter of indifference. It appears to us that the advantages of treating the subjects in a popular way, by first attending to the general properties and habitudes of bodies, and the methods of operating upon them, and from thence proceeding to the different classes of bodies, are such as entitle this method to a preference before other arrangements, which afford a greater appearance of synthetical order.

When we have simplified our notions of the causes of change which happen to bodies under the distinction or division of chemistry, we must resolve them into two, namely, heat and attraction. Daily experience shows us that bodies may be more or less heated, and also that they adhere to each other. We are in truth unable to proceed farther in our abstractions. The causes of those well known effects have not yet been develoved by the manifestation of any more simple facts upon which they may depend. We can only observe the laws, according to which these powers have been found to act, and make our classification of the phenomena; and as it is of some utility, in directing our future researches, to make conjectures by analogy, it may also be permitted to speculate upon the causes of these primary effects, provided it be done with caution, and without that bigotry, which even in systems of philosophy has so frequently established the results of error.

Besides the effects of heat and attraction, we find that bodies are changed and modified by light, electricity, galvanism, and magnetism; the three last of which are accompanied by attraction, or repulsion. But as these are much less generally applicable in operative chemistry than the powers first mentioned, and as it seems likely that future discoveries may lead to some intimate relation, or perhaps show the identity of the cause of heat, light, and the other affections of matter, which have here engaged our attention, it is unnecessary to enlarge upon these in the present article.

The word attraction denotes the unexplained tendency which bodies have to move to each other. We observe it acting at a distance in the fall of bodies on the surface of the earth, and in the motions of the heavenly bodies, as well as in such as are affected by electricity, galvanism, or magnetism; and in the cohesion which gives solidity, or, more properly, rigidity, to bodies, as well as in those effects wherein the parts of different bodies unite to form new compounds, we deduce its effects from motions or actions, which cannot be separately distinguished. And these differences, though they cannot be shown to arise from one and the same power, or from energies originally dissimilar, require, at least for the purposes of language, to be treated apart from each other. Chemistry seems to have little to do with the perceptible attractions: it is principally confined to the state of bodies, as it relates to the cohesion and the combination of their parts.

Heat, or rather temperature, is a well known modification of bodies, by which they produce a peculiar sensation, distinguished by the same word. Its laws have been very successfully investigated by our contemporaries; for which see Caloric, Heat, and Combustion. The operative chemist considers it as the means of converting solid bodies into dense fluids, and dense fluids into elastic fluids, called gas or vapour, while compound bodies may have their parts separated from each other by this treatment.

When bodies of different kinds are brought into contact, they produce very little of the change called chemical, while they continue in the solid state. Mechanical trituration will forward their mutual action, by multiplying the surfaces of contact; but still the masses continue too large to be moved amongst each other by the peculiar attractions they may be capable of exerting. It has been considered as an axiom in chemistry, that bodies do not act on each other, unless one or both be in the fluid state; and though this is not strictly and universally true, yet it is requisite for almost every operation of chemistry, that this condition, either of dense or of elastic fluidity, should obtain. The facility with which the parts of fluids move amongst each other is, no doubt, the principal cause of this increased effect.

The practical part of chemistry may be therefore said to consist almost entirely in separating or changing the order of the parts of bodies by heat, or of placing bodies in such situations with regard to each other, as that, with the assistance of heat, if needful to produce fluidity; changes or separations of the same kind may take place among their parts. The actions of electricity, galvanism, and light, will probably be soon combined among the leading resources of chemistry.

No change could take place by this or any other treatment, if the attractions of the parts of bodies to each other were all perfectly the same. It is manifest from the facts, that the attractions between some bodies is stronger than between others, and from this remarkable variety in the habitudes of bodies, the attractions of chemistry have been called elective attractions.

A distinction has been made between those processes in which water is present, and those in which the requisite fluidity is produced by strong heat. The first method is called the humid way, and the other the dry way.

The practice of chemistry requires, in most cases of solid bodies, previous to the application of heat, or of one body to another, for the exercise of the attractions, that some mechanical means should be taken to divide their parts from each other. These are, 1, chopping or cutting; 2, rasping, filing, or shaving; 3, pulverizing or grinding; 4, granulation, as when shot is formed by pouring lead into water, or a powder of the metal is obtained by shaking it in a box, in the fused state, till it congeals; 5, elutriation, or washing, to separate the finer or lighter parts of bodies from the coarser or larger, as when earthy matters are washed from the heavier metallic ones, or when a fine powder, such as that of pounded emery, is suspended by agitation in water, which is decanted off, and then set to subside, while the coarser particles, which settle immediately, are left behind; 6, hammering, or forging, as in the making of tin foil, or leaf gold, or in the extension of other metals, whether hot or cold; 7, laminating, as when the metals are passed between steel rollers, or when wax is poured upon a wooden cylinder, turned round in cold water; and, 8, wire drawing, as when the metals are drawn through a hole in a plate to make wire, or forced through an engine, such as that employed for glazier's lead, &c.

Bodies are distinguished, with regard to heat, into fixed, volatile, and refractory. The first can scarcely, if at all, be evaporated; the second are easily raised or driven off; and the third undergo no change.

The simple application of heat is distinguished by various terms, according to the nature of the operation, or of the effects produced. These are, 1, roasting, which consists in exposing minerals to an open fire, to drive off their volatile contents; 2, calcination is the exposure of a body to strong heat, in an open vessel, till it undergoes no farther change. This word, which was formerly used in a general way, is now confined to earths and some of the salts, and is indeed seldom used; 3, oxydation is the like process with metallic bodies: 4, fusion, or melting, is the production of the state of dense fluidity; 5, cementation is a process, wherein solid bodies of different kinds, one or more of them being in powder, are exposed to heat in a vessel nearly closed, with the intention that the more volatile parts of the one may unite with the other, or its fixed parts; 6, eliquation is the exposure of a compound body, usually metallic, to heat, sufficient to fuse one of its ingredients, which runs out, and leaves the other solid and porous; 7, digestion consists in keeping bodies for a considerable time immersed in a fluid more or less heated, in order to effect some combination between them; 8, evaporation is the dissipation of a fluid by heat; 9, concentration consists in diminishing the proportion of water in any solution of saline matter, either by heating it, or by freezing the surplus water and taking out the ice; 10, when evaporation is performed in any apparatus of vessels, partly or quite closed, and the vapours, after being raised by heat in one part or vessel, are received in another sufficiently cold to condense them into the fluid state, this process is called distillation; 11, when a fluid obtained by distillation is again distilled, in order to obtain the most volatile part of the first product, this last part is said to be rectified, and the process is called rectification. This term has become nearly obsolete in scientific description, but is still retained in the arts; 12, there are many products of evaporation, which congeal, or become solid, at a temperature much higher than that of the atmosphere, and are not, therefore, obtained in the fluid, but the solid state. These usually adhere in the form of crystals to the upper part of the apparatus, and on this account, as well as because the operation does not in general require the same kind of vessel, it is distinguished by the name of sublimation, and the products themselves are called sublimates, and in some instances flowers; but these two last terms are more particularly confined to the arts. Other terms are also used, such as fusible, evaporable, &c. but their sense is manifest.

For the apparatus used in these and the other operations of chemistry, see Laboratory.

The consideration of what happens to the parts of bodies, in consequence of their elective attractions, constitutes the most difficult part of the science, whether the mind be employed in developing the facts, or in deducing the general theory which may be indicated from them. It is, therefore, necessary to consider them with some attention, and in a regular manner.

The adhesion of parts, considered to be of the same kind, is called aggregation. Thus a number of pieces of glass melted together form an aggregate: and the smallest parts into which an aggregate can be imagined to be divided, so as not to change its nature, are called integrant parts; so that the integrant parts of glass are themselves glass. But when the body is known to be made up of parts of different kinds or nature, and it is considered with regard to these, the body is called a compoond, or combination, and the parts are called component parts or principles. In this manner glass is a compound of the earth called silex, and a salt called alkali, combined together at a strong heat: and we may imagine, that if there were any means by which glass could be reduced, first to its integrant parts, and the division could be carried farther, the parts would then be no longer integrant and glass, but would become divided into component parts, namely, earth, and alkali. Bodies are also considered in a wide manner by the name of mixtures, when small aggregates of different kinds are united, as in a variety of minerals, where the parts are frequently distinguishable by the senses: and in the arts we have sand and lime made into mortar by mixture, or sand, clay, and other earths, made into pottery, and hardened by a moderate fire; but these by a stronger heat may be made to combine into glass, and are then no longer mixtures, but compounds.

The early chemists were led into a supposition, that the bodies they were unable to analyze were simple, and they distinguished them by the name of elements. It is probable that the great variety of bodies around us are formed by combination, out of a few simple principles, or perhaps out of one single element, variously combined as to figure and position of parts; but it is useless and unprofitable to speculate on probabilities, which experiment can never verify. Modern chemists, very properly, consider those bodies as simple, which have not yet been decomposed; but this is merely with relation to the present state of our knowledge, and for the sake of arrangement and induction. They do not lose sight of the necessity of instituting experiments for their farther analysis; and the great discoveries which have done honour to our own times, are a proof of their diligence and sagacity.

We do not know of any means of ascertaining, by experiment, whether compound bodies do enter as principles into other bodies still more compounded; or whether in bodies of three or more principles, all the simple particles do dispose themselves without any dependance on the order of time, according to which they may have been put together. It is probable that the former is the case, so that we may hereafter be enabled to designate primary principles, or bodies not yet decomposed; secondary principles, or bodies of two primary principles, which nevertheless can enter into combination, or be disengaged without separation from each other; ternary principles, &c. In this manner sulphur, by combining with oxygen and water, will form sulphuric acid, and this acid may be combined with a metal, so as to form a salt capable of giving out its acid again by heat. Our systematic books are written according to the supposition of secondary and more complicated principles; but the facts do not indisputably prove their existence.

When two bodies in the solid state which are disposed to combine are brought into contact, the combination will begin at the place where they touch; and if the compound be of such a nature, as that its freezing point (see Caloric) is lower than the common temperature of the bodies, it will be fluid, and the combination may proceed to the other parts of each, till the whole shall have united. Thus snow and salt will form a fluid brine, if the temperature be higher than 6° below the commencement of Fahrenheit's scale.

If a solid be united with and suspended in a fluid, the former is said to be dissolved, or in solution, and the fluid is called a solvent. In this manner water dissolves sugar or salt. Fluids in general dissolves greater quantities the higher the temperature, probably from the fluid state being promoted by heat.

Some substances unite in all proportions, such as most acids in water; but others have a limit; as, for example, water will dissolve only one-fourth of its weight of common salt. It is then said to be saturated. But chemists use the word saturation in another sense. When two principles, as, for instance, an acid and an alkali, are combined, the properties of each disappear when a due proportion of each is present; but if either of the principles exceed that proportion, the predominating property will be that of the principle which is in excess In these cases, the principles are said to be saturated when the properties are most completely balanced; but in the other cases, the principle which is defective in quantity is said to be super-saturated, or over saturated, and the other principle which is in excess, is said to be under-saturated: acids united with alkalies manifest these cases very strikingly.

In the consideration of the phenomena of chemical or elective attraction between the principles of bodies, it will be very difficult to select instances for illustration, which shall be simple, either as to the principles or the effects, because in almost every case there is a degree of complexity which obtains in nature; and even where we suppose a great simplicity of principles, they may hereafter be discovered to be compound. But the doctrine will be understood, and fixed in the memory, by the examples to be brought; in the same manner as when diagrams are used by geometricians, though the actual figures cannot strictly agree with their hypotheses or postulates.

1. The mutual action of two bodies exhibits the phenomena of simple elective attraction and rejection: when two principles are presented to each other, they may either combine or reject each other. Thus water combines with and dissolves gum, but rejects camphor; and alcohol combines with and dissolves camphor, but rejects gum.

It is probable, that all simple bodies, if insulated, would combine together, and that the phenomenon of rejection, when it takes place, is an effect of some of the compound elective attractions, upon which we shall presently speak.

When a body is suspended to saturation in a solvent, no more can be taken up or supported, because the cohesive attraction, or that of the parts of the body to each other, is stronger than that of the fluid to the same; and it is found that the power of the solvent is greater the less it is charged, until it ceases at the point of saturation. Elasticity, or the energies by which bodies are converted into gas or vapour, is likewise an opponent to solution or combination, and gives a point of saturation which may be varied, by preventing or impeding the assumption of the elastic state.

2. When three bodies or principles are

presented to each other in succession, we may conceive a variety of results, all which appear to take place in nature. Thus (*a*) they may not perceptibly unite, or (*b*) two may unite, and the third have no action, either upon them singly or when in their combination; or (*c*) all three may unite, from attractions exerted between each singly upon the others, and form a triple compound; or (*d*) two of them may have no attraction for each other, but being both capable of combining with a third, this last may be the instrument of union between the two, and a triple compound will be thus formed. In this case, the effect is said to be performed by intermediate attraction, and the attracting body is called a medium. Thus oil and water will not unite, but either of them will unite with an alkali; and if this last be united with oil, it forms soap, which can be united with water. The alkali is the medinm; or (*e*) two principles which attract each other may neither of them be capable of direct or ready union with a third; but when the two former shall be actually combined together, the compound shall attract and combine with the third body, and form a triple compound. This new power is called resulting attraction. Thus neither sulphur nor potash have any sensible action upon gold; but when they are fused together, they combine with that metal. Most of the effects of resulting attraction are consequences of the change of state of bodies, particularly to that of fluidity; and the effects of this attraction and that by a medium often exist in the same case; or (*f*) if we suppose three principles to be in such circumstances of aggregation or temperature, as to have no perceptible disposition to unite in pairs, but that the resulting attraction of a compound of two of them, if united, would then act upon the third, and produce a triple combination, it may happen that this resulting attraction, which seems to be only in prospect, shall have power to complete the triple compound; and the modification is called disposing attraction. Thus vinegar has no perceptible action upon copper, but it can dissolve the compound of copper and oxygen, called the oxide of copper: neither vinegar nor copper have any disposition to take oxygen from its elastic state in the atmosphere, so that copper and vinegar may be kept together without solution in a closed vessel: but if the air be admitted, the presence of the vinegar will dispose the copper to take oxygen and form an oxide, and with this combination the vinegar will unite. There is much convenience in the term, disposing attraction, as used to express this phenomenon, though it must be confessed that this prospective disposition, ascribed to unconscious beings, seems to produce some confusion in the mind. It may therefore be proper to notice, that the case seems to belong to disposing attraction, and may be thus hypothetically explained. Copper, and several other metals, which attract oxygen from the air, become covered with a thin oxide or rust, which prevents any farther access of that fluid, and consequently it rusts no farther, unless the thin coat of oxide be scraped off and a new surface exposed; and if this were continued to be done, all the copper would be gradually oxided. Now the vinegar, by the condition of our case, does this, and the copper is gradually and totally dissolved; not, as it appears, because the copper and oxygen are disposed to unite by a third power, which, as it were, waits for them, but because this power removes an impediment, which would impede their progressive union.

(*g*) The case of attraction, which has most particularly engaged the attention of chemistry, is that, where two principles being combined are separated from each other by the addition of a third, which combines with one of them. This has, perhaps improperly, been called simple elective attraction, and by others precipitating attraction: its principal effects or distinguishing character would, it seems, be better designated by the term decomposing attraction. Thus, if sulphuric acid and magnesia be combined in the salt called sulphate of magnesia (dissolved in water) and potash be added, the acid will unite with this last, and the magnesia will be separated and fall down. It was for a long time thought that these combinations and separations were complete and entire; but they appear in every instance to form cases of the intermediate or resulting attractions, wherein the proportions of the soluble and insoluble parts are extremely different, and the degrees of saturation often modify the results. For the body separated has always a small proportion of the two others, and the new compound usually suspended is not binary, but triple at least; and the proportions and effects are more or less altered by the quantity of solvent present, and the aptitude of the new combinations to take the solid, fluid, or elastic states.

Tables of separation or decomposition have been called tables of simple elective attraction. They are usually drawn up to express effects in the humid way with moderate proportions of water at the middle atmospheric temperature; and in the dry way by the operation of fire acting upon the containing vessels, to raise their temperature. From the reasons just mentioned, they cannot be admitted as denoting invariable effects, but they are nevertheless useful, provided the modifications of circumstances be attended to in our general reasoning. See ELECTIVE ATTRACTION.

3. In our present discussion it was not practicable, from the nature of the subject to avoid presenting facts for illustration, in which more than three principles were concerned; though the doctrines to be elucidated supposed no more than that number to be present. This supposition can admit only of one combination, either of two or of three principles; but in the complex effects of chemical attraction, four or more bodies may be treated of as forming distinct and separate combinations; and these compounds being presented to each other, may be affected by all the habitudes and circumstances upon which we have so long dwelled, besides such others as arise from their greater complexity. These cannot be here fully treated. It will be sufficient at present to overlook those effects wherein compounds of many principles may be formed, or in which the intermediate, or resulting, or disposing attractions may operate, and regard only the cases in which two binary compounds, being presented to each other, do either remain unaltered, or else exchange their principles so as to form two other binary compounds. A few years ago this was thought to comprehend the greatest part of the doctrine of chemical attractions; but, as practical science advances, the supposed simplicity of the facts becomes less than before.

These phenomena, afforded by two binary compounds, have been classed under the denomination of effects of double elective attraction. These facts may be considered with regard to the whole force of the attractions that tend to retain the original compounds, which have been called quiescent attractions, and the whole force of the attractions that tend to produce two new binary compounds, which have been called divellent attractions. If the former be the greatest, the change will not take place; but if the latter exceed, it will. Thus, if to the sulphate of potash lime be presented, the sulphuric acid being more strongly attracted by potash than by lime, no decomposition will ensue; but if muriate of lime be presented to the sulphate of potash, the lime will not only attract the sulphuric acid, but the muriatic acid will attract the potash; and the sum of the divellent attractions, namely, of the lime to the sulphuric acid, of the muriatic acid to the potash, being greater than the sum of the original or quiescent attractions; namely, of the sulphuric acid to the potash, and of the muriatic acid to the lime; two new compounds, namely, sulphate of lime and muriate of potash, will be formed. See ELECTIVE ATTRACTION.

The most essential difference between the complicated cases of attraction here described, and those treated of just before, is, that the principles in these last are either saturated, or nearly so, when presented to each other; and from this difference, and the number of principles, it is, that the effect of solvents, the force of cohesion and of elasticity, as well as of temperature, and other circumstances, act with more effect than in the simpler cases.

Whenever the cohesive attraction operates so as to form solid aggregates, whether by the congelation of fused bodies by cooling, or the deposition of bodies from their solvents, the aggregates, if not disturbed by too rapid condensation, or by other causes, have the form of solids bounded by flat surfaces, meeting each other in certain definite angles. These solids are called crystals. The property of crystallizing seems to be a natural consequence of the resulting attractions. For if a binary compound be attracted by any other principle or compound, and the time and circumstances allow the particles to turn round, it appears obvious that the appulse and adhesion will be made by such sides of the bodies as are occupied by particles most strongly attractive of each other; and this regularity of opposition must produce regularity of figure. See CRYSTALLIZATION.

After this general statement of the means and agents of chemistry, it remains only for us, in this general article, to give an outline of the different substances or principles upon which the processes of nature and art are performed, and upon which the articles devoted to each may be consulted.

CHEMISTRY.

CHEMICAL ARRANGEMENT OF BODIES.

I. *Substances not yet decomposed, called simple principles.*

1. Principles of doubtful existence. These are (*a*) heat, (*b*) light, and the causes of (*c*) galvanic, (*d*) electric, and (*e*) magnetic phenomena. These energies cannot be confined in vessels; they are not measurable by figured extension or by gravity; we know nothing of their compounds; and they accompany and are excitable in other bodies by manipulation: from which, and other reasons, they have been thought to be modes, properties, or occasional habitudes of bodies. But, on the other hand, they possess so many distinctive characters, that a large class of philosophers ascribe them to certain peculiar fluids, or to one common fluid. See Ether.

2. Simple principles, which have been exhibited only in the gaseous form, unless in combination These are (*a*) oxygen, (*b*) hydrogen, (*c*) azote, or nitrogen. The character here assumed for classification might seem insufficient, as being merely relative to our present means of attempting to condense these bodies, if there were not some strong distinctive circumstances belonging to them. In particular, oxygen with hydrogen forms water, of which an immense ocean covers two-thirds of the surface of our planet; and oxygen with nitrogen forms the air of that atmosphere which surrounds us on all sides to the height of many miles, and would, if it could be compressed to the density of common earth, cover all the land and sea to the depth of at least fifteen feet: and (*d*) the unknown base of muriatic acid ought probably to be admitted in this place.

3. Simple principles, not combustible. These are (*a*) earths, distinguished by a want of fusibility, volatility, and solubility in water, which in most species is almost total. There are nine at present known; namely, silex, alumina, lime, magnesia, barytes, strontites, zircon, ittria, glucine: and (*b*) alkalies, which are fusible, volatile by a red heat, and very soluble in water: three are known; potash, soda, and ammonia.

The recent decomposition of the two former alkalies (see Alkali,) and the well known composition of the latter, must with propriety exclude them from their present situation: but they are retained in this class of incombustibles until the confirmation and developement of those facts shall have perfectly settled their place.

4. Simple principles, conbustible, and in some aggregations transparent. These are, (*a*) diamond, or carbon; (*b*) sulphur; and (*c*) phosphorus. The two latter of these combine readily, and burn with the oxygen of the atmosphere; the latter, in various of its compounds and species, appears to be impeded in its combustion by the force of cohesion in the aggregate.

5. Simple principles, combustible, opaque in every state of solid aggregation, and peculiarly brilliant by reflection; metals. Of these, 28 are at present known. 1. Gold; 2. Platina; 3. Silver; 4. Mercury; 5. Iridium; 6. Osmium; 7. Rhodium; 8. Palladium; 9. Copper; 10. Iron; 11. Lead; 12. Tin; 13. Zinc; 14. Bismuth; 15. Antimony; 16. Nickel; 17. Cobalt; 18. Manganese; 19. Arsenic; 20. Tellurium; 21. Chrome; 22. Molybdena; 23. Tunsten; 24. Titanium; 25. Uranium; 26. Columbium; 27. Tantalium; 28. Cerium.

II. *Primary compounds, or combinations of two simple principles.*

1. Water, composed of oxygen and hydrogen.

2. Ammonia; composed of hydrogen and azote. And in this place we may expect hereafter to place the other alkalies and earths.

3. Oxides; composed of combustible principles, particularly metals, combined with oxygen. These are, (*a*) oxides of carbon; as plumbago, common charcoal, carbonic oxide of azote—of sulphur,—of phosphorus; and (*b*) of the metals.

4. Acids; combustibles, or metals combined with a larger portion of oxygen than exists in their oxides. The oxygenated substance is called the base of the acid, and there are acids with two, and perhaps more bases. Rejecting, for the present, their modifications, arising from more or less of oxygen, they are, the sulphuric, nitric, muriatic, phosphoric, carbonic, fluoric, boracic, arsenic, molybdic, chromic, tungstic, columbic, acetic, benzoic, moroxylic, camphoric, oxalic, mellitic, tartaric, citric, sebacic, saclactic, laccic, malic, suberic, formic, prussic, gallic.

5. Compounds of two incombustible principles. These are either earths with earths, as in (*a*) pottery, which for the

most part is a mixture of aggregates;—of earths with alkalies, which form (*b*) glass.

6. Compounds of a combustible and an incombustible principle. (*a*) Sulphurets of lime, magnesia, barytes, strontites, potash, soda, ammonia; (*b*) carburet of alumina; and (*c*) phosphurets of lime; barytes; strontites.

7. Compounds of two combustible principles. (*a*) Hydrogen with carbon; carburetted hydrogen gas; supercarburetted hydrogen gas, or olefiant gas. (*b*) Hydrogen with metals; gasiform suspension of arsenic, zinc, or iron. (*c*) Carbon with sulphur; carburet of sulphur. (*d*) Carbon with iron; carburet of iron, or crude iron. (*e*) Sulphur with hydrogen; sulphuretted hydrogen gas. (*f*) Sulphur with phosphorus; sulphuret of phosphorus. (*g*) Sulphur with most of the metals; sulphurets of each. (*h*) Phosphorus with hydrogen; phosphorized hydrogen gas, phosphuretted hydrogen gas. (*i*) Phosphurets of carbon. (*k*) Phosphurets of many of the metals. (*l*) Metals with metals; alloys.

III. *Secondary compounds, or compounds of more than two simple principles.*

Though it cannot yet be determined whether the binary and other compounds, enumerated in the last section, may exist as distinct principles in the combination into which they may enter, it is nevertheless certain, that, either from this cause, or from the general predominance of the attractions to which they owe their formation, the appearances in composition and decomposition are such as admit of the affirmative supposition in by far the greater number of cases. This was taken for granted by the earlier chemists, and habit and convenience has continued their language to the present time.

The binary compounds, taken in the preceding order, will indicate the following secondary combinations.

1. Water combines with a great number of bodies, and in general may be separated by evaporation, congelation, or the effect of elective attraction, without any change in its own composition. It has been accordingly considered for a long time as a simple element, and is even now very often disregarded in its agency upon substances which it may hold in solution. (*a*) It absorbs very small portions of oxygen, hydrogen, or azote, and emits them upon raising the temperature, or lowering it to congelation. No proof has been given of its being capable of uniting in perfect combination with either of its component parts beyond the point of saturation. (*b*) It dissolves barytes plentifully, and strontites and lime sparingly; and it very actively takes up large proportions of the alkalies; but from all these it may be separated without alteration by mere heat. (*c*) Its action upon carbon, sulphur, phosphorus, or the metals, is not sufficient to produce any sensible combination or decomposition, unless at a very elevated temperature, such as that of ignition. (*d*) The oxides are scarcely affected by it; perhaps only when they approach the state of acidity. (*e*) Many of the acids unite strongly, and in all proportions, with it, and they are all more or less soluble. (*f*) The sulphurets and phosphorets are suspended, and decomposition of the water takes place by disposing durable affinity, part of the sulphur taking oxygen from the water, and forming acid, which combines with the earth or alkali; and another part of the combustible uniting with the hydrogen of the decomposed water, and forming hydrosulphuret, part of which remains in solution, and part rises in form of gas. (*g*) The compounds of two or more combustibles are not sensibly acted upon by water.

2. The alkalies combine (*a*) with all the acids, and form compounds called neutral salts, more or less soluble in water; and also (*b*) with several of the earths, and (*c*) of the metallic oxides; forming combinations, which, from the little attention yet paid to them, have received no particular denominations.

3. The earths also unite (*a*) with the acids, and form salts similar to those called neutral, and also for the most part soluble in water. Some of these likewise unite (*b*) with each other, and (*c*) with metallic oxides, by compound attraction during precipitation in the humid way.

4. Acids are the most powerful agents of combination with alkalies, earths, and metallic oxides, in the humid way, with which, as has been observed, they form salts. The earth silex is not taken up in any perceptible quantity by any acid but the fluoric, and this suspends it even in the form of gas.

5. The compound of hydrogen and sulphur acts in the manner of an acid upon the alkalies, earths, and metallic oxides. For which, and the effect of

acids on the compound combustibles, reference must be made to the respective articles.

It would carry us too far into the business of arrangement in this place, if we were not to adopt the same proceeding of referring to the parts and products of VEGETABLE and ANIMAL *bodies*; we shall therefore only mention five classes of the products of organized substances, which, from their exclusive application to chemical operations, cannot be passed without notice. These, in the last results, afford carbon and hydrogen, or carbon, hydrogen, and oxygen. They are, (*a*) alcohol, or spirit, ardent; (*b*) ether; (*c*) oils, volatile; (*d*) oils, fixed; (*e*) bitumens.

CHENOLEA, in botany, a genus of the Pentandria Monogynia class and order: natural order of Holoraceæ: Atriplices, Jussieu. Essential character: calyx globular, one-leafed, five-parted; capsule one-celled, containing one smooth seed, bifid at the tip. There is but one species, *viz.* C. diffusa, which is a native of the Cape of Good Hope.

CHENOPODIUM, in botany, English *goose foot*, a genus of the Pentandria Digynia class and order: natural order of Holoraceæ: Atriplices, Jussieu. Essential character, calyx five-leaved, five-cornered; corolla none; seed one, centicular, superior. There are twenty-three species. The C. anthelminticum is, as its name imports, a medicine possessing the property of expelling worms; worm-oil, as it is called, is made principally of this plant. It is a native in many parts of the United States, and Pursh says is common in the streets of Philadelphia.

CHERLERIA, in botany, so called in honour of Cherler, assistant and son-in-law to John Bauhin: a genus of the Decandria Trigynia class and order: natural order of Caryophyllei. Essential character: calyx five-leaved; nectaries, five, bifid, resembling petals; anthers alternate, barren; capsule one-celled, three-valved, three-seeded. There is but one species, *viz.* C. sedodides; stone crop cherleria. It is found on the mountains of Dauphine, Switzerland, Savoy, the Valais, Austria, Carniola, and the Highlands of Scotland. Perennial; flowering in August.

CHERMES, in natural history, a genus of insects of the order Hemiptera. Generic character; snout placed in the breast, with three inflected bristles; antennæ filiform, pubescent longer than the thorax; four wings deflected; thorax gibbous; hind legs formed for leaping. There are 24 species. They inhabit various trees and plants, and produce, by their punctures, protuberances and excrescences of various shapes and sizes, in which are frequently enclosed the eggs and insects in their several states, the larva is six-footed and apterous: the pupa is distinguished by two protuberances on the thorax, which are the rudiments of future wings. C. alni is founded on the leaves and shoots of alder; its larva is entirely covered about the hinder part by viscid down or cotton; this, if purposely rubbed off, is quickly reproduced by the animal, which secretes the white fibres from large pores placed in a circle at some distance from the vent. These larva are gregarious, often appearing in such numbers on the shoots of the tree that the whole shoot appears covered with cotton, which, if touched with the finger, separates into distinct tufts, from the animals being suddenly disturbed, and moving in all directions. C. buxi; antennæ setaceous; wings yellowish brown. Its punctures make the leaves bend in towards each other at their extremity, forming a hollow knob, in which the larva are enclosed.

CHERRY *tree*, in botany. See PRUNUS.

CHESNUT *tree*. See FAGUS.

Next to the oak, the chesnut timber is most coveted by carpenters and joiners. It likewise makes the best stakes, pallisadoes, vine props, hop-poles, &c. and is also proper for mill timber and water-works. It is likewise fit for chests, tables, bedsteads, columns, &c.

CHESS, a game played by two persons sitting *vis-a-vis*, and having between them a square board, containing 64 rectangular chequers, alternate white and black: each player has the white corner square at his right hand. The pieces are as follows, for each party. A queen, which is always placed on her own colour: thus the white queen is on a white square, the fourth from the corner, and the black queen on the black square, facing the white queen. Their respective kings are then placed by the sides of the queens, so that each couple occupy the two centre squares on the lines nearest the players. Two bishops are then placed, one on the side of the king, the other on the side of the queen, on squares of different colours. Bishops are generally distinguished by a kind of mitre on their tops: at the sides of the bishops are placed the two knights, also on different coloured squares: these are usually distinguished by horses' heads, or by having a piece obliquely taken off from their flat round bonnets. The exterior pieces are called castles or rocks, and are commonly made to resemble turrets; or may be only pawns of a larger size. The pawns, eight in number, are ranged so as to occupy all the squares on the second line, immediately in front of the line of pieces. Pawns are generally pieces of turned wood, of a neat pattern, and with spherical summits. This description of one party will answer for both; observing that the players are designated according to the colour of their pieces. Such as are white or yellow, are called white, and such as are black, red, green, &c. are called black.

The king can only move one square at a time, but in any direction that may be open to him: he cannot, however, move to, nor remain on, a square which is commanded by any of the adversary's pieces or pawns. The queen moves only in right lines, but her range is unlimited where the board is clear: thus she can go the whole breadth, or the whole length, or the whole diagonal of the board. If placed in the centre of the board, she could, consequently, move in any one of the eight, *i. e.* four rectangular, and four diagonal directions, diverging from the square on which she might stand. The bishops always move in a diagonal direction, each invariably adhering to that colour on which he was originally placed; these pieces are called according to the colour on which they stand and move, without any reference to their own complexions respectively. Thus the white party has a black and a white bishop; though they are both made of a white substance: the same holds in regard to the adversary's bishops. The knights have a circular move, always proceeding to such squares, within two distant, as may be of opposite colour to that from which they move; counting that square, say it be white, as one, the knight passes over one square, either black or white, and settles on a black square next thereto. Hence a knight can remove to or command eight squares, all in different directions from that on which he stands. The castles only move at right angles with the board; proceeding, if nothing should interrupt, either the whole length, or the whole breadth, at pleasure. The pawns have each the privilege of moving forward two squares, at the first move of each respectively, provided no obstacle should present itself; but ever after they can only move forward one square at a time. When pawns capture, they do it obliquely, but only at one square distance; thus a pawn, on a white square, can take any pawn or piece of the adversary's that may be on either of the diagonals proceeding from such white square, right and left, provided such pawn or piece be on the square next to that on which the pawn stands. Pawns never recede; all their moves are straight forward; they have, however, the great privilege of being changed for any piece the party they appertain to may choose, whenever they can reach that line on which the adversaries' pieces were originally arranged: on such occasions the successful pawn is taken off the square, and any piece its owner may have lost is placed thereon in its stead. As a queen is usually chosen, where one has been lost, this is called making a queen.

A review of the chess board will show that every piece, as it stands on the board, protects one pawn, while each of the two centre pawns has four defences. The weakest parts of the board are the pawns before the knights and bishops.

The king cannot remain in check, nor can he remove to a square that is commanded by any piece or pawn of the adversary. When he is so situated as to be liable to be taken, *i. e.* in check, and that he cannot move but into a similar situation, the game is ended, by what is called check-mate. When the party cannot move any of his pieces or pawns, and his king is not in check, or, as it is called, *en prise*, but would be so if he moved, he wins the game, under the plea of stale-mate. To effect this, when the party has lost his defences, is therefore an object of moment. Young players, when carrying all before them, very frequently give their adversaries this negative victory, by pushing on, without attending to the consequences of too closely confining the opponent's king.

When the space between the king and either castle is clear, and that neither the king nor castle is *en prise*, the castle may then be brought next to the king, and the king be placed on the opposite side of the castle; this is called castleing, but can only be done once in the game, and before either the king or the castle has made any move. If either the king, or castle, crosses or comes upon a square that is commanded by a piece or pawn belonging to the adversary, the castleing cannot be allowed.

This operation is resorted to, either for the purpose of withdrawing the king from an attack directed against the square on which he is placed, or against that of his pawn; or it is used as the means of opening a communication between the two castles, when all the intermediate pieces are removed; or to strengthen the defence of the centre pawns, as well as to carry the game into the centre of the adversary's board. It is to be remarked, that the centre is ever to be strongly defended, if the measures pursued by the other party should admit. When the lateral game is played, that defence must be adopted which circumstances demand. The judicious chess player never makes an useless move, nor leaves a pawn or a piece unprotected. He forms his plans regularly, so as to calculate with precision what would be the position of the pieces after four or five moves he has in contemplation may have been made. He looks more to the solidity of his measures than to little ensnaring stratagems; though he will not fail to appear ignorant of such designs as he may perceive to be within the intention of his opponent, when he knows that by an affected inattention, or blindness, to the device, he can make a more immediate impression, and render the whole speculation, not only void, but the means of ruining its projector.

The game of chess has certainly some affinity to the art of war; but the analogy is not so strict as players generally suppose. We can, however, inform the amateurs of this pleasing species of contest, that a work is now in the press which cannot fail to afford a treat, as it opens a new field for the display of skill, and teems with the most ample and interesting varieties.

CHEVRON, or Cheveron, in heraldry, one of the honourable ordinaries of a shield, representing two rafters of an house, joined together as they ought to stand; it was anciently the form of the priestesses' head attire: some say it is a symbol of protection; others, of constancy; others, that it represents knights' spears, &c. It contains the fifth part of the field.

A chevron is said to be abased, when its point does not approach the head of the chief, nor reach farther than the middle of the coat; mutilated, when it does not touch the extremes of the coat; cloven, when the upper pieces are taken off, so that the pieces only touch at one of the angles; broken, when one branch is separated into two pieces; couched, when the point is turned towards one side of the escutcheon; divided, when the branches are of several metals, or when metal is opposed to colour; inverted, when the point is turned towards the point of the coat, and its branches towards the chief.

CHIEF, in heraldry, is that which takes up all the upper part of the escutcheon from side to side, and represents the ornaments used on a man's head.

CHILIAD, denotes a thousand of any things, ranged in several divisions, each of which contains that number.

CHILIAGON, in geometry, a regular plain figure of a thousand sides.

CHIMÆRA, in natural history, a genus of fishes of the Linnæan order Chondropterigius, and according to Shaw, of the order Cartilagenei. Generic character: head pointed on the upper part; mouth placed beneath, with the upper lip five-cleft; cutting teeth two in front, both above and below. There are two species, *viz.* C. monstrosa or borealis, and C. callorynchus or australis. The former is remarkable for the singularity of its appearance; it is a native of the northern seas, where it inhabits the deepest recesses, and preys on the smaller kind of fishes, as well as on various sorts of the mollusca and testacea tribes. It is about three or four feet long. Notwithstanding the Linnæan name of monstrosa, its appearance is not at all formidable, and its colours highly elegant. See Plate II. Pisces, fig. 5. The C. australis is a native of the southern seas, and its manner of life similar to that of the northern ocean.

CHIMARRHIS, in botany, a genus of the Pentandria Monogynia class and order. Essential character: corolla funnelform, with a very short tube; capsule inferior, obtuse, two-celled, two-valved, the valves bifid at the tip; seed one in each cell. There is but one species, *viz.* C. cymosa, a lofty tree, with a handsome head, the boughs spreading out horizontally. Flowers numerous, small, with white corollas, without scent; capsule small. The wood is white, and used for beams, rafters, &c. It is called in Martinico, where it is comman, bois de reviere.

CHIMES *of a clock*, a kind of periodical music, produced at equal intervals of time, by means of a particular apparatus added to a clock.

CHIMNEY is that part of a house which serves to conduct the smoke of the fires to the exterior. This will not, however, be effected, unless the draught of air be decidedly from the bottom to the top. To insure this, the fire-place should be rather wide than narrow in the front, and gradually taper backwards, so as to proceed all the way up in rather a conical form, causing the smoke to rush forth with velocity. This is the great secret, the want of which, added to angular instead of curved lines, where bends are requisite in any part of the flue, and the being overtopped by adjoining buildings, trees, banks, &c, has caused much inconvenience. Some persons are so very particular in listing their doors, and in making apartments completely wind-tight, that the want of draught has occasioned the best constructed chimnies to smoke intolerably; a few holes made with a gimlet in the sashes have remedied the defect. When a chimney is very foul, so as to be choked in a certain degree, the soot will generally check the draught. Short flues are subject to repel the smoke, because the wind from above can so easily reach all the way down, which in long flues it cannot do. If it could be applied to general use, the form of a tile-kiln should be generally adopted for that of the chimney

CHIMNEY *sweeping*. Smoke, in its passage through a chimney, deposits a great part of the soot with which it is loaded, upon the sides of the flue, which causes danger from fire, and is besides apt to fall back into the room. It is therefore frequently necessary to have the flues cleaned. To effect this, various expedients have been resorted to, but that most commonly adopted is the use of climbing boys, who ascend within the chimney and sweep down the soot. The evils of this disagreeable and unwholesome occupation to those engaged in it are generally acknowledged, and of late years the public attention has been directed to this subject, and premiums offered for the discovery of methods which might be substituted to a practice so offensive to humanity.

In the year 1802, a number of public-spirited and wealthy persons in London associated for this purpose, and offered considerable premiums to those who might invent, and bring into practice, a method of cleansing chimneys, by mechanical means, that should supersede the necessity of climbing boys. Feeling themselves, perhaps, inadequate to the task of carrying their laudable intentions into full execution, they applied to the "Society for the Encouragement of Arts, Manufactures," &c. in the Adelphi, requesting them to engage in it, and to offer premiums on the subject. In consequence of this application, the society offered their gold medal to the person, who should invent the most effectual mechanical or other means for cleansing chimnies from soot, and obviating the necessity of children being employed within the flues. In a few months there were five candidates for this premium, whose several inventions were put to the test of experiment upon chimnies not less than 70 feet high. One of the inventions consisted of a set of brushes with pullies and weights, which were to be let down from the top of the chimney; but as the object was to find an apparatus to effect the purpose from the inside of the house, this was deemed unfit to accomplish the views of the society. Another gentleman proposed the plan of throwing gravel up the chimney by means of condensed air: the machine was tried, and deemed wholly inadequate to the purpose. A third apparatus consisted of elastic rods of whale-bone and cane, with a brush at the end of the upper one, which was found to answer only in short and straight chimnies. The next consisted of laths several feet long, which locked into one another, and on the upper one was fixed an elastic expanding brush, which, in its ascending and contracted state, occupied a space of only six or eight inches, but which was to be opened, when forced to the top of the chimney, by means of a string attached to it, the whole length of the rods. After many experiments before divers persons appointed to examine its merits, this was given up as ineffectual to the purpose required. The only remaining apparatus was invented by Mr. George Smart, the patentee of a method of making hollow masts for ships: to him, after a long series of practice, in which he has been almost uniformly successful, the gold medal was adjudged; he has received also, we believe, some other premiums for his invention. As his method is now practised by several persons in and near the metropolis, we shall give a more particular account of it. The principal parts of the machine are, a brush, some rods or hollow tubes, that fasten into each other by means of brass sockets, and a cord for connecting the whole together.

The method of using the machine is this: having ascertained, by looking up the chimney, what is the direction of the flue, a cloth is then to be fixed before the fire-place, with the horizontal bar, and the sides to be closed with two upright bars. The brush is introduced through the opening of the cloth, which opening is then to be buttoned, and one of the rods is to be passed up the cord into the socket on the lower end of the rod which supports the brush; the other rods are in like manner to be brought up one by one in succession, till the brush is raised somewhat above the top of the chimney, observing to keep the cord constantly tight, and when those rods which have a screw in the socket are brought up, they are to be placed on the purchase; the cord is to be put round the pulley, and drawn very tight, and screwed down, by which all the rods above will be firmly connected together, and the whole may be regarded as one long flexible rod. In pulling the machine down, the edges of the brush, striking against the top of the chimney, will cause it to expand, and there being a spring to prevent its contracting again, it will bring down the soot with it. In drawing down the machine, the person should grasp with his left hand the rod immediately above that which he is separating with his right hand, to prevent the upper ones from sliding down too soon. The rods, as they are brought down, are to be laid carefully one by one in as small a compass as possible, and arranged like a bundle of sticks.

This machine has been found useful in extinguishing fires in chimnies: for that purpose a coarse cloth is to be tied over the brush, dipped in water, and then passed up in the manner directed. After three years experience, Mr. Smart's machine has been found, in a great measure, to answer the purposes for which it was intended; in the course of several thousand trials, it is ascertained that not more than one or two chimnies, at most, in a hundred, has resisted the passage of the brush. It is, however, of importance to observe, that the invention cannot be deemed in a state of perfection; soot from some coals adheres so strongly to the sides of the chimney, and chimney-pot, that no brush will of itself bring it down, so that after a considerable time it may be expected that means must be found to scrape off the soot, as the climbing boys now generally do: we wish, therefore, that such an addition to the apparatus could be devised, as should remedy this defect. It is well known that one cause of the smoking of chimnies is from the circumstance, of the top of the chimney-pot being clogged with soot that adheres to the upper edge, which it is certain Mr. Smart's brush has in many instances failed to remove. He has done much to obviate an evil long complained of: an evil that has deprived of health, and eventually of life, a multitude of persons in their youth, that might for a long course of years have been useful to the community, and we wish to see in his hands the invention, so honourable to his talents, rendered still more useful by being more perfect. He has attained, with regard to making his brush ascend the chimney, all that can be expected, and instead of bringing up infants to climb the fiftieth or hundredth chimney, which on account of the direction of the flue no apparatus can be made to ascend, other means may be adopted.

CHIOCOCCA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Aggregatæ. Rhubiaceæ, Jussieu. Essential character: corolla funnel-form, equal; berry one-celled, two-seeded, inferior. There are two species. C. racemosa, climbing snowberry-tree, or David's root, is a native of the West-Indies; and C. barbata, a native of the Marquesas, Society and Friendly Islands, in the South Sea.

CHIONANTHUS, in botany, *fringe*, or *snowdrop tree*, a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Jasmineæ, Jussieu. Essential character: corolla quadrifid, with the divisions extremely long: drupe with a striated nut. There are four species, of which C. Virginica, Virginia fringe-tree, or snowdrop-tree, is common in South-Carolina, where it grows by the sides of rivulets,, and is rarely more than ten feet high: the leaves are as large as those of the laurel, but are of a much thinner substance: the flowers come out in May, hanging in long bunches, of a pure white colour, whence the inhabitants call it snowdrop-tree; and the flowers being cut into narrow segments, they give it the name of fringe-tree. This beautiful tree is one of the American plants in the highest esteem in Europe, and is always eagerly sought and cultivated in the gardens of the curious.

CHIROMANCY, a species of divination, drawn from the different lines and lineaments of a person's hand; by which means it is pretended the inclinations may be discovered.

CHIRONIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Rotaceæ. Gentianæ, Jussieu. Essential character: corolla rotated; pistil declinate; stamens on the tube of the corolla; anthers finally spiral;

pericarp two-celled. There are ten species, mostly natives of the Cape of Good Hope.

CHISSEL, an instrument much used in carpentry, masonry, joinery, sculpture, &c. and distinguished, according to the breadth of the blade, into half-inch chissels, quarter-inch chissels, &c. They have also different names, according to the different uses to which they are applied, as, 1. The former, used by carpenters, &c. just after the work is scribed: it is struck with a mallet. 2. The paring-chissel, which is used in paring off the irregularities made by the former: this is pressed with the workman's shoulder. 3. The skew-former cleanses acute angles with the point of its narrow edge. 4. The mortice-chissel, used in cutting deep square holes in the wood, for mortices: it is narrow, but thick and strong, to endure hard blows. 5. Socket chissels, having their shank made with a hollow socket at top, to receive a strong wooden sprig fitted into it with a shoulder. 6. Ripping chissel, having a blunt edge, with no basil, used in tearing two pieces of wood asunder. And 7. The gouge.

CHITON, in natural history, a genus of Vermes Testacea. Animal inhabiting the shell a doris: shell consisting of several segments or valves disposed down the back. There are 28 species. They differ very much in colour, and are found on almost every coast in the ocean. C. tuberculatus: shell seven-valved; body tuberculate; inhabits America; oblong-oval, narrow, with tubercles above disposed in quincunx; the sides cinereous, mixed with white, and marked with brown undulate bands; back greenish, with a broad, deep, black band. C. cinereus: shell eight valved, smooth, carinate; body reddish, with a subciliate border; inhabits the Norwegian seas among the roots of ulvæ; two lines long; depressed and narrower before, with two longitudinal grooves down the back, bounding the ridge in the middle; when alive both the shell and animal are reddish, when dried cinereous.

CHIVALRY, iu law, is a tenure of service, whereby the tenant is bound to perform some noble or military office to his lord; and is either regal, when held only of the king; or common, such as may be held of a common person, as well as the king: the former is properly called serjeanty, and the latter escuage.

Chivalry, in antiquity, an institution, which, according to some writers, took its rise from the crusades; but, according to others, it gave occasion to that enterprise, and which, though founded in caprice, and productive of extravagance, had a very considerable influence in refining the manners of the European nations, during the twelfth, thirteenth, fourteenth, and fifteenth centuries.

This institution naturally arose, says Dr. Robertson, from the state of society at that period. The feudal state was a state of perpetual war, rapine, and anarchy; during which the weak and unarmed were exposed to perpetual insults or injuries. The power of the sovereign was too limited to prevent these wrongs; and the administration of justice too feeble to redress them. Against violence and oppression there was scarcely any protection, besides that which the valour and generosity of private persons afforded. The same spirit of enterprise, which had prompted so many gentlemen to take arms in defence of the oppressed pilgrims in Palestine, incited others to declare themselves the patrons and avengers of injured innocence at home. When the final reduction of the Holy Land under the dominion of infidels put an end to these foreign expeditions, the latter was the only employment left for the activity and courage of adventurers. The objects of this institution were, to check the insolence of overgrown oppressors, to succour the distressed, to rescue the helpless from captivity, to protect or to avenge women, orphans, and ecclesiastics, who could not bear arms in their own defence, to redress wrongs and to remove grievances. These were considered as acts of the highest prowess and merit. Valour, gallantry, and religion, were blended in this institution; humanity, courtesy, justice, and honour, were its characteristic qualities; the enthusiastic zeal produced by religion served to give it singular energy, and to carry it even to a romantic excess: men were trained to knighthood by long previous discipline; they were admitted into the order by solemnities no less devout than pompous; every person of noble birth courted the honour; it was deemed a distinction superior to royalty; and monarchs were found to receive it from the hands of private gentlemen. These various circumstances contributed to render a whimsical institution of substantial benefit to mankind.

Chivalry was employed in rescuing humble and faithful vassals from the oppression of petty lords; their women from savage lust; and the hoary heads of hermits (a species of Eastern monks, much reverenced in the Holy Land) from rapine and outrage. In the mean time the courts of the feudal sovereigns became magnificent and polite; and as the military constitution still subsisted, military merit was to be upheld; but destitute of its former objects, it naturally softened into fictitious images and courtly exercises of war, in "jousts" and "tournaments;" where the honour of the ladies supplied the place of zeal for the holy sepulchre; and thus the courtesy of elegant love, but of a wild and fanatic species, as being engrafted on spiritual enthusiasm, came to mix itself with the other characters of the knights-errant.

Chivalry, whatever might be the era of its origin, declined in England during the inglorious reigns of King John and Henry III; but revived under Edward I. This prince was one of the most accomplished knights of the age in which he flourished, and both delighted and excelled in feats of chivalry. As a proof of this, it will be sufficient to allege, that when he was on his return from the Holy Land, after his father's death, and knew that his presence was ardently desired in England, he accepted an invitation to a tournament at Chalons in Burgundy, where he displayed his skill and valour to great advantage, and gained a complete victory. Edward III. was no less fond of chivalry, and encouraged it both by his example and munificence. Having formed the design of asserting his claim to the crown of France, he laboured to inspire his own subjects with a bold enterprising spirit, and to entice as many valiant foreigners as possible into his service.

"This singular institution, says Dr. Robertson, in which valour, gallantry, and religion, were so strangely blended, was wonderfully adapted to the taste and genius of martial nobles; and its effects were soon visible in their manners. War was carried on with less ferocity, when humanity came to be deemed the ornament of knighthood no less than courage. More gentle and polished manners were introduced, when courtesy was recommended as the most amiable of knightly virtues. Violence and oppression decreased, when it was reckoned meritorious to check and to punish them. A scrupulous adherence to truth, with the most religious attention to fulfil every engagement, became the distinguishing characteristic of a gentleman, because chivalry was regarded as the school of honour, and inculcated the most delicate sensibility with respect to that point. The admiration of these qualities, together with the high distinctions and prerogatives conferred on knighthood in every part of Europe, inspired persons of noble birth, on some occasions, with a species of military fanaticism, and led them to extravagant enterprises. But they imprinted deeply on their minds the principles of generosity and honour. These were strengthened by every thing that can affect the senses or touch the heart. The wild exploits of those romantic knights, who sallied forth in quest of adventures, are well known, and have been treated with proper ridicule. The political and permanent efforts of the spirit of chivalry have been less observed. Perhaps, the humanity which accompanies all the operations of war, the refinements of gallantry, and the point of honour, the three chief circumstances which distinguish modern from ancient manners, may be ascribed in a great measure to this whimsical institution, seemingly of little benefit to mankind. The sentiments which chivalry inspired had a wonderful influence on manners and conduct, during the twelfth, thirteenth, fourteenth, and fifteenth centuries. They were so deeply rooted, that they continued to operate after the vigour and reputation of the institution itself began to decline." In a word, chivalry, which is now an object of ridicule, was, at the period to which we have above refered, a matter of the greatest moment, and had no little influence on the manners of mankind, and the fate of nations.

A respectable writer has traced, with ingenuity and much learning, a strong resemblance between the manners of the age of chivalry and those of the heroic ages delineated by Homer. See Letters on Chivalry, &c.

CHLORA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Rotaceæ. Gentianæ, Jussieu. Essential character: calyx eight-leaved; corolla one-petalled, eight cleft; capsule one-celled, two-valved, many-seeded. Stigma four-cleft. There are four species.

CHLORANTHUS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Aggregatæ. Essential character: calyx none; corolla a petal, three-lobed by the side of the germ; anthers growing to the petal; drupe one-seeded. There is but one species.

CHLORIS, in botany, a genus of the

Polygamia Monoecia class and order. Hermaphrodite calyx, glume two-valved, two-flowered; awned, corolla none; stamina three; styles two; seeds one; male calyx, glume one-valved; female sessile; calyx, glume two-valved. There are five species, natives of the West Indies.

CHLOROSIS, in medicine, a disease commonly called the green-sickness. See MEDICINE.

CHOCOLATE is made of roasted cocoa, which being first coarsely pounded in a stone mortar, is afterwards levigated on a slab of the finest grained marble; to this a small quantity of vanilla is added. The mixture is heated, sometimes with cream, and put into tin moulds of the size in which the cakes appear. Chocolate is nutritive, and not unwholesome, provided the stomach be active, and that exercise be not neglected: it would be less objectionable if the vanilla were omitted, that being of a very heating quality, but on it the flavour chiefly depends. Manufactured chocolate, and cocoa-paste, are prohibited from importation under severe penalties. See THEOBROMA.

CHOCOLATE BROOM. A plant, from the seeds of which a beverage resembling chocolate is made in some parts of Pennsylvania. See HOLCUS BICOLOR.

CHOIR, that part of the church or cathedral where choristers sing divine service: it is separated from the chancel, where the communion is celebrated; and also from the nave of the church, where the people are placed; the patron is said to be obliged to repair the choir of the church.

CHOMELIA, in botany, a genus of the Tetrandria Monogynia class and order. Calyx four-parted; corolla salver-shaped, four-parted; drupe inferior, with a two-celled nut; stigmata two, thickish. One species, found in America.

CHONDRILLA, in botany, a genus of Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx calycled; floscules in many rows; seeds muricated; pappus simple, stipitated. There are three species.

CHONDROPTERIGIOUS, a term applied by the Linnæan system to an order of fishes with cartilaginous gills. Dr. Shaw, and other naturalists, have united the Branchiostegi and Chondropterygii under the general title of Cartilaginei. Linnæus separated the cartilaginous from the other fishes, and placed them in the class Amphibia, where they constituted the order Nantes. This distribution was made under the supposition of the cartilaginous fishes being furnished both with lungs and gills. The supposed lungs, however, have been since ascertained by naturalists to be only a modification of the gills, and it, therefore, now appears that this cartilaginous tribe are in reality fishes, differing principally, if not entirely, from other fishes, in having a cartilaginous skeleton. They differ from the generality of other fishes, in having gills destitute of bony rays, or in the gills being cartilaginous, and they are deficient for the most part at least of obvious scales, those being either very deciduous, minute, or so deeply imbedded in the skin, as to be scarcely visible. In many of the cartilaginous fishes there is not the slightest appearance of scales on the surface of the skin. The Chondropterigii genera are,

Acipenser	Chimæra	Gastrobranchus
Petromyzor	Pristis	Raia
Squalus: which see.		

CHORD *of an arch*, is a right line joining the extremes of that arch.

CHORD *of the complement of an arch*, the chord that subtends the rest of the arch, or so much as makes up the arch a semicircle.

It is demonstrated in geometry, that the radius bisecting the chord also bisects the arch, and is perpendicular to the chord. From hence may be deduced these problems: 1. To make a circle pass through any three given points, not lying in a right line. 2. To find the centre of any circle. 3. To complete a circle from an arch given. 4. To describe a circle about any triangle given.

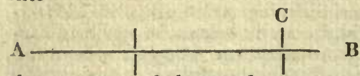
CHORDS, *line of*, one of the lines of the sector and plane scale. See INSTRUMENTS, *mathematical.*

CHORDS, or CORDS, in music, are strings, by the vibrations of which the sensation of sound is excited, and by the divisions of which the several degrees of tune are determined.

The chords of musical instruments are ordinarily made of cat-gut; though some are made of brass or iron wire, as those of harpsichords, spinnets, &c. Chords of gold-wire in harpsichords would yield a sound almost twice as strong as those of brass; and those of steel a feebler sound than those of brass, as being both less heavy and less ductile.

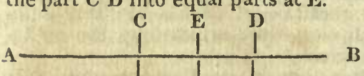
The rules for dividing chords, so as to

constitute any given interval, are as follow: to assign such part of a chord A B as shall constitute any concord; for example, a fifth, or any other interval, with the whole chord: divide the line A B into as many parts as the greatest number of the interval has units; thus the fifth being 2 : 3, the line is divided into



three parts: of these take as many as the lesser number 2 = A C, then is A C the part sought; that is, two lines whose lengths are to each other as A B to A C, make a fifth. Hence, if it be required to find several different sections of the line A B, for instance such as shall be octave, fifth or third greater; reduce the given ratios 1 : 2, 2 : 3, and 4 : 5 to one fundamental, the series becomes 30 : 24, 20 : 15, the fundamental is 30, and the sections sought are 24 the third greater, 20 the fifth, and 15 the octave.

To divide a chord A B in the most simple manner, so as to exhibit all the original concords. Divide the line into two equal parts at C, and subdivide the part C D into equal parts at D, and again the part C D into equal parts at E.



Here A C : A B is an octave, A C : A D a fifth, A D : A B a fourth, A C : A E a third greater; A E : A D a third less; A E : E B a sixth greater; A E : A B a sixth less.

Chord is also used in music for the note or tone to be touched or sounded: in this sense the fifth is said to consist of five chords or sounds.

CHORDOSTYLUM, in botany, a genus of the Cryptogamia Fungi. Fungus tenacius; on a very long, tough, slightly branched stem; head globular, somewhat deciduous, bearing the seeds. There are five species.

CHORION, in anatomy, the exterior membrane which invests the fœtus in the uterus.

CHOROGRAPHY, the art of delineating or describing some particular country or province: it differs from geography, as a description of a particular country differs from that of the whole earth; and from topography, as a description of a country differs from that of a town or district.

CHOROIDES, in anatomy, an epithet of several membranes, which on account of the multitude of their blood-vessels resemble the chorion.

Choroides denotes the coat of the eye placed immediately under the sclerotica. It is very full of vessels, and coloured black.

CHORUS, in dramatic poetry, one or more persons present on the stage during the representation, and supposed to be by-standers, without any share in the action. Tragedy in its origin was no more than a single chorus, who trod the stage alone, and without any actors, singing dithyrambics or hymns in honour of Bacchus. Thespis, to relieve the chorus, added an actor, who rehearsed the adventures of some of their heroes; and Æschylus, finding a single person too dry an entertainment, added a second, at the same time reducing the singing of the chorus, to make more room for the recitation. But when once tragedy began to be formed, the recitative, which at first was intended only as an accessory part, to give the chorus a breathing time, became a principal part of the tragedy. At length, however, the chorus became inserted and incorporated into the action: sometimes it was to speak, and then their chief, whom they called Coryphæus, spoke in behalf of the rest: the singing was performed by the whole company; so that when the Coryphæus struck into a song, the chorus immediately joined him.

The chorus sometimes also joined the actors, in the course of the representation, with their plaints and lamentations on account of any unhappy accidents that befel them: but the proper function, and that for which it seemed chiefly retained, was to show the intervals of the acts: while the actors were behind the scenes, the chorus engaged the spectators; their songs usually turned on what was exhibited, and were not to contain any thing but what was suited to the subject, and had a natural connection with it; so that the chorus concurred with the actors for advancing the action. In the modern tragedies the chorus is laid aside, and the music supplies its place.

Chorus, in music, is when, at certain periods of a song, the whole company are to join the singer in repeating certain couplets or verses.

CHRISTIANITY, the religion of Christians, who derive their name from the founder, Christ, so denominated from the Greek word χριω, I anoint, from the custom of anointing persons in the sacerdotal or regal character, as a public signal of their separation to important offices. After the death of Jesus, his disciples were for some years called Nazarenes, from Nazareth, where he was brought up. This name afterwards became the designation of a particular sect; and we learn from a passage in the Acts of the Apostles, that about the year 42, they who adopted the principles and professed the religion which Jesus had taught, and for the sake of which he cheerfully laid down his life, were distinguished by the name of Christians at Antioch. Hence the system itself is called Christianity. The foundation of a Christian's faith and practice, his ultimate, and, in truth, his only appeal, must be to the facts, the doctrines, and the precepts of the Scriptures, particualrly those of the New Testament. Other formularies, other confessions of faith, from whatever motives dictated, and from whatever reasons recommended, should ever be regarded with a suspicious eye; lest, by laying stress upon what is human, we should overlook that which comes recommended upon divine authority. The careful reader of the New Testament will find a detail of instructions given, of wonders performed, and of future events revealed. He will also be struck with a very particular account of the sufferings, death, resurrection, and ascension of Jesus, the founder. The history containing these things appears to be fairly written, and to carry with it as substantial proofs of its authenticity, as any history that has gained credit in the world. Is the Christian called upon for the reason why he believes in the antiquity of the writings of the New Testament? he may reply, "For the same reason that I believe the antiquity of Virgil's poems, Cæsar's Commentaries, or Sallust's narrations: and that is, the concurring testimony of all intervening ages. Do any ask, Why I believe that the several books were written by the persons whose names they bear? I answer, for the same reason that I believe the Georgics to be the production of Virgil; Jerusalem Delivered, that of Tasso; Paradise Lost, that of Milton; an Essay upon the Subject of Miracles, to be the work of Hume; and a Refutation of that Essay, the performance of Campbell. Do any inquire, Whether the sacred pages have not been greatly corrupted? I answer, They have not been greatly corrupted: as appears by a collation of the earliest manuscripts, and an appeal to the earliest versions and ancient fathers. So many corroborating circumstances plead in favour of the Gospel, that I must either disturb all records, or continue to admit the authenticity of those which display the duty and hopes of a Christian."

In reasoning upon the truth of Christianity we may appeal to its internal evidence, and, combining the doctrine and precepts of the system, infer from them the validity of the system itself. The early triumphs of this religion furnish another powerful argument in its support: especially if it be remembered, that in the estimation of the world it was neither honourable, profitable, nor popular. Under every disadvantage, and struggling under the most terrible persecution, it flourished, and has maintained its ground for nearly two thousand years. Another argument for the truth of the Christian religion arises from the completion of prophecies, of which some preceded Jesus, and were accomplished in him, and others were uttered by him, and came to pass during his life; such were the treachery of Judas, and the cowardice and meanness of Peter; or within a few years after his crucifixion; of this kind was the memorable destruction of Jerusalem. The character of Christ, and the miracles which he wrought, are evidences of the divinity of his mission. On these grounds, if the question be put "Why are you a Christian?" the answer has been given by a good writer, from whom we shall transcribe it. "Not because I was born in a Christian country, and educated in Christian principles; not because I find the illustrious Bacon, Boyle, Locke, Clarke, and Newton, among the professors and defenders of Christianity; nor merely because the system itself is so admirably calculated to mend and exalt human nature; but because the evidence accompanying the Gospel has convinced me of its truth. The secondary causes assigned by unbelievers do not, in my judgment, account for the rise, progress, and early triumphs of the Christian religion. Upon the principles of scepticism, I perceive an effect without an adequate cause. I therefore stand acquitted to my own reason, though I continue to believe and profess the religion of Jesus Christ. Arguing from effects to causes, I think I have philosophy on my side. And reduced to a choice of difficulties, I encounter not so many, in admitting the miracles ascribed to the Saviour, as in the arbitrary supposition and conjectures of his enemies.

"That there once existed such a person as Jesus Christ; that he appeared in Judea in the reign of Tiberius; that he taught a system of morals superior to any inculcated in the Jewish schools; that he was crucified at Jerusalem; and that Pontius Pilate was the Roman governor by whose sentence he was condemned and executed; are facts which no one can reasonably call in question. The most inveterate Deists admit them without difficulty: and, indeed, to dispute these facts would be giving the lie to all history. As well might we deny the existence of Cicero, as that of a person by the name of Jesus Christ. And with equal propriety might we call in question the orations of the former, as the discourses of the latter. We are morally certain that the one entertained the Romans with his eloquence, and that the other enlightened the Jews with his wisdom. But it is unnecessary to labour these points, because they are generally conceded. They who affect to despise the evangelists and Apostles profess to reverence Tacitus, Suetonius, and Pliny. And these eminent Romans bear testimony to several particulars which relate to the person of Jesus Christ, his influence as the founder of a sect, and his crucifixion. From a deference to human authority, all therefore acknowledge that the Christian religion derived its name from Jesus Christ. And many among the Deists are so just to its merits, as to admit that he taught better than Confucius, and practised better than Socrates or Plato.

"To come then to the question: Why are you a Christian? I answer, Because the Christian religion carries with it internal marks of its truth; because not only without the aid, but in opposition to the civil authority, in opposition to the wit, the argument, and violence of its enemies, it made its way, and gained an establishment in the world; because it exhibits the accomplishment of some prophecies, and presents others which have been since fulfilled; and because its author displayed an example, and performed works, which bespeak not merely a superior, but a divine character. Upon these several facts I ground my belief as a Christian. And, till the evidence on which they rest can be invalidated by counter evidence, I must retain my principles and my profession."

CHROMATICS, is that part of optics which explains the several properties of the colours of light and of natural bodies.

Before the time of Sir Isaac Newton, the notions concerning colour were very vague. Des Cartes accounted colour a modification of light; and he imagined that the difference of colour proceeds from the prevalence of the direct or rotatory motion of the particles of light. Grimaldi, Dechales, and many others, imagined that the differences of colour depended upon the quick or slow vibrations of a certain elastic medium, with which the universe is filled. Rohault conceived that the different colours were made by the rays of light entering the eye at different angles with respect to the optic axis. And Dr. Hooke imagined that colour is caused by the sensation of the oblique or uneven pulse of light; which being capable of no more than two varieties, he concluded there could be no more than two primary colours.

Sir Isaac Newton, in the year 1666, began to investigate this subject; when finding that the coloured image of the sun, formed by a glass prism, was of an oblong and not of a circular form, as, according to the laws of equal refraction, it ought to be, he conjectured that light is not homogeneal: but that it consists of rays of different colours, and endued with divers degrees of refrangibility. And, from a farther prosecution of his experiments, he concluded that the different colours of bodies arise from their reflecting this or that kind of rays most copiously. This method of accounting for the different colours of bodies soon became generally adopted, and still continues to be the most prevailing opinion. It is hence agreed that the light of the sun, which to us seems white and perfectly homogeneal, is composed of no fewer than seven different colours, *viz.* red, orange, yellow, green, blue, purple, and violet or indigo: that a body which appears of a red colour has the property of reflecting the red rays more plentifully than the rest; and so of the other colours, the orange, yellow, green, &c.: also that a body which appears black, instead of reflecting, absorbs all or the most part of the rays that fall upon it; while, on the contrary, a body which appears white reflects the greater part of all the rays indiscriminately, without separating them one from another.

The foundation of a rational theory of colours being thus laid, the next inquiry was, by what peculiar mechanism, in the structure of each particular body, it was fitted to reflect one kind of rays more than another, and this is attributed by Sir I. Newton to the density of these bodies. Dr. Hooke remarked, that thin transparent substances, particularly soap-water blown into bubbles, exhibited various colours, according to their thinness; and yet, when they have a considerable degree of thickness, they appear colourless. And Sir Isaac himself had observed, that as he was compressing two prisms hard together, in order to make their sides (which happened to be a little convex) to touch one another, in the place of contact they were both perfectly transparent, as if there had been but one continued piece of glass: but round the point of contact, where the glasses were a little separated from each other, rings of different colours appeared. And when he afterwards, farther to elucidate this matter, employed two convex glasses of telescopes, pressing their convex sides upon one another, he observed several series of circles or rings of such colours, different, and of various intensities, according to their distance from the common central pellucid point of contact.

As the colours were thus found to vary according to the different distances between the glass plates, Sir Isaac conceived that they proceeded from the different thickness of the plate of air intercepted between the glasses; this plate of air being, by the mere circumstance of thinness or thickness, disposed to reflect or transmit the rays of this or that particular colour. Hence, therefore, he concluded, that the colours of all natural bodies depend on their density, or the magnitude of their component particles: and hence also he constructed a table, in which the thickness of a plate necessary to reflect any particular colour was expressed in the millionth parts of an inch.

From a great variety of such experiments, and observations upon them, our author deduced his theory of colours. And hence it seems that every substance in nature is transparent, provided it be made sufficiently thin; as gold, the densest substance we know of, when reduced into thin leaves, transmits a bluish green light through it. If we suppose any body, therefore, as gold, for instance, to be divided into a vast number of plates, so thin as to be almost perfectly transparent, it is evident that all, or the greatest part of the rays, will pass through the upper plates, and when they lose their force will be reflected from the under ones. They will then have the same number of plates to pass through which they had penetrated before; and thus, according to the number of those plates through which they are obliged to pass, the object appears of this or that colour, just as the rings of colours appeared different in the experiment of the two plates, according to their distance from one another, or the thickness of the plate of air between them.

This theory of the colours has been illustrated and confirmed by various experiments, made by other philosophers. Mr. Delaval produced similar effects by the infusions of flowers of different colours, and by the intimate mixture of the metals with the substance of glass, when they are reduced to very fine parts; the more dense metals imparting to the glass the less refrangible colours, and the lighter ones those colours that are more easily refrangible. Dr. Priestley and Mr. Canton, also, by laying very thin leaves or slips of the metals upon glass, ivory, wood, or metal, and passing an electrical stroke through them, found that the same effect was produced, *viz.* that they were tinged with different colours, according to the distance from the point of explosion.

Mr. Delaval has given also an account of some experiments made upon the permanent colours of opaque substances, which may prove of great importance in the arts of dying, &c.

The changes of colour in permanently coloured bodies, he observes, are produced by the same laws that take place in transparent colourless substances; and the experiments by which they are investigated consist chiefly of various methods of uniting the colouring particles into larger masses, or dividing them into smaller ones. Sir Isaac Newton made his experiments chiefly on transparent substances; and in the few places where he treats of others, he acknowledges his want of experiments. He makes the following remark, however, on those bodies which reflect one kind of light and transmit another, *viz.* that if these glasses or liquors were so thick and massy that no light could get through them, he questioned whether they would not, like other opaque bodies, appear of one and the same colour in all positions of the eye; though he could not yet affirm it from experience. Indeed it was the opinion of this great philosopher, that all coloured matter reflects the rays of light, some reflecting the more refrangible rays most copiously, and others those that are less so; and that this is at once the true and only reason of these colours. He was likewise of opinion, that opaque bodies reflect the light from their anterior surface, by some power of the body evenly diffused over and external to it.

With respect to transparent coloured bodies, he thus expresses himself: "A transparent body, which looks of any colour by transmitted light, may also look of the same colour by reflected light; the light of that colour being reflected by the farther surface of that body, or by the air beyond it: and then the reflected colour will be diminished, and perhaps cease, by making the body very thick, and pitching it on the back side to diminish the reflection of its farther surface, so that the light reflected from the tinging particles may predominate. In such cases the colour of the reflected light will be apt to vary from that of the light transmitted."

To search out the truth of these opinions, Mr. Delaval entered upon a course of experiments with transparent coloured liquors and glasses, as well as with opaque and semitransparent bodies. And from these experiments he discovered several remarkable properties of the colouring matter; particularly, that in transparent coloured substances it does not reflect any light; and when, by intercepting the light which was transmitted, it is hindered from passing through such substances, they do not vary from their former colour to any other, but become entirely black.

This incapacity of the colouring particles of transparent bodies to reflect light, being deduced from very numerous experiments, may therefore be taken as a general law. It will appear the more extensive, if it be considered that, for the most part, the tinging particles of liquors or other transparent substances, are extracted from opaque bodies; that the opaque bodies owe their colours to those particles in like manner as the transparent substances do; and that by the loss of them they are deprived of their colours.

Notwithstanding these and many other experiments, the theory of colour seems not yet determined with certainty. The discoveries of Sir Isaac Newton, however, are sufficient to justify the following aphorisms.

1. All the colours in nature arise from the rays of light. 2. There are seven primary colours; namely, red, orange, yellow, green, blue, indigo, and violet. 3. Every ray of light may be separated into these seven primary colours. 4. The rays of light, in passing through the same medium, have different degrees of refrangibility. 5. The difference in the colours of light arises from its different refrangibility: that which is the least refrangible producing red; and that which is the most refrangible violet. 6. By compounding any two of the primary, as red and yellow, or yellow and blue, the intermediate colour, orange or green, may be produced. 7. The colours of bodies arise from their dispositions to reflect one sort of rays, and to absorb the others; those that reflect the least refrangible rays appearing red, and those that reflect the most refrangible violet. 8. Such bodies as reflect two or more sorts of rays appear of various colours. 9. The whiteness of bodies arises from their disposition to reflect all the rays of light promiscuously. 10. The blackness of bodies proceeds from their incapacity to reflect any of the rays of light. And from their thus absorbing all the rays of light that are thrown upon them, it arises, that black bodies, when exposed to the sun, become hot sooner than all others.

Sir Isaac Newton, in the course of his investigations of the properties of light, discovered that the lengths of the spaces occupied in the spectrum by the seven primary colours exactly correspond to the lengths of chords that sound the seven notes in the diatonic scale of music; which is made evident by an experiment. On a paper, or other fit substance, in a darkened room, let a ray of light be refracted by means of a prism into a spectrum of some size, marking upon it the precise boundaries of the several colours, and it will be found that the spaces by which the several colours are bounded, *viz.* the space containing the red, that containing the orange, yellow, &c. will be in exact proportion to the divisions of a musical chord for the notes of an octave; that is, as the intervals of these; 1 $\frac{8}{9}$; $\frac{5}{6}$; $\frac{3}{4}$; $\frac{2}{3}$; $\frac{3}{5}$; $\frac{9}{16}$; $\frac{1}{2}$. See COLOURS, OPTICS, &c.

CHROME, a metal discovered by Vauquelin. It exists in the state of an acid, combined with oxide of lead, in a beautiful mineral named red lead, found in Siberia, and with regard to which very discordant analyses had been given by different chemists. Vauquelin reduced the metallic acid which he discovered in it to the metallic acid, and his researches have been confirmed by those of Klaproth and Gmelin. It derives its name from the splendid and numerous colours which it presents in its saline combinations. It has since been discovered in various minerals. The native chromate of lead, or the red lead of Siberia, is generally crystallized in oblique tetrahedral prisms. Its colour is a fine aurora red; its lustre shining, and intermediate between adamantine and resinous; the crystals are translucid; the fracture is uneven; the specific gravity 6.0269. It depreciates before the blow-pipe, and melts into a blackish scoria. It colours borax green by fusion. According to Vauquelin, it is composed of 57.10 of lead, 6.86 of oxygen, and 36.04 of chromic acid. There is found with the chromate of lead, a mineral of a green colour, in minute crystals, which Vauquelin found to be composed of the oxides of chrome and lead, and which, as he conjectures, has probably originated in the decomposition of the perfect chromate, from some process by which part of its oxygen has been abstracted.

Native chromate of iron has more lately been found in the department of Var in France, and likewise in Siberia. This mineral is massive, of a blackish brown colour, with no great lustre, and opaque; its fracture is uneven, and it is hard and difficult to break; its specific gravity is 4.0. It is scarcely fusible before the blow-pipe, but with borax it melts into a glass of a fine green colour. According to an accurate analysis of it, it consists of 63.6 of chromic acid, or perhaps rather oxide of chrome, and 36 of oxide of iron.

Chrome has been also found in smaller quantities in other minerals, particularly in some gems, of which it appears to be the colouring principle. It exists in the emerald, in the state of green oxide, and in the spinal ruby, in the state of acid.

Vauquelin extracted the metal from the red lead ore, by adding to it muriatic acid, which combines with the oxide of lead, and forms a compound that is precipitated, the chromic acid remaining in solution. To abstract a little muriatic acid combined with it, oxide of silver is cautiously added, and the pure chromic acid being decanted from the precipitate of muriate of silver, and evaporated, is exposed to a very strong heat, excited by a forge, in a crucible of charcoal, placed within another of porcelain. It is thus reduced to the metallic state. It is to this chemist that we are indebted, principally, for a knowledge of its properties.

Chrome is of a white colour inclining to grey: it is very brittle; its fracture presents a radiated appearance, needles crossing in different directions, with interstices between them Its other physical qualities have not been determined. This metal is difficult of fusion. Exposed to the heat of the blow-pipe, it does not melt. When fused, by having been exposed to the intense heat necessary to its reduction, it presents crystalline filaments, which rise above the metallic mass. Chrome is not easily acted on by the acids. Even when reduced to a fine powder, and treated with concentrated boiling, nitric acid, it is oxydized with much difficulty, and communicates to the acid only a green tinge.

Chrome, in the state of acid, appears to be more susceptible of combination, and this acid being obtained without difficulty from its native combinations, its chemical relations have been more examined. Chromic acid is very soluble in water; the taste of the solution is sharp and metallic; it is of an orange-red colour; by evaporation, either spontaneous or with a gentle heat, it affords crystals in long slender prisms, of a ruby-red colour. This acid combines with the alkalies, earths, and metallic oxides, forming neutral salts, which are named chromates.

The combinations of this acid with metallic oxides are in general possessed of very beautiful colours, and are well adapted to form the finest paints. That with oxide of lead has an orange yellow, of various shades; that with mercury, a vermilion red; with silver, a carmine red; with zinc and bismuth, the colours are yellow; with copper, cobalt, and antimony, they are dull.

CHRONOLOGY, is that science which relates to time; treats of the division of it into certain portions, as days, months, years, centuries; and the application of these portions, under various forms and combinations, as cycles, æras, &c. to the elucidation of history. What is proposed in the present article is, to point out the chief methods by which the several portions of time have been computed, and in which they have been employed in ascertaining the connection, and determining the dates, of past transactions.

The divisions of time which most probably first attracted the notice of mankind, as most obvious to their senses, were those marked by the revolutions of the heavenly bodies, days, lunar months, and years: and if these had corresponded so exactly to each other, that every lunation had consisted uniformly of the same number of days, and each year of a regular number of complete lunations, the business of chronology would have been attended with comparatively little difficulty. In consequence, however, of variations in the revolutions of the earth, which it is not requisite here to explain, it has become necessary to adjust these periods to each other by certain artificial divisions. Of these divisions,

The Day claims our first notice. In common speech, a day means that period of time, which is included between the first appearance of light in the morning and the return of darkness in the evening, or during which the sun is visible above the horizon. But the word is used, in a more comprehensive sense, to denote the time of a complete revolution of the earth round its axis. The former has been denominated a natural, the latter a civil, and sometimes a solar, day. The beginning of the day has been variously reckoned by different nations. The Chaldæans, Syrians, Persians, and Indians, reckoned the day to commence at sunrise. The Jews, also, used this method for their civil, but began the sacred day at sun-set: this latter mode was used likewise by the Athenians, the Arabs, the Ancient Gauls, and some other European nations. The Egyptians appear to have had several methods of reckoning their day; probably the mode varied in different parts of the country, and in the same place at different periods. The ancient inhabitants of Italy computed the day from midnight, and in this they have been followed by the English, French, Dutch, Germans, Spaniards, and Portuguese; modern astronomers, after the Arabians, count the day from noon.

The day was subdivided by the Jews and Romans into four parts, which they denominated watches or vigils; the first commenced at six in the morning, the second at nine, the third at twelve, and the fourth at three in the afternoon. The beginning of the first watch was, by the Jews, called the third hour, and so on in succession to the fourth watch, which was reckoned the twelfth hour. The night was divided in a similar manner. Other modes of dividing the day have been in use among different nations; but that which is now most general in civilized countries is into 24 equal parts or hours. With respect to the different inventions which have been used for measuring or distinguishing the hours of the day, we refer to the articles Clepsydra, Clock, Sun-Dial, &c.

The Week, is a division of time, of which it may be proper to take some notice before we proceed to the month. Various divisions which might be included under this denomination have obtained in different countries. The earlier Greeks divided their month into three portions, of ten days each: the Northern Chinese had a week of fifteen days, and the Mexicans one of thirteen. But the Chaldeans, and most other Oriental nations, have, from time immemorial, used the Jewish week of seven days, which has been adopted by the Mahommedans, and introduced, with christianity, to most of the civilized nations of the world. In the Old Testament, the term week is occasionally applied to a period of seven years, as well as of seven days; and to this it is necessary to attend, in order to understand the passages wherein the word is used in that sense.

The Month. There can be little doubt, but that this division of time was at first suggested by the phases, or the periodical change in the appearances of the moon, and consequently, that in ancient computations the months were invariably lunar. The difficulty, however, of adjusting this month to the annual revolution of the earth, led, with the improvement of astronomy, to the invention of other divisions under this name. Months are now divided into astronomical and civil. The astronomical months, with which chronology is concerned, are measured by the revolutions of the moon, and are either periodical or synodical. The periodical lunar month is composed of the time which elapses between the departure of the moon from any part of her orbit, and her return to the same point, which is 27 days, 7 hours, and 43 minutes. The synodical lunar month is reckoned from one conjunction of the sun with the moon to another. This period is not always the same, being subject to the variation occasioned by the motion of the sun eastward on the ecliptic: a mean lunation consists of 29 days, 12 hours, and 44 minutes. This was the lunar month mostly in use in ancient times. The civil month is that artificial space of time, by means of which the solar year is divided into twelve parts: these months, which were first ordained by Julius Cæsar, consist of thirty, or thirty-one days each, with the exception of February, which commonly contains twenty-eight, and every fourth year twenty-nine, days.

Years. The year may be termed the largest natural division of time. As the diurnal revolution of the earth would naturally lead to the division into days, and the phases of the moon, with a little attention, to that into months, so the annual motion of the earth round the sun, which would be marked by the periodical return of certain appearances, seasons, &c. would in due course lead to the adoption of this larger division. At what time this took place is uncertain, but probably not before considerable advances had been made in astronomical science. It was long, however, after its first adoption, before it attained to any thing like an accurate form. The most ancient measure of the year, of which we know, consisted of twelve lunar months, which, for the facility of computation, being all considered as equal in length, and to contain thirty days each, amounted to 360 days. It is conjectured that this gave rise to the division of the ecliptic, which still obtains, into 360 equal parts or degrees.

This luni-solar year probably had its rise in Chaldæa, or Egypt; we learn, at least, from the testimony of Herodotus, that it was used in the latter country. Hence, with the diffusion of science, it was carried into other regions, and very generally adopted. It was early in use among the Indians, Chinese, the Medes, and Persians, and the ancient Greeks. Its measure being, however, inaccurate, containing five days and a quarter more than the lunar, and as much less than the true solar year, and this defect becoming every year more perceptible from the retrocession of the seasons, &c. it was soon considered necessary to subject it to some revision. The Thebans are supposed to have been the first who undertook its correction, by making an annual addition of five days to the luni-solar year. Thales introduced this improvement into the ancient Grecian year, and it was adopted, with some trifling variations in particular instances, into the Indian, the Chinese, and the Jewish year.

The Roman year, as regulated by Romulus, and afterwards reformed by his successor Numa, was reckoned by lunar months, and adjusted to the seasons by a number of intercalary days. It consisted of ten lunar months, of which December was the last, and to these two whole intercalary months were added, but not inserted in the calendar. This year began at first in March; but the Decemviri, who undertook its reformation, changed the order of the months into that in which they now stand, introduced the two intercalary months, January and February, into the calendar, and made January the first month of the year.

Owing to the ignorance, or the carelessness, of the Pontifices Maximi, to whose care the regulation of the intercalary days was committed, the year was reduced to such disorder in the time of Julius Cæsar, that the winter months had fallen back to the autumn. To restore them to their proper season, Cæsar formed a year of 445 days, which has been styled the year of confusion. With the assistance of Sosigenes, a mathematician of Alexandria, he afterwards, in the year B. C. 45, instituted a solar year of 365 days 6 hours, which is now known under the name of the Julian year. To adjust this year to the annual revolution of the earth, which is six hours and some minutes more than 365 days, the length of the ordinary year, a day was appointed to be intercalated every fourth year in the month of February: this day, from its position in the Roman calendar, was called bissextile, a name which has also been given to the year in which the intercalation takes place.

The Julian year, although it approaches very near the truth, is not, however, perfectly correct. The true time of the annual revolution of the sun in the ecliptic is 365 days, 5 hours, and nearly 49 minutes, which falls short by a few minutes of the time assumed in the Julian year. How trifling soever this difference might at first appear, it amounted in a hundred and thirty-one years to a whole day: in consequence of this, the vernal equinox, which Sosigenes, in the first year of the Julian correction, observed to fall on the 25th of March, had gone back in A. D. 325, at the time of the council of Nice, to the 21st, and in A. D. 1582, to the 11th of March. To remedy this growing defect, Pope Gregory XIII. caused the calendar to undergo another correction. In A. D. 1580, he ordered ten days to be cut out of the month of October, so that the fourth was reckoned the 15th day: and to prevent such retrocession in future, in addition to the Julian regulation with respect to the bissextile year, he ordained that the years 1600, 2000, 2400, and every fourth centutury in succession, should have an intercalation of a day, but that in the other centuries, 1700, 1800, 1900, 2100, &c. the day should be omitted, and those years remain common years. This regulation comes so near the truth, that the only correction it will require will be the suppression of a day and a half in five thousand years.

The Gregorian year, or, as it is vulgarly called, the new style, was immediately adopted in Spain, Portugal, and part of Italy. It was introduced into France in

October of the same year, the tenth of which month was, by an ordinance of Henry III. reckoned the twentieth day. In Germany it was adopted by the Catholic states in 1583, but the Protestant states adhered to the old calendar until the year 1700. Denmark also adopted it about this period, and Sweden in 1753. It was not used in England before 1752, when, by act of Parliament, the style was changed, and the third of September was reckoned the fourteenth, the difference having by this time increased to eleven days. Russia is the only country in Europe in which the old mode of reckoning is still in use.

The want of some specific standard, which could be regarded as common to all nations, has occasioned great diversity in different countries in fixing the beginning of the year. The Chaldæans and Egyptians reckoned their years from the autumnal equinox. The Jews also reckoned their civil year from this period, but began their ecclesiastical year in the spring. Gemschid, the King of Persia, ordered the year in that country to commence at the vernal equinox. In Sweden the year formerly commenced at the winter solstice. The Greeks used different methods, some of the states beginning the year at the vernal, others at the autumnal equinox, and some at the summer solstice. The Roman year at one time began in March, but afterwards was made to commence in January. The new year's day of the Church of Rome is fixed on the Sunday nearest the full moon of the vernal equinox. In England, the year began in March until A. D. 1752, when the act of Parliament which altered the style ordained it to commence on the first of January.

Having thus given a short account of the lunar and solar years which have been mostly in use, and an acquaintance with which is of most consequence in chronology, it will be proper just to notice some combinations of years which are mentioned in ancient history, and therefore proper to be known.

Lustra. The Romans sometimes reckoned by lustra, a period of five years, which derived its name from a census instituted by Servius Tullius, which was to be paid by the Roman people every fifth year.

The Olympiads were, however, the most remarkable of these combinations. They consisted of four Grecian years, and derived their names from the public games celebrated every fourth year at Olympia, in Peloponnesus. These games were instituted in honour of Jupiter, but at what time, or by whom, is not known. After they had been neglected and discontinued for some time, they were restored by Iphitus, King of Elis, in the year B. C. 776; and it is from this date that the Olympiads are reckoned in chronology.

Cycles are fixed intervals of time, composed of the successive revolutions of a certain number of years. The lustra and the olympiads may perhaps be included under this name, but the term is more commonly appropriated to larger intervals, connected with the periodical return of certain circumstances and appearances. The great use made of cycles in chronology requires that they be particularly noticed.

From the defective nature of the Greek calendar, the olympic year, as it has been called, was subject to considerable variation; and, from the retrocession of the months which it occasioned, producing a gradual change of the seasons when the games were to be celebrated, led to much inconvenience. Cleostrates, a mathematician of Tenedos, endeavoured to give it a more perfect form, by inventing a cycle of eight years: this, however, being computed by lunar years, still left the calendar subject to great inaccuracies. To rectify these, Meton, a mathematician of great celebrity, invented—

The Lunar Cycle, a period of nineteen solar years, at the end of which interval the sun and moon return to very nearly the same part of the heavens. This improvement was at the time received with universal approbation; but not being perfectly accurate, was afterwards corrected by Eudoxus, and subsequently by Calippus, whose improvements modern astronomers have adopted.

The use of this cycle was discontinued when the games, for the regulation of which it was composed, ceased to be celebrated. The Council of Nice, however, wishing to establish some method for adjusting the new and full moons to the course of the sun, with the view of determining the time of Easter, adopted it as the best adapted to answer the purpose: and from its great utility, they caused the numbers of it to be written on the calendar in golden letters, which has obtained for it the name of the golden number. The golden number for any year is found as follows:—The first year of the christian æra corresponds to the second of this cycle; if then to a given year of this æra one be added, and the sum be divided by 19, the quotient will denote the number of cycles which have revolved since the commencement of the Christian æra, and the remainder will be the golden number for the given year. *e. g.* If the golden number of the present year (1808) be required, one being added, the sum will be 1809; this being divided by 19, will give 95 for the quotient, and 4 for the remainder, or golden number sought.

The Solar Cycle is another of these periods, the inventor of which is at present, however, unknown. It consists of 28 years, at the expiration of which the sun returns to the sign and degree of the ecliptic which he had occupied at the conclusion of the preceding period, and the days of the week correspond to the same days of the month as at that time. It is used to determine the Sunday, or dominical, letter, which we shall briefly explain.

In our present calendars the days of the week are distinguished by the first seven letters of the alphabet: A, B, C, D, E, F, G; and the rule for applying these letters is, invariably, to put A for the first day of the year, whatever it be, B for the second, and so in succession to the seventh. Should the first of January be Sunday, the dominical, or Sunday, letter for that year will be A, the Monday letter B, &c. and as the number of the letters is the same as that of the days of the week, A will fall on every Sunday, B on every Monday, &c. throughout the year. Had the year consisted of 364 days, making an exact number of weeks, it is obvious that A would always have stood for the dominical letter: the year containing, however, one day more, it follows that the dominical letter of the succeeding year will be G. For Sunday being the first day of the preceding year will be also the last, and the first Sunday in the next year will fall on the seventh day, and will be marked by the seventh letter, or G. This retrocession of the letters will, from the same cause, continue every year, so as to make F the dominical letter of the third, &c. If every year were common, the process would continue regularly, and a cycle of seven years would suffice to restore the same letters to the same days as before. But the intercalation of a day, every bissextile or fourth year, has occasioned a variation in this respect. The bissextile year containing 366, instead of 365 days, will throw the dominical letter of the following year back two letters; so that, as in the present year (1808), if the dominical letter at the beginning of the year be C, the dominical letter of the next year will be, not B, but A. This alteration is not effected by dropping a letter altogether, but by changing the dominical letter at the end of February, where the intercalation of a day takes place. Thus, in the present year, C is the dominical letter in January and February, but B is substituted for it in March, and continues to be the dominical letter through the remainder of the year. In consequence of this change every fourth year, twenty-eight years must elapse, before a complete revolution can take place in the dominical letter, and it is on this circumstance that the period of the solar cycle is founded. A table constructed to shew the dominical letters, for any given years of one of these cycles, will answer for the corresponding years in every successive cycle. The first year of the Christian æra corresponds to the ninth of this cycle; if, therefore, to any given year of the Christian æra nine be added, and the sum be divided by 28, the quotient will denote the number of the revolutions of the cycle since the ninth year B. C. and the remainder will be the year of the cycle. If there be no remainder, the year of the cycle will be the last, or twenty-eight. *e. g.* Nine being added to 1808, makes 1817; this sum being divided by 28, gives a quotient of 64 for the revolutions of the cycle, and a remainder of 25 for the year of the cycle. There is another cycle in use, called

The Cycle of Indiction. It consists of fifteen years, and is derived from the Romans. Learned men are not agreed as to the origin of it, but the most probable opinion is, that the return of this period was appointed for the payment of some public taxes or tributes. The first year of this cycle is made to correspond to the year 3 B C. If therefore to any given year of the Christian æra 3 be added, and the sum be divided by 15, the remainder will be the year of this cycle. There is however another mode of calculating it. This cycle was established by Constantine A. D. 312; if therefore from the given year of the Christian æra 312 be subtracted, and the remainder be divided by 15, the year of this cycle will be obtained. In either of these ways, if there be no remainder, the indiction will be 15. We subjoin an example, calculated by each of the methods above specified.

1808	1808
3	312
15)1811(120	15)1496(99
15	135
31	146
30	135
11 { the indiction for the present year	11

The Julian Period, some acquaintance with which is indespensable in the study of chronology, will be easily undertood from the preceding account of the cycles. It is formed by the combination of the three, by multiplying the numbers 28, 19, and 15, of the cycles of the sun, moon, and indiction, into each other. The total of years thus produced is 7980, of which the Julian period consists, at the expiration of which, and not sooner, the first years of each of those cycles will again come together. This period was invented by Joseph Scaliger, as one by which all æras, epochs, and computations of time, might readily be adjusted. The first year of the Christian æra corresponds to the 4714th of the Julian period, and it extends as far back as 706 years beyond the common date of the creation 4004. The year of the Julian period, corresponding with any given year before or since the commencement of the Christian æra, may easily be fonnd by the following rule. If the year required be of the latter kind, add to it 4713, the number of years of the Julian period elapsed before the Christian æra, and the sum will be the year required. If it be of the former, subtract the year B. C. from 4714, and the difference will give it.

This period has been esteemed by many to be of the highest importance in chronology, as affording a common standard for the adjustment of different epochs. Modern chronologers are not however so warm in their admiration of it as their predecessors have been. A common standard is unquestionably of the highest consequence in the comparison of dates and æras, and in the general arrangement and division of time; and from its great utility, and the necessity of its frequent application, it is of importance that it should be as simple as possible in its nature and construction. The Julian period is liable to objection on the latter score, as being rather complicated in its formation; and its necessity is now altogether superseded by the very general adoption of the Christian æra as the standard of time. Any events or æras, prior or subsequent to its commencement, may easily be computed by it, and the date of them be impressed in the memory with very little exertion or difficulty.

It remains that we give some account of *Epochs and Æras*, terms which constantly recur in history, and the elucidation of which belongs to the province of chronology. An epoch is a certain point, generally determined by some remarkable event, from which time is reckoned: and the years computed from that period are denominated an æra. The birth of Christ is considered as an epoch—the years reckoned from that event are called the Christian æra.

In sacred chronology, the first and most remarkable epoch is that of the creation of the world. As learned men could not agree as to the precise time when this took place, the folly of reckoning from it as a standard soon became appearent, and the practice was in consequence abandoned. Archbishop Usher, whose scripture chronology is adopted in our English Bibles, fixes this event in the year 4004 before Christ. Playfair places it in 4007.

The universal deluge forms another epoch, this is placed by Usher in the year B. C. 2349. A third sacred epoch is the call of Abraham, which happened, according to the same learned authority, B. C. 1921. The next epoch is the departure of the Israelites from Egypt, which Usher places B. C. 1491.

In profane history, we shall first notice the epoch of the Argonautic expedition, an event much celebrated in ancient history, and of some importance in chronological discussion, from being adopted by Sir Issac Newton as the foundation of his system of chronology. The date of this transaction has been placed in the year 1225 B. C. but in this chronologers are not agreed.

The destruction of Troy forms another remarkable epoch. Considerable uncertaintly prevails as to the exact time when this event, as well as the preceding, took place. Playfair fixes it in the year B. C, 1184.

The æra of the Olympiads we have noticed above, and it will be unnecessary to give any farther account of it here. The epoch of the building of Rome is the next that claims our attention. From the total want of early records, and other necessary documents for deciding the question, the date of this event is involved in the obscurity common to many other remote occurrences. The Roman writers themselves, and all who have followed them on the subject, differ widely respecting it. Polybius fixes it in the year B. C. 751. Cato, and others, one year earlier. Terentius Varro places it in 753 B. C. Fabius Pictor, who is followed by Diodorus Siculus, assigns it to 747 B. C. Sir Isaac Newton adopts the year 627 B. C. and Playfair, after Varro, whose computation was used by the Roman Emperors in their public instruments, places it in the year B. C. 753. Great use is made of this epoch in the histories of ancient Rome, and the historical student will do well to ascertain, if possible, what opinion the author he may be perusing adopts, and to what year of the Christian æra the first year of Rome, according to his author, corresponds. The dates of the events will by this method be accurately ascertained as he proceeds. The Romans sometimes reckoned the year from the establishment of the consular dignity, and afterwards from the years of the Emperors.

The æra of Nabonassar is another of those standards by which the dates of events in some histories are regulated. Nabonassar was the founder of the Babylonish monarchy. This æra is reckoned from the commencement of his reign, which is placed in the year B. C. 747, of the Julian period 3967, and extends as far down as the death of Alexander. The Nabonassarean year consists of 12 months of 30 days each, and five intercalary days, making in all 365 days.

The æra of the Seleucidæ, or, as it is sometimes called, the year of the contracts, is reckoned from the establishment of Seleucus, one of Alexander's generals, after that conqueror's death, in the empire of Babylon, and is reckoned from the year B. C. 312. It is generally supposed to have begun in the spring. It was used in a large district of Asia, and adopted by the Jews.

The Spanish æra, founded on a division of the Roman provinces among the Triumviri, was long in use in Spain and Africa, and was adopted in the dates of the principal councils and synods held in those countries. It is reckoned from the first of January B. C. 38. This was afterwards superseded by

The Christian æra. Learned men have differed in opinion with respect to the exact time of the birth of Christ, some placing it four, others seven, years earlier than the first year of the Christian æra. The uncertainty which exists upon this point arises from the æra not having been used until so many centuries had elapsed, that it was impossible to fix the date with accuracy. This is, however, of very little consequence in the application of this æra to chronological purposes, for all are agreed as to the numerical date of every year, the year 1808, for instance, being universally received as the year 1808 of the Christian æra, although probably not the exact measure of the time which has elapsed from the birth of Christ. This æra was invented about the year 527 by Dionysius, a Roman abbot, who reckoned the first year of it to correspond with the 4714th of the Julian period. It may be useful to give the reader a view of the years of the other principal æras which correspond to the first of this: according to Playfair, (who, it is to be observed, differs in many respects from other chronologers, but is, nevertheless, a most respectable authority) these are the 4008th year of the world, the first year of the 195th Olympiad, the 754th year of Rome, the 749th of the Nabonassarean æra, the 313th of the Seleucidæ, the 46th Julian year, and the 39th of the Spanish æra.

The æra of Dioclesian was used pretty generally by the Christians previous to the invention of the Christian æra. It is dated from the year A. D. 284, and probably took its rise from the persecution under that Emperor, although its date is computed from the first year of his reign.

The Hegira, which may be called the Mohammedan æra, is founded upon the flight of Mohammed from Mecca to Medina, to escape the persecution of his enemies, and is computed by his followers from A. D. 622. The beginning of their year is however made to correspond with the 16th day of July. In comparing any year of this æra, therefore, with the corresponding year of the Christian æra, it will be necessary to bear this in mind before it can be done with accuracy. The same may also be observed with regard to some of the other æras, the beginnings of the years of which do not exactly correspond with that of the Julian year.

The Persian æra, or the æra of Yezdejerd, is the last we shall notice. Yezdejerd was the last of the Persian monarchs who was subdued by the Saracens. According to the opinion of the most reputable modern chronologers, this æra commenced in June, A. D. 632, corresponding with the beginning of the eleventh year of the Hegira, and with the first year of the reign of Yezdejerd. The years of this æra, like the Nabonassarean, consists of 12 months of 30 days, with an addition of 5 intercalary days at the end, making in all 365 days.

The limits of our plan will not allow us to enter more minutely into the details of this important science. For these we must refer to separate treatises on the subject. The abstract which is here given will, however, be found sufficient for all the general purposes of the historical student. We have purposely refrained from giving a chronological table of remarkable events, as such tables are to be procured with very little trouble. Various ingenious methods have been invented, of associating the name of some remarkable event with the date of its occurrence, with the view of impressing it on the memory; for some account of these, we must refer to the article Memory Artificial.

CHRONOMETER, an instrument or machine for measuring time. The word is more particularly used by workmen and navigators to denote a watch, or portable machine, in which, by the nature of the escapement and the compensations for heat and cold, mean time is or ought to be kept with sufficient accuracy to determine the longitude at sea.

The relation between time and longitude will be fully explained hereafter: it will therefore be sufficient in this place to remind the reader, that the rotation of the earth upon its axis brings the several places upon its surface, in succession, opposite the sun, causing day and night; so that the absolute instant of noon, or of any other determined apparent time of the day, at each place must be earlier, at a place which lies to the eastward of another, with which that place may be compared. From this general fact it follows, that allowing 24 hours for the whole rotation of the earth, and proportionally for every smaller part of the rotation, we may determine (provided the apparent time at two places be known) what is the difference of longitude between them. Thus, if a chronometer set to the time at Greenwich were to be carried to Petersburgh, in Russia, it would indicate time two hours later than the clocks at Greenwich; that is to say, it would shew when it was noon at Greenwich, instead of when at Petersburgh. The obvious conclusion would be, that the sun arrives at the meridian of Petersburgh earlier, and consequently that this town lies more easterly than Greenwich; and as two hours are in proportion to 24 hours, so is 360°, the earth's circumference, to 30°, the longitude of St. Petersburg, reckoned from Greenwich. Upon the same principle it is, that the clocks in a large town ought not to indicate the same time. Thus the clocks at St. Paul's, St. Clement's, St. Martin's, and St. George's, Hanover Square, in London, ought to strike each four seconds after the other; and this difference, it may be added, would nearly vanish, if heard from any of the westerly stations, on account of the time employed for the passage of sound; and for the same reason it would be nearly doubled in the opposite direction.

From the intimate relation which subsists between the construction of watches and clocks, the similitude of the escapements, and the common principles upon which the compensations for heat and cold are effected in each, we shall explain the principles of each under the general article Horology; and at present we shall only give an account of the nature of the expedients adopted to produce superior accuracy in these portable machines.

The train of wheels, which constitutes so large a part of every time-piece, must necessarily transmit the force of the first mover with periodical irregularities, arising from oblique actions of their teeth upon each other; and these irregularities will be subject to other variations, arising from the greater or less degree of fluidity in the oil applied to the pivots and elsewhere. The first mover also in a portable machine being a spring will be more rigid, and consequently act with greater power when cold than when hot. The balance, or vibrating measurer of the time, is a wheel, or equivalent piece, fixed on an axis, upon which it could freely turn; but this liberty is restrained by a fine spring, called the pendulum spring, which is fastened to the axis, and after taking several turns round without touching it, the other end of the spring is fixed to the frame of the machine. By this contrivance the balance will, if not prevented, come to rest in one particular position; and if at any time disturbed, it will only vibrate each way from the line of quiescence, performing larger or smaller arcs, according to the disturbing force. This force in a watch or time-keeper is communicated from the train; most commonly during the time of each vibration: and the machinery or contrivance, by or through which the successive impulses, or actions, are made, is called a 'scapement or ESCAPEMENT, several of which are described at the articles referred to.

According to the nature of the escapement, and the part of the vibrating arc at which the impulses are applied, the vibrations of the balance may be made to employ a longer or shorter time than they would have employed if the balance had been separate from the works. Thus, in the common watch, these impulses quicken the vibrations; and consequently an increase in the maintaining force will make the watch go faster; as may be easily tried by gently forcing the key in the opposite direction to winding up.

If the balance and its spring were to continue unchanged in all temperatures, and under all circumstances, and if its long and short vibrations measured equal times when separate from the machine, it would only be required that the escapement should be so constructed as neither to accelerate nor retard them. But none of these conditions can be had in the ordinary structure of watches, and in the superior time-pieces considerable difficulties are found in the attempt to obtain them.

By the natural contraction, to which all bodies are subject when cooled, the diameter of the balance will be less the lower the temperature: it will therefore be more easily carried by the vibrating forces, and will then vibrate more quickly.

The spring attached to the balance, which is called the pendulum spring, will likewise act with greater force when cold, and on this account also the vibrations will be quicker.

The remedies for these causes of imperfection are the following:

1. The Remontoire. As the irregularities in the transmission of force from the main spring are certainly increased by the number of wheels in the train, it was proposed, in the infancy of the art, to detach the last wheel, or that nearest the balance, or time measurer, from the rest, and to move this by a separate spring or weight: so that in this contrivance the time measurer is acted upon by one single wheel, and the rest of the train is employed in winding up the secondary first mover at short intervals, such, for example, as every half minute. We shall also have to mention some escapements, in which the winding up is performed in every single vibration. With regard to remontoires, it may be remarked, that they either greatly shorten, or else destroy the periodical irregularities of the train, and those of the main-spring; but that with regard to the influence of oil, and other causes of more permanent difference, their advantage is not very considerable, because the remedy is not applied where the motion is quickest.

Whether the irregular action of the maintaining power be diminished by the remontoire or not, it is desirable that the impulse on the balance, through the escapement, should affect the natural measure of its vibrations as little as possible; or rather that it should tend to equalise them when the arcs of vibration vary. Some attention, but not much, has been paid to the equalizing quality of an escapement, principally by making the faces of the pallets of a figure suitable to that effect; but these are now for the most part abandoned, and the method of applying the force constitutes the distinguishing feature in this part of our modern chronometers. If a balance be set to vibrate by the mere action of its pendulum spring, its motion will soon decay; but if we suppose a lever or pallet to proceed from its axis, and a maintaining power to be applied to this, it is obvious, that if the power meet the pallet in its progress from the point of quiescence, it will shorten the time, and also the arc of that semi-vibration; and, again, that if the power follow the pallet in its progress towards the point of quiescence, it will drive it home sooner, and consequently will shorten the time of that semi-vibration; and that actions contrary to these would lengthen the times. If, therefore, the action itself, which may be considered as an accelerating force, be not applied on both sides of the point of quiescence through a certain arc, determinable from the circumstances, the maintaining power, when it comes to be applied, will alter the time; and if this vary, the time must also vary. Now the remedy at present adopted is, to make the balance vibrate through a very large arc, such as a semicircle or more, and to follow the pallet in each returning vibration by a strong power exerted through a very small arc, as, for example, 15° or 16°. By this contrivance the balance will vibrate at perfect liberty, out and home, through two semicircles, or 360°, excepting the small part during which the impulse is given; and if the impulse vary, the arc of vibration will vary, and with it the time, unless the spring be made of a certain definite length, or tapered in its thickness according to the experience which many artists in this country possess.

The escapement generally used in our best chronometers, as we shall hereafter see, consists of a toothed wheel at the end of the train, which is prevented from running down by a detent or hook, and of two pallets, a longer and a shorter, fixed upon the verge or axis of the balance. These pallets are so placed, that when the face of the longer pallet has just arrived before one of the teeth of the wheel, the shorter pallet strikes out the hook, and allows the wheel to push forward the longer pallet with its tooth, during which action, the hook falls again into its place, to catch the succeeding tooth. The balance therefore proceeds in its vibration, and returns again without disturbing the train; because the short pallet does not strike out the hook in its backward course, but only acts on a slender spring, resembling those formerly used in the jacks of harpsichords. In this manner the vibrations are kept up; and so little do the variations in the maintaining power affect the rate, when all the adjustments are made, that if the main spring be let down to only a small part of its ordinary tension, these time-pieces will keep the same rate for many hours together.

However perfect, practically speaking, the application of the maintaining power may be, yet if the balance and its spring be subject to vicissitudes from heat and cold, it will be in vain to expect accuracy. There are two ways of correcting this compound time-measurer. The first, which was invented by Peter Leroy, consists in causing the balance to enlarge itself, instead of contracting by heat; by which means the spring, when in the state of greater rigidity, has more work to do; and the other acts by lengthening or shortening the spring, when cold or heat may have given it more or less of force. This was invented by Harrison, and depends on the well-known fact, that a short spring is stiffer than a longer; so that by shortening his spring at the time when it was weakened by heat, and the balance enlarged by the same cause, he gave it the stiffness requisite to compensate for these alterations; and the same contrivance produced the contrary effect in cold temperatures. As we shall more fully exhibit these inventions under the article Horology, it is only necessary to observe, that Peter Leroy constructed his first time-piece with fluid thermometers on the balance, and that he also invented our present expansion balance of brass and steel, soldered or fused together in the rim, which was afterwards introduced and brought to great perfection by Arnold.

Machines, made upon the principles here cursorily pointed out, have measured time to a wonderful degree of perfection; and from the immense maritime trade of the British empire, and the scientific disposition of many wealthy individuals, the demand has been so great, as to have produced a very great number of able workmen, fully equal to their construction, at the same time that the prices have been considerably reduced. Most sea commanders of any respectability are provided with two or more of them.

Among the other causes of irregularity in time measurers, the resistance of the air has been occasionally considered by authors. But artists seem to suppose, either that it is a constant quantity, or that its variations are not considerable enough to be brought into the account. The very accurate performance of some chronometers, and the steady going of astronomical clocks, seem to give weight to this supposition: but on the other hand it may be remarked, that though the slow motion of heavy pendulums vibrating through small arcs in astronomical clocks must be subject to very little resistance indeed from the air, yet it does not follow that the rapid vibrations of a balance may not be affected by this cause; and the extreme precision of some chronometers will not, perhaps, be admitted as a very strong argument, when we consider that the changes from barometrical causes may have compensated each other, and that the most perfect machines will vary as much as one second per day, from causes which have not been yet clearly detected, though these are probably resolved into that before us. We are more particularly led to these reflections by a communication from Mr. Manton, of Davies-street, who found by experiment that a chronometer, which was going upon a gaining rate of five seconds per day, did increase its arc of vibration by an additional 50 degrees immediately upon the air being exhausted; and that being kept in vacuo, its rate became 37 seconds per day, the gain being 34 seconds upon the former rate. Hence it follows, that as the difference between the highest and the lowest stations of the barometer indicate a change of about one-fourteenth part in the density of the air, the correspondent change per day, in the rate, may be two seconds and a half, or about one second per inch. Hence it may happen that a capital time-keeper shall indicate a more steady rate from week to week than from day to day.

The causes of imperfection in chronometers, which still call for farther exertions of sagacity in our artists, are, 1. The spring gradually tires or falls off from its strength, and neither the law of this variation nor its remedy are known. The effects of this change are, that all the adjustments are disturbed by it. 2. There is great reason to apprehend that the expansion-bars of brass and steel do change in their relative powers of flexure by their continued action on each other, though it is probable they settle at last. 3. The wear of the acting parts is uncertain, and will affect the time of striking out the detent and the arc of impulse. 4. No certain rules have been given, or are perhaps known, for making all the vibrations equal in time. If we suppose the long and short vibrations to be at first adjustable, with certainty, to equal times, not only for the extremes, but for all the means or intermediate arcs, it will not follow that the falling off from wear or from tiring, or from change in the balance, will continue to be accompanied by the same isochronism. 5. The best artists find very great difficulty in adjusting a pocket chronometer for all positions, preserving at the same time the other needful adjustments. See Escapement, Horology, Pendulum, Train, and the articles thence referred.

CHRYSALIS, in natural history, a state of rest and seeming insensibility, which butterflies, moths, and several other kinds of insects, must pass through, before they arrive at their winged or most perfect state. The first state of these animals is in the caterpillar or reptile form; then they pass into the chrysalis-state, wherein they remain, immoveably fixed to one spot, and surrounded with a case or covering, which is generally of a conical figure; and, lastly, after spending the usual time in this middle state, they throw off the external case wherein they lay imprisoned, and appear in their most perfect and winged form of butterflies, or flies. See Caterpillar.

CHRYSANTHEMUM, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Dioscoideæ. Corymbiferæ, Jussieu. Calyx, hemispherical, imbricated; the marginal scales membranaceous; pappus margined; receptacle naked. There are twenty-seven species. One of these, the Chrysanthemum leucanthemum, or ox-eyed daisy, has been introduced from Europe, and become naturalized in the United States; it has in fact become one of the most troublesome and pernicious weeds which infest our country. It covers hundreds of acres of ground with its white flowers, in the month of June.

CHRYSIS, *golden fly*, in natural history, a genus of insects of the order Hymenoptera. Mouth horny, projecting; lip much longer than the jaw, which is linear, membranaceous, and emarginate at the tip; no tongue; feelers four, unequal, filiform; antennæ short, filiform, of twelve articulations, the first longer; body gilt polished; abdomen arched beneath, with a scale on each side; tail generally toothed; sting pungent, nearly concealed; wings flat. These are generally found in the holes of old walls. There are more than thirty species.

CHRYSITRIX, in botany, a genus of the Polygamia Dioecia class and order. Natural order of Calamariæ. Cyperoideæ, Jussieu. Essential character: hermaphrodite; glume bivalve; corolla of numerous setaceous chaffs; stamina many, solitary, between the chaffs; pistil one: male as in the hermaphrodite; pistil one. There is but one species; viz. C. capensis, a perennial plant; native of the Cape of Good Hope.

CHRYSOBALANUS, in botany, a genus of the Icosandria Monogynia class and order. Natural order of Pomaceæ. Rosaceæ, Jussieu. Essential character: calyx five-cleft; petals five; style lateral; drupe with a five-furrowed, five-valved nut. There is but one species: viz. C. icaco, cocoa plumb, a shrub about eight feet high. Native of the Caribbee islands, and the neighbouring continent near the sea.

CHRYSOBERYLL, in mineralogy, a species of the flint genus. Its chief colour is asparagus green, passing on the one side into an apple-green, mountain green, and greenish white: on the other side it passes through light olive and oil green into yellowish grey, which inclines to brown. It occurs but seldom crystalized, and then the crystals are small, externally shining, internally splendent, and intermediate between the resinous and vitreous. It is brittle, not easily frangible; specific gravity from 3.6 to 3.8. Before the blow-pipe it is infusible without addition: it is found in Brazil, in the sands of Ceylon, along with rubies and sapphires: it is sometimes cut for ring stones, and is usually set with yellow foil, but is seldom to be met with even in the possession of jewellers: it is called the Oriental chrysolite, in commerce: constituent parts

Alumina - - - - -	71.5
Silica - - - - - -	18.0
Lime - - - - - -	6.0
Oxide of Iron - -	1.5
Loss - - - - - -	3.0
	100.

CHRYSOCOMA, in botany, English *goldy locks*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx hemispherical, imbricate; style scarcely longer than the florets; pappus simple; receptacle naked. There are thirteen species: almost all of them natives of the Cape of Good Hope.

CHRYSOGONUM, in botany, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx five-leaved; seeds involved in a four-leaved calycle; pappus one-leafed, three-toothed; receptacle chaffy. There is but one species; viz. C. virginianum, a native of Virginia.

CHRYSOLITE, in mineralogy, a species of the flint genus; the chief colour of which is pistachio green, of all degrees of intensity: it occurs sometimes in original, angular, pretty sharp-edged pieces, which are frequently notched, and exhibit a peculiar, rough, scaly, splintery surface; also in rolled pieces, and crystallized; brittle; easy frangible; specific gravity about 3.4; infusible before the blow-pipe without addition; constituent parts, according to Klaproth,

Silica - - - - -	38.0
Magnesia - - - -	39.5
Oxide of iron - -	19.0
Loss - - - - -	3.5
	100.0

It is found principally in Upper Egypt; but has been met with in Bohemia, and in the isle of Bourbon. It is employed as a precious stone in different kinds of jewelry, but of no very great value. Werner thinks that the stone described by the ancients under the name of yellow chrysolite answers to our topaz.

CHRYSOMELA, in natural history, a genus of insects of the order of Coleoptera. Antennæ moniliform; six feelers, growing larger towards the end; thorax marginate; shells immarginate; body mostly oval. Of this genus there are several hundred species. They are separated into three distinct divisions. A. lip entire; hind legs equal. B. oblong; lip bifid; hind thighs equal. C oblong; lip bifid; hind thighs thickened. This numerous and very beautiful tribe is found every where in woods and gardens. Their motion is slow, and some of them when caught emit an oily liquor of a disagreeable smell. The larvæ of this genus, and also of the Cryptocephalus, feed on the leaves of trees and plants.

CHRYSOPHRAS, in mineralogy, a species of the Flint genus, of an apple-green, of all degrees of intensity, passing through the various shades of greenish grey. It is found massive in angular pieces, and thick plates. Internally it is dull; some rare varieties are glimmering. Specific gravity 3.25. Before the blow-pipe it loses its colour and transparency, and is infusible without some addition. By analysis it is found to contain

Silica	96.16
Lime	0.83
Oxide of nickel . .	1.00
	97.99

A trace of alumina and oxide of iron.—It is found with quartz, opal, chalcedony, &c. in serpentine, in Lower Silesia. It is chiefly used for ring-stones; but is difficult to cut and polish. The apple-green variety is the most highly valued, and ring-stones of that colour will fetch 10, or 12*l*. It passes into horn-stone and chalcedony, and into a fossil which is intermediate between chrysophras and opal. It loses much of its colour when kept in a warm and dry place, or when much exposed to the air. Very elegant specimens of this beautiful fossil are to be seen in the great cathedral at Prague, where a closet is inlaid with it.

CHRYSOPHYLLUM, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Sapotæ, Jussieu. Essential character: corolla bell-shaped, ten-cleft; segments alternate, spreading; berry ten-seeded. There are six species; natives of the West Indies.

CHRYSOSPLENIUM, in botany, a genus of the Decandria Digynia class and order. Natural order of Succulentæ. Essential character: calyx four or five-cleft, coloured; corolla none; capsule two-beaked, one-celled, many-seeded. There are two species; *viz.* C. alternifolium, alternate leaved golden saxifrage: and C. oppositifolium, opposite-leaved golden saxifrage. These plants are found in moist shady places, by the sides of rivulets, in Lapland, Sweden, Denmark, Germany, Switzerland, and with us, about Norwich, and Worcestershire. The latter species is native in the United States.

CHURCH, has different significations, according to the different subjects to which it is applied. 1. It is understood of the collective body of christians, or all those over the face of the whole earth, who profess to believe in Christ, and acknowledge him to be the Saviour of mankind. This is what the ancient writers call the catholic or universal church. 2. Church is applied to any particular congregations of Christians, who at one time, and in one place, associate together, and concur in the participation of all the institutions of Jesus Christ, with their proper pastors and ministers. Thus we read of the church of Antioch, the church of Alexandria, the church of Thessalonica, and the like. 3. Church denotes a particular sect of Christians, distinguished by particular doctrines and ceremonies. In this sense we speak of the Romish church, the Greek church, the Reformed church, the church of England, &c.

The Latin or Western church comprehends all the churches of Italy, France, Spain, Africa, the North, and all other countries whither the Romans carried their language. Great Britain, part of the Netherlands, of Germany, and of the North, have been separated from hence ever since the time of Henry VIII. and constitute what we call the Reformed church, and what the Romanists call the Western Schism. The Greek or Eastern church comprehends the churches of all the countries anciently subject to the Greek or Eastern empire, and through which their language was carried; that is, all the space extended from Greece to Mesopotamia, and Persia, and thence into Egypt.

Church, the place which Christians consecrate to the worship of God. By the common law and general custom of the British realm, it was lawful for earls, barons, and others of the laity, to build churches; but they could not erect a spiritual body politic, to continue in succession, and capable of endowment, without the king's license; and before the law shall take knowledge of them as such, they must also have the bishop's leave and consent, to be consecrated or dedicated by him.

CHURCHWARDENS, the guardians or keepers of the church, are persons annually chosen in Easter week, by the joint consent of the minister and parishioners, or according to the custom of the respective places, to look after the church and church-yard, and things thereunto belonging. They are entrusted with the care and management of the goods and personal property of the church, which they are to order for the best advantage of the parishioners; but they have no interest in, or power over, the freehold of the church itself, or of any land or other real property belonging to it; these are the property of the parson or vicar, who alone is interested in their loss or preservation. The churchwardens therefore may purchase goods and other articles for the use of the parish; they may likewise, with the assent of the parishoners, sell or otherwise dispose of the goods of the church; but without such consent they are not authorised to alienate any of the property under their care.

All peers of the realm, clergymen, counsellors, attorneys, clerks in court, physicians, surgeons, and apothecaries, are exempt from serving the office of churchwarden, as is every licensed dissenting teacher, pretending to holy orders.

CHURN, an implement for agitating cream, or milk, so as to separate the butyrous particles from the serous, and to effect the production of butter. Some churns are made upright, of a tapering form, and are worked by means of a pole and cross, the former passing through a hole in the lid. These are pail or bell churns. Many churns are in the form of a barrel; in some of these beaters, or projecting battens, are affixed within four or five of the staves, which strike the cream as the barrel is moved round by means of a winch: in others, the barrels are at rest, while a cross fly, of four or more leaves, is turned within it: in either case the barrel is supported on a frame. The Indian churn has an alternate motion, being worked by a vertical pole, which is turned much the same as a hand-lathe; having its lower part split, the pole occasions great agitation in the cream. A great variety of churns are in use: but, in general, their formation evinces more ingenuity than practical knowledge. Those moved by pedals, and of which, as well as of the Indian churn, an accurate description is given in the Agricultural Magazine for October, 1807, merit particular attention, for their great simplicity and many good qualities.

CHYLE. See CHYME, ASSIMILATION, &c.

CHYME, in animal economy: in the process of digestion, the food is subjected to a temperature usually above 90° of Fahrenheit; it is mixed with the gastric juice, a liquor secreted by the glands of the stomach, and is made to undergo a moderate and alternate pressure, by the contraction of the stomach itself. It is thus converted into a soft uniform mass of a greyish colour, in which the previous texture or nature of the aliment can be no longer distinguished.

The chyme, as this pulpy mass into which the food in the stomach is resolved is termed, passes by the pylorus into the intestinal canal, where it is mixed with the pancreatic juice and the bile, and is still exposed to the same temperature and alternating pressure. The thinner parts of it are absorbed by the slender tubes termed the lacteals. The liquor thus absorbed is of a white colour: it passes through the glands of the mesentery, and is at length conveyed by the thoracic duct into the blood. This part of the process is termed chylification, and the white liquor thus formed, chyle. It is an opaque milky fluid, mild to the taste. By standing for some time, one part of it coagulates; another portion is coagulated by heat.

The chyle, after mixing with the lymph conveyed by the absorbent vessels, is received into the blood which has returned from the extreme vessels, and before it passes to the heart. All traces of it are very soon lost in the blood, as it mixes perfectly with that fluid. It is probable, however, that its nature is not immediately completely altered. The blood passing from the heart is conveyed to the lungs, where it circulates over a very extensive surface presented to the atmospheric air, with the intervention of a very thin membrane, which does not prevent their mutual action. During this circulation, the blood loses a considerable quantity of carbon, part of which, it is probable, is derived from the imperfectly assimilated chyle, as this, originating in part from vegetable matter, must contain carbon in larger proportion than even the blood itself. See ASSIMILATION.

CICADA, in natural history, a genus of insects of the order Hemiptera. Generic character: snout inflected; antennæ setaceous; the four wings membranaceous and deflected; legs in most of the species formed for leaping. These insects live on various plants; the larva is apterous; the pupa furnished with the mere rudiments of wings; both of them six footed and active, the male of the perfect insect chirps like the cricket. There are some hundred species noticed and described by different authors, and enumerated with their characters by Gmelin. There are three divisions. A. antennæ subulate, inserted in the front. B. legs not formed for leaping. C. antennæ filiform, inserted under the eyes; this class is subdivided into, 1. *a.* lip abbreviated, truncate, emarginate; and, 2. *b.* lip rounded, setaceous at the tip. The most common of the European species, is C. flebeia, which has been long confounded with the grasshopper. It is a native of the warmer parts of Europe, appearing in the hotter months, and continuing its chirping during the greater part of the day, generally sitting among the leaves of trees. The insects proceed from eggs deposited by the parent in and about the roots of trees, near the ground. They hatch into larva, in which state they continue nearly two years, cast their skins, and produce the complete insect. The male cicada alone makes the chirping, the female being entirely mute; the noise of the former proceeds from a pair of concave membranes, seated on each side the first joint of the abdomen: the large concavities of the abdomen, immediately under the two broad lamellæ in the male insect, are also faced by a thin, pellucid, irridescent membrane, serving to increase and to reverberate the sound, and a strong muscular apparatus is exerted, for the purpose of moving the necessary organs. Among the smaller European species is C. spumaria, or cuckow-spit cicada, so named from the circumstance of its larva being found constantly enveloped in a mass of white froth, adhering to the leaves and stems of vegetables. This froth, which is popularly known by the name of cuckow-spittle, is found in the summer, and is the production of the included larva, which, from the time of its hatching from the egg deposited by the parent insect, continues, at intervals, to suck the juices of the stem on which it resides, and to discharge them from the vent in the form of very minute bubbles; and by continuing the operation, completely covers itself with a large mass of froth, which is sometimes so over-charged with moisture, that a drop may be seen hanging from its under surface.

CICCA, in botany, a genus of the Monoecia Tetrandria class and order. Essential character: male, calyx four-leaved; corolla none: female, calyx three-leaved; corolla none: styles four; capsule tetracoccous. There is but one species, *viz.* C. disticha, a native of the East Indies.

CICER, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx five parted, length of the corolla; the four upper segments incumbent on the banner; legume rhombed, turgid, two-seeded. There is but one species, *viz.* C. arietinum, chick pea, which is an annual, and a native of the South of Europe, the Levant, and Africa, where it is frequently eaten both raw and boiled.

CICHORIUM, in botany, English *succory*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Simiflosculosæ. Cinarocephalæ, Jussieu. Essential character: calyx calycled; pappus slightly five-toothed, obscurely hairy; receptacle somewhat chaffy. There are three species: the first of which, C. intybus, wild succory, is generally considered as a common weed; it is, however, cultivated as food for cattle; C. endivia, broad-leaved succory, or common endive, is cultivated in our English gardens, being one of the principal ingredients in our autumn and winter salads. C. spinosum, prickly succory, grows naturally on the sea coast in Sicily, and the islands of the Archipelago.

CICINDELA, in natural history, a genus of insects of the order Coleoptera; antennæ setaceous: feelers six, filiform; the hind ones hairy: mandible prominent, armed with many teeth: eyes prominent: thorax rounded, margined, narrower than the head. There are about 60 species, in two divisions. A. lip three-toothed. B. lip rounded, pointed entire. The cicindela is in general a very beautiful genus of insects: they are found in dry sandy places, and prey with the most ravenous ferocity upon all other insects which come in their way, and which they can overcome: the larva is soft, white, long, six-footed, with a brown scaly head, and lurks in a round perpendicular hole in the ground, with its head at the entrance, to draw in and devour whatever insects may come near or fall into it. These insects are remarkable for the celerity and vigour of their flight: they are generally seen on the wing in the hottest part of the day, chiefly frequenting dry meadows, &c. C. campestris, one of the most common European species, is a highly beautiful insect, being of a bright grass green, with the wing-shells each marked by five small, round, white spots; the head, thorax, and limbs are of a rich gilded cast, and the eyes black and prominent; the legs are long and slender: it is common in the fields, and is about half an inch long.

CICUTA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character; fruit subovate, furrowed. There are three species, of which C. virosa, long-leaved water hemlock, generally grows near the sides of large stagnant waters, or in shallow slow rivers. Towards the end of autumn, the root for the succeeding summer is formed out of the lower part of the stalk: this is divided transversely into many large unequal cells; so that it becomes specifically lighter than water, and in winter, when the rivers or pools swell, is buoyed up. It is an inhabitant of the northern parts of Europe, and is one of the rankest of vegetable poisons.

CIENFUEGIA, in botany, a genus of the Monadelphia Dodecandria class and order. Calyx double, the outer of twelve setaceous leaves; petals five; style filiform; stigma clavate; capsule three-celled, three seeds. A single species, found in Senegal.

CIMEX, in natural history, the *bug*, a genus of insects of the order Hemiptera. Snout inflected: antennæ longer than the thorax; wings four, folded crosswise; the upper ones coriaceous on the upper part; back flat; thorax margined; legs formed for running. Of this genus, more than a thousand species have been enumerated and described. The divisions are, 1. A. antennæ inserted before the eyes; which is subdivided into, *a.* without a lip: *b.* lip long, subulate, annulate: *c.* lip short. rounded; body long, linear: *d.* sheath four-jointed, the first membranaceous: body long and narrow. B. antennæ inserted above the eyes. Of this very extensive genus only the C. lectuarius, or common bed bug, is apterous, or without wings. It is said not to have been known in England before the year 1670, when it was imported among timber used in rebuilding the city of London after the great fire in 1666. The bug is one of the best subjects for exhibiting a microscopic view of the circulation of the blood. See Bug.

CIMICIFUGA, in botany, a genus of the Polyandria Tetragynia class and order. Natural order of Multisiliquæ. Papaveraceæ, Jussieu. Essential character; calyx four or five-leaved; nectary four, urceolate; capsule four to seven. There is but one species; *viz.* C. fœtida, a native of the distant parts of Siberia, flowering in July, and ripening its seeds in August. The whole plant has a strong virose smell, occasioning the head-ach. To this genus Pursh has referred Actea Racemosa, or black snake-root; called also rich-weed, cattle-weed, and squaroot. It is one of the medicines of the Indians of our country.

CIMOLITE, in mineralogy, is of a light greyish white, inclining to pearl-grey; but by exposure to the air it acquires a reddish tint. It occurs in mass, forming large strata; its fracture is earthy, uneven, and its texture more or less slaty. It is opake, of a greasy lustre, and may be scraped with a knife. It adheres firmly to the tongue, stains the fingers in some degree, and, though soft, is very tough, and pulverized with difficulty. The specific gravity 2.0. When exposed to the action of the blow-pipe, it becomes at first of a dark grey colour; but afterwards recovers its whiteness with little or no alteration: with borax it forms a light brown glass. Its component parts are,

Silex	63.00
Alumina	23.00
Oxide of iron	1.25
Water	12.00
	99.25

It abounds in the island of Cimola, and was in great request by the ancients for its detergent properties; at present its use is almost entirely confined to the inhabitants of the island. It produces the same effects as fuller's earth, but in a higher degree.

CINCHONA, in botany, so named in honour of the Countess del Cinchon, lady of a Spanish viceroy, whose cure is said first to have brought the Peruvian bark into reputation, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Rubiaceæ, Jussieu. There are nine species. See Bark.

CINCHONIN, in chemistry: it has been supposed that a principle, analogous to animal gelatine, exists in some vegetables, particularly in the Peruvian bark: this has been denominated cinchonin. In this principle it has been supposed that the febrifuge power of the bark resided, and some have gone so far as to recommend animal glue as a substitute for bark.

CINERARIA, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character; calyx simple, many leaved, equal; pappus simple; receptacle naked. There are forty-one species, most of them natives of the Cape of Good Hope.

CINNA, in botany, a genus of the Monandria Digynia class and order. Natural order of grasses. Essential character: calyx glume two-valved, one-flowered; corolla glume two-valved; seed one. There is but one species, *viz.* C. arundinacea, a native of Canada, and many parts of the United States.

CINNABAR, in mineralogy, a species of the genus Mercury, of which there are two sub-species, *viz.* the dark red, and the bright red. The former occurs massive, disseminated, in blunt cornered pieces, in membranes, amorphous, dendritic, and fruticose; it occurs also crystallized. The specific gravity is from 7 to 10, and the constituent parts are

Mercury	81
Sulphur	15
Iron	4
	100

Before the blow-pipe it is completely volatalized, giving a blue flame, and a smoke which has the odour of sulphur. Both species are found in Bohemia, Hungary, Transylvania, and many other parts of the continent; but the most important mercury mines are those of Almadin in Spain, which have been worked upwards of two thousand years. It is from this ore that the greatest quantity of the mercury of commerce is obtained. It is used also as a pigment, but not by any means equal to the artificial cinnabar. See the next article.

CINNABAR, in chemistry, is a sulphuret of mercury, and is prepared by mixing one part of sulphur with seven or eight of mercury, and by applying such a heat as to make them combine. The black powder which they form is then exposed to heat sufficient to produce inflammation; after which the remaining mass is sublimed in close vessels. The sublimate is mercury in combination with sulphur: it is of a very fine red colour, and when levigated, is in common use as a pigment, under the name of cinnabar or vermilion.

CINNAMON is the bark of the laurus cinnamomum, indigenous in some of the Eastern Islands, but an inferior kind, taken from the laurus cassia, is often sold for or mixed with it. Cinnamon is most grateful, aromatic, highly pungent, and yields a very fine cordial. The bark is used in many culinary preparations, and is generally taken from the tree by making an incision on the under side for the whole length of the branch, which causes the bark to curl, and to separate itself, almost voluntarily, when acted upon by the sun's heat. That from the smaller twigs is accounted the best: it should be thin, very brittle, and very hot to the tongue. What we use is the inner bark; the exterior rind being of no value.

CINNAMON *stone*, in mineralogy, a species of the genus Zircon, found at Columbo, in the island of Ceylon. It is known in Holland under the name of kanelstein, which signifies cinnamon stone, probably from its resemblance in colour to that spice.

CINNAMON *tree*. See LAURUS CINNAMOMUM.

CINQUE PORTS, five havens that lie on the east part of England, towards France, thus called by way of eminence, on account of their superior importance, as having been thought by our kings to merit a particular regard for their preservation against invasions. Hence they have a particular policy, and are governed by a keeper, with a title of the lord warden of the Cinque Ports, which office belongs to the constable of Dover; and their representatives are called Barons of the Cinque Ports.

They have various franchises, similar, in many respects, to those of the counties palatine, and particularly an exclusive jurisdiction before the mayor and jurats of the port, their warden having the authority of an admiral among them, and sending out writs in his own name; and the king's writs do not run there. However, on a judgment in any of the king's courts, if the defendant hath no goods, &c. except in the ports, the plaintiff may get the records certified into chancery, and from thence sent by mittimus to the lord warden to make execution.

The Cinque Ports, it has been observed, are not "jura æqualia," like counties palatine, but are parcel of the county of Kent, so that if a writ be brought against one for land within the Cinque Ports, and he appears and pleads to it, and judgment is given against him in the Common Pleas, this judgment shall bind him, for the land is not exempted out of the county, and the tenant may wave the benefit of his privilege. These five ports are, Dover, Hastings, Romney, Hythe, and Sandwich; to which Winchelsea and Rye have been since added.

CIPHER. See CYPHER.

CIRCÆA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Aggregatæ. Onagræ, Jussieu. Essential character: corolla two-petalled; calyx two-leaved, superior; seed one, two-celled. There are two species; *viz.* C. lutetiana, common enchanter's nightshade, and C. alpina, mountain enchanter's nightshade. Both are natives of the United States.

CIRCLE, the name of various astronomical instruments for observing right ascensions, declinations, azimuths, altitudes, and likewise for the purposes of the most improved theodolite.

Plate "Circular Instrument" is a representation of an instrument made by Mr. Troughton, and of which he liberally permitted our draughtsman to take a drawing. It is an instrument which measures both horizontal and vertical angles with great accuracy, and is equally adapted for astronomical purposes and surveying.

The instrument is supported on three screws, two of which, *x*, *y*, are shewn in the figure; the three arms through which these pass meet in the centre, and hold a strong, vertical steel axis, truly turned, and very exactly fitted into two sockets, one at the top and the other at the bottom of a cone, A: upon this axis the upper part of the instrument turns. B is the azimuth circle, laying upon the three arms of the tripod, and capable of turning round on the steel axis before mentioned: it is held by a screw, *g*, which moves the circles slowly round when turned: this motion is to adjust the circle, so that the plane of the vertical circle, P, shall be in the meridian when the index is set to zero. The circle is divided into degrees and every five minutes, and the microscope subdivides them into seconds. Another similar microscope is fixed diametrically opposite, upon the circular plate H, and turns round upon the vertical axis with the rest of the instrument. (For the constructions of these microscopes, see that article.) I, I, are two hollow conical pillars, screwed on the index plate to support the axis of the vertical circle, P, by means of two bars (one only of which can be seen, *h*,) screwed at the top of the pillars, and holding at their outer ends tubes, which contain angular bearings for the pivots of the axis: these bearings, or Y's, as they are called, from resembling that letter, can be elevated or depressed by screws *e*, beneath them, to bring the axis parallel to the plane of the azimuth circle. *m*, *m*, are two crooked hollow tubes, screwed to the upright pillars, holding two microscopes, *n*, *n*, reading divisions diametrically opposite to each other on the vertical circle P. The vertical circle is composed of two circles, each cut from a solid plate, and attached to two flanches on a hollow conical axis E; they are firmly braced together by short pillars, as in the figure; between the circles the telescope F is fixed, it is 30 inches long and 2 in diameter. O is a thin plate of metal, screwed to the further main pillar, I, by its lower end, and its upper end supporting a clamp for fixing the circle, when set at any elevation, and a screw for moving it slowly a small quantity after clamping. A similar screw, for occasionally attaching the index plate, H, to the azimuth circle, B, is seen at *p*. *a* is a small roller pushed upwards by a spring, I: it acts against a ring upon the conical axis E, and its use is to support part of the weight of the circle and telescope, and take the bearing from the pivots at the end of the axis. R is a spirit level hung to the two horns *m*, *m*, and adjustable by a screw at its end. S is a telescope beneath the instrument, which is set to any distant object when the instrument is in use, and serves to shew that the instrument does not change its position. See OBSERVATORY and SURVEYING.

CIRCLE, in geometry, a plane figure comprehended by a single curve line, called its circumference, to which right lines or radii, drawn from a point in the middle, called the centre, are equal to each other.

The area of a circle is found by multiplying the circumference by the fourth part of the diameter, or half the circumference by half the diameter: for every circle may be conceived to be a polygon of an infinite number of sides, and the semidiameter must be equal to the perpendicular of such a polygon, and the circumference of the circle equal to the periphery of the polygon: therefore half the circumference multiplied by half the diameter gives the area of the circle.

Circles, and similar figures inscribed in them, are always as the squares of the diameters; so that they are in a duplicate ratio of their diameters, and consequently of their radii.

A circle is equal to a triangle, the base of which is equal to the periphery, and its altitude to its radius: circles therefore are in a ratio compounded of the peripheries and the radii.

To find the proportion of the diameter of a circle to its circumference. Find, by continual bisection, the sides of the inscribed polygon, till you arrive at a side subtending any arch, however small; this found, find likewise the side of a similar circumscribed polygon; multiply each by the number of the sides of the polygon, by which you will have the perimeter of each polygon. The ratio of the diameter to the periphery of the circle will be greater than that of the same diameter to the perimeter of the circumscribed polygon, but less than that of the inscribed polygon. The difference of the two being known, the ratio of the diameter to the periphery is easily had in numbers, very nearly, though not justly true. Thus Archimedes fixed the proportion at 7 to 22.

Wolfius finds it as 1000000000000000 to 3141592653589793: and the learned Mr. Machin has carried it to one hundred places, as follows: if the diameter of a circle be 1, the circumference will be 3,14159, 26535, 89793, 23846, 26433, 83279, 50288, 41971, 69399, 37510, 58209, 74944, 59230, 78164, 05286, 20899, 86280, 34825, 34211, 70679 of the same parts. But the ratios generally used in practice are that of Archimedes, and the following; as 106 to 333, as 113 to 355, as 1702 to 5347, as 1815 to 5702, or as 1 to 3.14159.

CIRCLE, *the quadrature of the*, or the manner of making a square, whose surface is perfectly and geometrically equal to that of a circle, is a problem that has employed the geometricians of all ages.

Many maintain it to be impossible; Des Cartes, in particular, insists on it, that a right line and a circle being of different natures, there can be no strict proportion between them: and in effect we are at a loss for the just proportion between the diameter and circumference of a circle.

Archimedes is the person who has come nearest the truth; all the rest have made paralogisms. Charles V. offered a reward of 100,000 crowns to the person who should solve this celebrated problem; and the States of Holland have proposed a reward for the same purpose.

Circle, *great, of the sphere*, that which, having its centre in the centre of the sphere, divides it into two equal hemispheres; such are the equator, ecliptic, horizon, the colures, and the azimuths, &c. See Equator, Ecliptic, &c.

Circle, *lesser, of the sphere*, that which, having its centre in the axis of the sphere, divides it into two unequal parts: these are usually denominated from the great circles to which they are parallel, as parallels of the equator.

Circle *of curvature*, a circle, the curvature of which is equal to that of a certain curve at a given point.

Circle, *horary*, on the globe, a brazen circle fixed on every globe, with an index, to shew how many hours, and consequently how many degrees, any place is east or west of another.

Circle *of perpetual apparition*, one of the lesser circles, parallel to the equator, described by any point touching the northern point of the horizon, and carried about with the diurnal motion: all the stars included within this circle are always visible above the horizon.

Circle *of perpetual occultation*, another circle at a like distance from the equator, on the south, containing all those stars which never appear in our hemisphere.

Circles, *diurnal*, are immoveable circles, supposed to be described by the several stars and other points of the heavens, in their diurnal rotation round the earth; or, rather, in the rotation of the earth round its axis.

Circles *of latitude*, or *secondaries of the ecliptic*, are great circles perpendicular to the plane of the ecliptic, passing through the poles of it, and through every star and planet. They serve to measure the latitude of the stars, which is an arch of one of those circles intercepted between the star and the ecliptic.

Circles *of longitude*, are several lesser circles parallel to the ecliptic, still diminishing in proportion as they recede from it; on these the longitude of the stars is reckoned.

Circles *of declination*, on the globe, are, with some writers, the meridians on which the declination or distance of any star from the equinoctial is measured.

Circles, *horary*, in dialling, are the lines which shew the hours on dials, though these be not drawn circular, but nearly straight.

Circles, *polar*, are parallel to the equator, and at the same distance from the poles that the tropics are from the equator. See Arctic.

Circles *of position*, are circles passing through the common intersections of the horizon and meridian, and through any degree of the ecliptic, or the centre of any star, or other point in the heavens; and are used for finding out the situation or position of any star.

Circles, *Druidical*, a name given to certain ancient inclosures, formed by rude stones circularly arranged. These, it is supposed, were temples, or places for solemn assemblies for councils, or seats of judgment. These temples, though generally circular, occasionally differ in magnitude. The most simple were composed of one circle. Stonehenge consisted of two circles and two ovals, respectively concentric. One near St. Just, in Cornwall, is formed of four intersecting circles. In magnitude these differ very much: some are formed of only 12 stones, while others, as Stonehenge and Abury, contained, the first 140, and the second 652, and occupied many acres of ground. These different numbers, measures, and arrangements, are supposed to have had reference, either to the astronomical divisions of the year, or some mysteries of the Druidical religion.

CIRCUIT, in electricity, denotes the course of the electrical fluid from the charged surface of an electric body to the opposite surface on which the discharge is made.

Circuit, in law, signifies a longer course of proceedings than is needful to recover the thing sued for: in case a person grants a rent charge of 10*l.* a year out of his manor, and afterwards the grantee disseises the grantor, who thereupon brings an assise, and recovers the land, and 20*l.* damages; which being paid, the grantee brings his action for 10*l.* of the rent, due during the time of the disseisin: this is termed circuity of action, because, as the grantor was to receive 20*l.* damages, and pay 10*l.* rent, he might only have received the 10*l.* for the damages, and the grantee might have retained the other 10*l.* for his rent, and by that means saved his action.

CIRCUIT also signifies the journey, or progress, which the judges take twice every year, through the several counties of England and Wales, to hold courts and administer justice, where recourse cannot be had to the King's courts at Westminster; hence England is divided into six circuits, *viz.* The home circuit, Norfolk circuit, Midland circuit, Oxford circuit, Western circuit, and Northern circuit. In Wales there are but two circuits, North and South Wales. Two judges are assigned by the King's commission to every circuit. In Scotland there are three circuits, *viz.* the Southern, Western, and Northern, which are likewise made twice every year, *viz.* in spring and autumn.

CIRCULAR *lines*, in mathematics, such straight lines as are divided from the divisions made in the arch of the limb, such as sines, tangents, secants, chords, &c.

CIRCULAR *numbers*, called also spherical ones, according to some, are such whose powers terminate in the roots themselves. Thus, for instance, 5 and 6, all whose powers do end in 5 and 6, as the square of 5 is 25, the square of 6 is 36, &c.

CIRCULATION *of the blood*, the natural motion of the blood in a living animal, whereby that fluid is alternately carried from the heart to all parts of the body by the arteries, and returned from the same parts to the heart, by the veins. See PHYSIOLOGY.

CIRCUMFERENCE, in a general sense, denotes the line or lines bounding a plane figure. However, it is generally used, in a more limited sense, for the curve line which bounds a circle, and otherwise called a periphery; the boundary of a right lined figure being expressed by the term perimeter.

The circumference of every circle is supposed to be divided into 360 degrees. The angle at the circumference of a circle is double that at the centre. For the ratio of the circumference of a circle to its radius, see CIRCLE.

CIRCUMFERENTOR, a mathematical instrument, used by land-surveyors for taking angles by the magnetic needle. It is an instrument (where great accuracy is not desired) much used in surveying, in and about woodlands, commons, harbours, seacoasts, in the working of coal-mines, &c. &c. where a permanent direction of the needle is of the most material consequence in surveying. The instrument is made of brass, and, in its most simple state, consists of the following parts; a brass compass box, about five inches diameter, or more; on the plate of the box are engraved and lettered the principal points of the compass, divided into four quarters of 90 degrees each, two of the quarters being figured from the south point, and terminated by 90 degrees at the east and west; and the other two quarters from the north point, terminating also at the east and west: on the circumference of the plate is fixed a ring, divided into 360 degrees, numbered from 0 to 360; the observer may therefore take his angles as bearing from the north and south towards the east and west; or, by that which is the most usual method, the whole circumference of a circle of 360 degrees, commencing from the north point: a magnetic needle of the usual kind turns upon an iron point, fixed in the centre of the compass plate; a stop and trigger wire is applied to the compass box, to throw the needle off its centre when not in use, in order to preserve the fineness of the centre point: a glass and brass spring ring covers the needle and closes the box; to the under side of the compass box, at the N. and S. points, is connected a bar about 15 inches long, from end to end, to each end of which is fixed a perpendicular brass sight about five inches long; each sight containing a long slit or perforation, and a sight line, so that the observer may take his line of sight, or observation of the line upon the station mark, at which end of the bar he pleases.

CIRCUMSCRIBED, in geometry, is said of a figure which is drawn round another figure, so that all its sides or planes touch the inscribed figure.

CIRCUMSCRIBED *hyperbola*, one of Sir Isaac Newton's hyperbolas of the second order, that cuts its asymptotes, and contains the parts cut off within its own space.

CIRCUMSCRIBING, in geometry, denotes the describing a polygonous figure about a circle, in such a manner that all its sides shall be tangents to the circumference. Sometimes the term is used for the describing a circle about a polygon, so that each side is a chord; but in this case it is more usual to say the polygon is inscribed, than the circle is circumscribed.

CIRCUMVALLATION, or *line of circumvallation*, in the art of war, is a trench bordered with a parapet, thrown up quite round the beseiger's camp, by way of security against any army that may attempt to relieve the place, as well as to prevent desertion. See FORTIFICATION.

CIRRUS, in botany, a *clasper* or *tendril:* that fine spiral string or fibre, put out from the foot-stalks, by which some plants, as the ivy and vine, fasten themselves to walls, pales, or trees, for support. It is ranked by Linnæus among the fulcra, or parts of plants that serve for support, protection and defence. Tendrils are sometimes placed opposite to the leaves, as in the vine; sometimes at the side of the foot-stalk of the leaf, as in the passion-flower; and sometimes, as in the winged-pea, they are emitted from the leaves themselves.

CIRSOCELE, or *hernia varicosa,* in surgery, a preternatural distension or divarication of the spermatic veins in the process of the peritonæum.

CISSAMPELOS, in botany, a genus of the Dioecia Monadelphia class and order. Natural order of Sarmentaceæ. Menispernia, Jussieu. Essential character: male, calyx four-leaved; corolla none; nectary wheel-shaped; stamina four, with cornate filaments. Female, calyx one-leafed, ligulate, roundish; corolla none; styles three; berry one-seeded. There are three species.

CISSOID, in geometry, a curve of the second order, first invented by Diocles, whence it is called the cissoid of Diocles.

Sir Isaac Newton, in his appendix "De Æquationum Constructione lineari," gives the following elegant description of this curve, and at the same time shews how, by means of it, to find two mean proportionals, and the roots of a cubic equation, without any previous reduction. Let A G (Plate III. Miscel. fig. 12) be the diameter, and F the centre of the circle belonging to the cissoid; and from F draw F D, F P, at right angles to each other, and let F P be = A G; then if the square P E D be so moved that one side E P always passes through the point P, and the end D of the other side E D slides along the right line F D, the middle point C of the side E D will describe one leg G C of the cissoid; and by continuing out F D on the other side F, and turning the square about by a like operation, the other leg may be described.

This curve may likewise be generated by points in the following manner:

Draw the indefinite right line B C (fig. 13.) at right angles to A B the diameter of the semicircle A O B, and draw the right lines A H, A F, A C, &c. then if you take A M = L H, A O = O F, Z C = A N, &c. the points M, O, Z, &c. will form the curve A M O Z of the cissoid.

CISSOID, *properties of the:* it follows from genesis, that drawing the right lines P M, K L, perpendicular to A B, the lines A K, P N, A P, P M, as also A P, P N, A K, K L, are continual proportions, and therefore that A K = P B, and P N = I K. After the same manner it appears that the cissoid A M O bisects the semicircle A O B. Sir Isaac Newton, in his last letter to Mr. Leibnitz, has shewn how to find a right line equal to one of the legs of this curve by means of the hyperbola; but suppressed the investigation, which, however, may be seen in his fluxions. The cissoidal space contained under the diameter A B, the asymptote B C, and the curve A O Z of the cissoid, is triple that of the generating circle A O B.

CISSUS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Hederaceæ. Vites, Jussieu. Essential character: berry one-seeded, surrounded by the calyx, and four-parted corolla. There are fifteen species; natives of both Indies.

CISTUS, in botany, *rock rose,* or *gum cistus,* a genus of the Polyandria Monogynia class and order. Natural order of Rotaceæ. Cisti, Jussieu. Essential character: corolla five-petalled; calyx five-leaved, with two of the leaflets smaller; capsule. There are sixty-six species, all of which are great ornaments to a garden; their flowers, though of short duration, are succeeded by fresh ones almost every day for about two months successively; the flowers are the size of a middling rose, but single, and of various colours; the plants continue their leaves all the year; they are most of them hardy enouch to live in the open air all the winter, except in very severe ones, which often destroy many of them; so that a plant or two of each sort should be kept in pots, and sheltered, to preserve the kinds. They are natives of warm climates.

CITADEL, a place fortified with four, five, or six bastions, built on a convenient ground near a city, that it may command it in case of a rebellion. The city therefore is not fortified on the part opposite to the citadel, though the citadel is against the city. The best form for a citadel is a pentagon, a square being too weak, and a hexagon too big.

CITATION, in ecclesiastical courts, is the same with summons in civil courts. A person is not to be cited out of the diocese where he lives, unless it be by the archbishop, in default of the ordinary, or where the ordinary is party to the suit, and in case of appeal.

CITHAREXYLUM, in botany, *English fiddle-wood*, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx five-toothed, bell-form; corolla funnel-wheel-form; segments above, equal; berry two-seeded; seeds two-celled. There are five species; all natives of the West Indies.

CITIES, *rise of*. After the fall of the Roman Empire, the proprietors of land lived principally on their own estates; the towns were inhabited by mechanics and tradesmen, chiefly in the condition of slaves. The people, to whom it was granted as a privilege that they might give away their own daughters in marriage without the consent of their lord, and that upon their death their own children and not their lord should succeed to their goods, must have previously been in entirely or nearly the same state of villanage as the occupiers of land in the country. They seem to have been much on a level with the hawkers and pedlars of modern times.

They were generally obliged to pay some tax or toll for the privilege of selling their goods at particular places. As this source of revenue was thought of some importance by the feudal sovereigns and lords, in order to ensure its regular payment, they were induced in many instances to farm it out for a certain sum to the inhabitants of different towns, who, in order enforce its payment by the traders, were invested with the powers and privileges still possessed by the corporations of cities and boroughs. A town thus became a privileged place, of which traders were not only the inhabitants, but the governors, at least in all that related to internal management.

The turbulent feudal lords were often incited by the riches of the burghs to attempt to plunder their houses and warehouses; hence the owners naturally feared and hated the lords; the sovereigns of the different states of Europe, for other reasons, likewise hated and feared the lords; this served as a bond of union between the sovereigns and the corporate towns, and enabled the towns to gain great privileges from those sovereigns who most needed their assistance, as King John in England; and in some instances to become independent, as was the case with the little republics of Italy, and the imperial cities in Germany.

CITRATES, in chemistry, salts formed by the combination of the citric acid, and alkalies and earths; thus we have the citrate of potash, the citrate of soda, &c. See CITRIC ACID.

CITRIC *acid*, in chemistry, is found in the juice of lemons and limes, and is that which gives it the sour taste. It is mixed, however, with mucilaginous and extractive matter. Scheele found that it could not be obtained pure and crystallized by mere evaporation of the lemon juice, and that even the addition of alcohol did not separate completely the foreign matter. The process he followed is, to saturate the expressed juice of the lemon, by the addition of chalk. The citric acid, combining with the lime, forms an insoluble compound, which of course precipitates. This is well washed with warm water, until the water pass off colourless; and in this way the mucilage and extractive matter are abstracted. The citrate of lime is then subjected to the action of as much sulphuric acid, previously diluted, as is sufficient to saturate the lime of the quantity of chalk that has been employed. The citric acid is disengaged and dissolved by the water; the mixture is boiled for a few minutes, to facilitate the precipitation of the sulphate of lime, and is then filtered. The filtered liquor is evaporated to the consistence of syrup, and sulphate of lime separated during the evaporation being withdrawn; and, on cooling and standing for some time, the citric acid is obtained in needle-like crystals.

Citric acid exists in a number of other fruits, from which it may be extracted, and much, it is said, of what is at present found in the shops is prepared from the juice of the lime. From Vauquelin's analysis of the pulp of the tamarind, it appears to be the chief acid constituent of that fruit; one pound of the common prepared pulp of the shops containing an ounce and a half, with smaller quantities of malic and tartaric acids. This acid is very soluble in water. At a moderate temperature, 100 parts of water dissolve 75 parts, cold being produced during the solution; at 212° it dissolves twice its weight of it. Like the other vegetable acids, its solution undergoes spontaneous decomposition, though not very readily. The more powerful acids decompose it, though with some difficulty. Concentrated sulphuric acid converts it into acetic acid. Scheele remarked, that nitric acid did not convert it, as it did some of the other vegetable acids, into oxalic acid; but Fourcroy and Vauquelin have found that, when acted on by a large quantity of nitric acid for a long time, it affords a small portion of oxalic, with a larger portion of acetic acid.

Citric acid combines with the alkalies and earths, forming salts denominated citrates. The citrate of potass is very soluble, and does not crystallize but with difficulty, and is deliquescent: its taste is purely saline, and rather mild. It contains 55.55 of acid, and 44.55 of alkali. Citrate of soda is likewise very soluble, requiring little more than its weight of water for its solution: it crystallizes in six-sided prisms, and the crystals are slightly efflorescent. Their taste is faintly saline; the proportions of the solid salt are 60.7 of acid, and 39.3 of soda. Citrate of ammonia is equally or even more soluble than the others, and does not crystallize but when its solution is much concentrated: the form of its crystals is an elongated prism. It consists of 62 of acid, and 38 of ammonia. The earthy citrates are in general less soluble. When the solution of barytes is poured into the acid, a precipitate, soluble in the liquid by agitation, is formed: when the whole is saturated, the salt is deposited at first in the form of a powder, which is covered afterwards with a kind of crystalline efflorescence, and which a large quantity of water dissolves. It consists of 50 of acid, and 50 of base. When the citric acid is saturated by lime, small crystals are deposited, which are very sparingly soluble: 100 parts contain 62.66 of acid, and 37.34 of lime. When saturated by magnesia, the concentrated solution does not easily crystallize regularly, but rather assumes the state of a white, opaque, and somewhat spongy salt. The proportions of the salt, are 66.66 of acid, and 33.34 of base.

Vauquelin has likewise examined the action of citric acid on the metals. It does not dissolve silver; but it combines with its oxide, and forms a salt, insoluble, of a harsh and strong metallic taste, and which, like the other salts of silver, is blackened by light: it is also decomposed by heat, sometimes leaving metallic silver intermixed with charcoal. It consists of 36 of acid, and 64 of oxide.

Citric acid, in its crystallized state, can be preserved for any length of time without decomposition; and a grateful lemonade may be prepared from it, by dissolving 30 or 40 grains in a pint of water, with the addition of a little sugar; and to communicate flavour, a little lemon peel, or powder, formed by rubbing sugar on the fresh lemon. The lemon juice may be regarded as a specific in scurvy, and there is every probability that the crystallized citric acid may be equally effectual.

CITRUS, in botany, a genus of the Polyadelphia Icosandria class and order. Natural order of Bicornes. Aurantia, Jussieu. Essential character: calyx five-cleft; petals five, oblong; anthers twenty; filaments united into various bodies; berry nine-celled. There are five species; of which we shall notice the C. aurantium, orange-tree; of this there are sixty varieties. 1. Seville orange, which is a handsome tree, and the hardiest of any, as it shoots freely in this country, and yields fruit of excellent quality for domestic uses. 2. The China orange, which does not come to perfection here, but in warm countries it grows in the open ground. 3. The forbidden-fruit tree, which resembles the common orange, but the fruit when ripe is larger and longer than the biggest orange: besides these, there are the horned orange; the hermaphrodite orange; and the dwarf. C. Medica, the citron tree; of this species the lemon tree is accounted a variety; of which there are many sorts. The flowers of all the species appear in May and June, and the fruit continues setting in June and July, and ripens the year following.

CIVET, a kind of perfume, bearing the name of the animal whence it is taken. The animal commonly known by the name of the civet, or civet-cat, is the viverra civetta of Linnæus.

The civet is an animal of a wild disposition, and lives in the usual manner of others of this genus, preying on birds, the smaller quadrupeds, &c. It is a native of several parts of Africa and India: but not of America, as some have erroneously asserted; though it has been transported from the Phillippine Islands, and the coast of Guinea. This animal, as well as the zibet, though originally natives of the warm climates of Africa and Asia, are capable of subsisting in temperate and even in cold countries, provided they are defended from the injuries of the weather, and fed with succulent nourishment. Numbers of them are kept in Holland, for the sake of procuring and selling the perfume which they yield, called civet, and sometimes erroneously confounded with musk. There is a considerable traffic of civet from Bassora, Calicut, and other places, where the animal that produces it is bred; though great part of the civet among us is furnished by the Dutch, who rear a considerable number of the animals. That which is obtained from Amsterdam is preferred to that which comes from the Levant, or India, because the latter is generally less pure. That brought from Guinea would be the best, if the negroes, as well as the Indians and Levanters, did not adulterate it with the juices of plants, or with labdanum, storax, and other balsamic and odoriferous drugs. The quantity supplied depends much on the quality of the nourishment, and the appetite of the animal, which always produces more in proportion to the goodness of its food. See VIVERRA.

CIVIL *death*, any thing that retrenches or cuts off a man from civil society, as a condemnation to the hulks, perpetual banishment, condemnation to death, outlawry, and excommunication.

CIVIL *law*, is that law which every particular nation, commonwealth, or city, has established peculiarly for itself. The civil law is either written or unwritten; and the written law is public or private; public, which immediately regards the state of the commonwealth, as the enacting and execution of laws, consultations about war and peace, establishment of things relating to religion, &c.; private, that more immediately has respect to the concerns of every particular person. The unwritten law, is custom introduced by the tacit consent of the people only, without any particular establishment. The authority of it is great, and it is equal with a written law, if it be wholly uninterrupted, and of a long continuance.

The civil law is allowed in Great Britain in the two universities, for the training up of students, &c. in matters of foreign treaties between princes; marine affairs, civil and criminal; in the ordering of martial causes; the judgment of ensigns and arms, rights of honour, &c.

CIVIL *list*, the money allotted for the support of the King's household, and for defraying certain charges of government.

CIVIL *year*, is the legal year, or annual account of time, which every government appoints to be used within its own dominions, and is so called in contradistinction to the natural year, which is measured exactly by the revolution of the heavenly bodies.

CIVILIAN, in general, denotes something belonging to the civil law; but more especially the doctors and professors thereof are called civilians; of these we have a college or society in London, known by the name of Doctors-commons.

CLAIM, a challenge of interest in any thing that is in the possession of another, or at least out of a man's own; as claim by charter, by descent, &c.

CLAIRAULT (ALEXIS CLAUDE), a celebrated French mathematician and academician, was born at Paris the 13th of May, 1713. His father, a teacher of mathematics at Paris, was his sole instructor, teaching him even the letters of the alphabet on the figures of Euclid's Elements, by which he was able to read and write at four years of age. By a similar stratagem it was that calculations were rendered familiar to him. At nine years of age he put into his hands Guisnee's Application of Algebra to Geometry; at ten he studied l'Hospital's Conic Sections; and between twelve and thirteen he read a memoir to the Academy of Sciences, concerning four new geometrical curves of his own invention. About the same time he laid the first foundation of his work upon curves that have a double curvature, which he finished in 1729, at sixteen years of age. He was named Adjoint-Mechanician to the Academy in 1731, at the age of eighteen, Associate in 1733, and Pensioner in 1738. During his connexion with the Academy, he had a great multitude of learned and ingenious communications inserted in their memoirs, besides several other works which he published separately. In the year 1750, the Academy of Petersburg proposed a prize on the subject of the lunar motions, which Clairault obtained: and in a few years he obtained another prize on the same subject. He was during life a most active and indefatigable man. He died in 1765, at the age of 52. His works are numerous, and his papers, inserted in the Memoirs of the Academy, may be found in the year 1727, and also for almost every year till 1762; being upon a variety of subjects, astronomical, mathematical, optical, &c.

CLAMP *in a ship*, denotes a piece of timber applied to a mast or yard, to prevent the wood from bursting; and also a thick plank lying fore and aft under the beams of the first orlop, or second deck, and is the same that the rising timbers are to the deck.

Clamp is likewise the term for a pile of unburnt bricks built up for burning. These clamps are built much after the same manner as arches are built in kilns, *viz.* with a vacuity betwixt each brick's breadth for the fire to ascend by; but with this difference, that instead of arching, they truss over, or over-span; that is, the end of one brick is laid about half way over the end of another, and so till both sides meet within half a brick's length, and then a binding brick at the top finishes the arch.

Clamp *nails*, such nails as are used to fasten on clamps in the building or repairing of ships.

CLAN, a term used in Scotland to denote a number of families of the same name, under a feudal chief, who protected them, and, in return for that protection, commanded their services as his followers, and led them to war, and on military excursions.

CLAP *net*, a device for catching larks. You entice the birds with calls, and when they are within your distance, you pull a cord, and your net flies up and claps over them.

CLARIFICATION, is the separation, by chemical means, of any liquid from substances suspended in it,and rendering it turbid. If a difference can be made between clarification and filtration, it is, that the latter is effcted by mere mechanical means, but the former either by heat or by certain additions, the action of which may be considered as chiefly chemical. The liquors subjected to clarification are almost without exception those animal or vegetable juices, in which the matter that renders them turbid is so nearly of the same specific gravity with the liquor itself, that mere rest will not effect a separation. In these too the liquid is generally rendered thicker than usual by holding in solution much mucilage, which further entangles the turbid matter, and prevents it from sinking. Hence it is that vinous fermentation has so powerful an effect as a clarifier, since this process always implies the destruction of a portion of saccharine mucilage, and the consequent production of a thin limpid spirit.

Coagulating substances are great clarifiers when mixed with any turbid liquor, the process of coagulation entangling with it all matters merely suspended and not dissolved, and carrying them either to the top in the form of a scum, or to the bottom in the form of a thick sediment, according to circumstances. Thus, to clarify muddy cider, the liquor is beaten up with a small quantity of fresh bullock's blood, and suffered to stand at rest for some hours, after which the liquor above is as clear as water, and almost as colourless, and at the bottom is a thick tough cake, consisting of the coagulated blood which has carried down with it all the opaque matter suspended in the liquor. Albuminous and gelatinous substances act in the same manner. The effect of white of egg in this way is known to every one. It should be first mixed with the turbid liquor without heat, and by agitation. Afterwards, on applying less than a boiling heat, the albumen of the egg coagulates, and carries up with it all the opaque particles, leaving the rest beautifully clear and limpid. Sometimes clarification takes place in a very unaccountable manner. Thus, it is well known that a handful of marl or clay will clarify a large cistern of muddy water, and marl is also used with advantage in clarifying vinous liquors.

CLARINET, in music, a wind instrument of the reed kind, the scale of which, though it includes every semitone within its extremes,is virtually defective. Its lowest note is E, below F cliff, from which it is capable, in the hands of good solo performers, of ascending more than three octaves. Its powers through this compass are not every where equal; the player, therefore, has not a free choice in his keys, being generally confined to those of C and F, which are the only keys in which the clarinet is heard to advantage. The music for this instrument is accordingly usually written in those keys.

CLARION, a kind of trumpet, whose tube is narrower, and its tone acuter and shriller, than that of the common trumpet.

CLARO *obscuro*, or Clair *obscure*, in painting, the art of distributing to advantage the lights and shadows of a piece, both with regard to the easing of the eye, and the effect of the whole piece. See Painting.

CLASS, an appellation given to the most general subdivisions of any thing. Thus, in the Linnæan system of natural history, the animal creation is divided into six classes, *viz.* Mammalia, Aves, Amphibia, Pisces, Insecta, Vermes.

Class, in botany, denotes the primary division of plants into large groups, each of which is to be subdivided, by a regular downward progression, in orders, or sections, as they are called by Tournefort, genera, and species, with occasional intermediate subdivisions, all subordinate to the division which stands immediately above them. So that the classes have been compared to the first layer of a truncated pyramid, which increases gradually as it receives the orders, genera, and occasional intermediate subdivisions, till at length it terminates in an immense base, consisting entirely of species. According to the definition of Linnæus, a class is founded on the agreement of the several genera with each other in the parts of fructification, according to the principles of nature and art. It is observed, that, in the formation of classes, they should not be very numerous, and that their boundaries should be strongly and distinctly marked.

CLATHRUS, in botany, a genus of Fungi. Essential character: roundish, consisting of a reticular, windowed, hollow body; the ramifications connected on every side. Linnæus reckons only four species, other botanists seven and eight.

CLAVA, in natural history, a genus of Vermes Mollusca. Body fleshy, gregarious, clavate, and fixed by a round peduncle; aperture single and vertical. There is but one species, *viz.* C. parasitica, covered with pellucid conic erect spines. It inhabits the Baltic, on seaweeds, shell fish, and floating timber. Like the Hydra it possesses the power of dilating and contracting the mouth. See HYDRA.

CLAVARIA, in botany, a genus of Fungi; one of the lowest order in the scale of vegetation, differing sometimes very little in substance from the rotten wood whence it issues. It is a smooth oblong body, of one uniform substance.

CLAVICLES, in anatomy, are two bones situated transversely, and a little obliquely opposite to each other, at the superior and anterior part of the thorax, between the scapula and sternum.

CLAUSE, signifies an article or particular stipulation in a contract, a charge or condition in a testament, &c.

Thus we say, a derogatory clause, a penal clause, saving clause, codicillary clause, &c.

CLAY. Any natural earthy mixture, which possesses plasticity and ductility when kneaded up with water, is in common language called a clay. All mineralogists, however, have comprehended within the appellation, not only clays, properly so called, but a few other mineral substances nearly allied to some of the clays, and which become plastic by decomposition. Clay, however, is by no means strictly a mineral species, being in most cases the result of the decomposition of other minerals. It seems advisable, therefore, to consider the property of plasticity as an essential character, and to exclude from the class of clays all earthy bodies that are destitute of it.

Mineralogists have generally arranged all the plastic clays under two species, rather from the economical uses to which they are applied, than according to their external characters, composition, or geological situation. The first species is the white infusible porcelain clay, and the second contains all the rest compounded together, under the general appellation potter's clay. We have, however, a different arrangement in Aikin's dictionary, which we shall lay before the reader.

Essential character: plastic by intimate mixture with water.

1. Porcelain clay. Its colour is generally reddish white, also greyish and yellowish white; it has no lustre, no transparency. It occurs either friable or compact; stains the fingers; adheres to the tongue; is soft but meagre to the feel; is easily broken. Specific gravity about 2.3. It falls to pieces in water, and by kneading becomes ductile, though not in a very great degree. The Cornish porcelain clay certainly originates from the decomposition of felspar, and contains particles of quartz, mica, and talc, from which it is separated by eleutriation. The Chinese kaolin also contains mica, and is probably of the same origin as the Cornish. The same remark may be applied to the French, &c. It is, however, by no means certain, that all porcelain clay is derived from felspar, as it varies considerably in its composition and fusibility; all the kinds indeed are infusible at any temperature less than a white heat; but some, especially the Japanese, are refractory in the most powerful furnaces. The Cornish clay, according to Wedgewood, consists of 60 per cent. alumina, nd 40 silex.

2. Steatitic clay. Its colour is a light flesh red, passing into cream colour; its texture is minutely foliated; it has a slight somewhat greasy lustre, and takes a polish from the nail. It stains the fingers, is very friable, and has a smooth unctuous feel. When laid on the tongue, it dissolves into a smooth pulp, without any gritty particles. It is very plastic,

and has a strong argillaceous odour. It occurs in nodules, in a hard cellular horn stone, that forms large mountainous masses near Conway, in North Wales, and originates from the decomposition of indurated steatite.

3. Clay from slate. Its colour is ash-grey, passing into ochre-yellow: its texture is foliated: it has a smooth unctuous feel, and its siliceous particles are so small, as to occasion scarcely any grittiness between the teeth. It occurs in thin beds on the tops of the softer kinds of slate-rock, and from its imperviousness to water is always found lining the bottoms of the peat-mosses, with which this kind of mountains is generally covered, and in these situations it is of a white ash colour, being deprived of its iron and carbon by the acid of the peat. It also occurs in thicker beds at the foot of the mountains, but is of a darker colour, and less plastic.

4. Clay from shale. Its colour varies from greyish blue to bluish black: its texture is foliated: it has a smooth unctuous feel, takes a polish from the nail, is excessively tenacious and ductile, and has but a slight degree of grittiness. It occurs abundantly in all collieries, and is produced by the spontaneous decomposition of the shale with which the beds of coal are covered. A sandy clay, of a greyer colour, and more refractory nature, is procured from the decomposition of the indurated clay that forms the floor of the coal, and is provincially called clunch. The Stourbridge clay, from which crucibles, glass-house pots, &c. are made, is of this kind.

5. Clay from trap. At the foot of the softer rocks of trap-formation, such as wakke, clay-porphyry, and some varieties of grunstein and hornblende rock, are found in beds of clay, evidently originating from the gradual disintegration of these by the weather.

6. Marly clay. The colour of this is bluish or brownish red: it occurs either compact or foliated: it has a soft unctuous feel, takes a polish by friction with the nail, is very plastic, more or less gritty, though not so much so as the common alluvial clay. It burns to a brick of a buff or deep cream colour, and at a high heat readily enters into fusion. It effervesces strongly with acids, and contains from one-fourth to one-tenth of carbonated lime. It originates sometimes from the decomposition of compact argillaceous lime-stone; but more frequently from the softer slaty varieties usually called stone-marl. It is largely employed as a manure, and where the calcareous part does not exceed 10 or 12 per cent. it is esteemed as a material for bricks.

7. Clay from metallic veins. Its colour is grey, verging into bluish, greenish, and yellowish, or red. It has a smooth unctuous feel; is very tenacious; often contains sulphuric acid, and certain metallic oxides, which are never observed in other clays, such as lead, silver, antimony, copper and bismuth. Is found in metallic veins.

8. Alluvial clay. The circumstances which characterize alluvial clay are the following. It contains a larger proportion of quartz sand than the preceding; rounded pebbles of various kinds are also imbedded in it; thus showing it to have been carried from its native situation, and mingled in its progress with a variety of extraneous bodies. At least three kinds of it may be distinguished; *viz.* pipe clay, potter's clay, and chalky clay. Pipe clay is of a greyish or yellowish white colour, an earthy fracture, and a smooth greasy feel; it adheres pretty strongly to the tongue; is very plastic and tenacious; when burnt, is of a milk-white colour; is difficultly fusible, though much more so than porcelain clay, from which it is further distinguished by its superior plasticity, and the sand which it contains. It is manufactured into tobacco pipes, and is the basis of the white or queen's-ware pottery. Potter's clay is of a reddish, bluish, or greenish colour; has a somewhat fine earthy fracture, and a soft, often greasy feel: it adheres to the tongue, and is very plastic. It burns to a hard, porous, red brick; and in a higher heat runs into a dark coloured flag. When tempered with water, and mixed with sand, it is manufactured into bricks: those varieties that are the most free from pebbles are made into tiles, and coarse red pottery. See ALUMINA.

CLAY *stone*, in mineralogy, is of a greenish, bluish, or grey colour, somewhat marked by brownish yellow spots and stripes. It occurs in mass, is opaque, dull, frangible, and soft. It forms large mountainous masses, occurring in beds and veins.

CLAYTONIA, in botany, so named in honour of Mr. John Clayton, a genus of the Pentandria Monogynia class and order. Natural order of Succulentæ. Portulaceæ, Jussieu. Essential character: calyx two valved; corolla five petalled; stigma trifid; capsule three valved, one-celled, three-seeded. There are two species, *viz.* C. Virginica and C. Sibirica, and Pursh has described a new species found in the United States.

CLEF, or CLIFF, in music, a mark set at the beginning of the lines of a song, which shows the tone or key in which the piece is to begin; or it is a letter marked on any line which explains the rest. It is called clef, or key, because hereby we know the names of all the other lines, and consequently the quantity of every degree or interval: but because every note in the octave is also called a key, this letter marked is, for distinction sake, denominated the signed clef; and by this key is meant the principal note of a song, in which the melody closes. See MUSIC.

CLEMATIS, in botany, *virgin's bower*, a genus of the Poliandria Polygamia class and order. Natural order of Multisiliquæ. Ranunculaceæ, Jussieu. Essential character: calyx none; petals four, sometimes five, or even six; seeds having a tail. There are twenty-one species.

CLEOME, in botany, a genus of the Tetradynamia Siliquosa class and order. Natural order of Putamineæ. Capparides, Jussieu. Essential character: nectareous glands three, at each sinus of the calyx, except the lowest; petals all ascending; silique one-celled, two-valved. There are twenty-three species, all of them natives of very warm countries.

CLEONIA, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: filaments forked, with an anther at one of the tips; stigma four-cleft. There is but one species, *viz.* C. lusitanica, sweet-scented cleonia, is an annual plant, native of Spain and Portugal.

CLEPSYDRA, a water-clock, or instrument to measure time by the fall of a certain quantity of water.

The construction of a Clepsydra. To divide any cylindrical vessels into parts, to be emptied in each division of time, the time wherein the whole, and that wherein any part is to be evacuated, being given. Suppose a cylindrical vessel, whose charge of water flows out in twelve hours, were required to be divided into parts to be evacuated each hour. 1. As the part of time 1 is to the whole time 12, so is the same time 12 to a fourth proportional 144. 2. Divide the altitude of the vessel into 144 equal parts: here the last will fall to the last hour: the three next above to the last part but one; the five next to the tenth hour; lastly, the twenty-three last to the first hour. For since the times increase in the series of the natural numbers 1, 2, 3, 4, 5, &c. and the altitudes, if the numeration be in a retrogade order from the twelfth hour, increase in the series of the unequal numbers 1, 3, 5, 7, 9, &c. the altitudes computed from the twelfth hour will be as the squares of the times 1, 4, 9, 16, 25, &c. Therefore the squares of the whole time, 144, comprehend all the parts of the altitude of the vessel to be evacuated. But a third proportional to 1 and 12 is the square of 12, and consequently it is the number of equal parts in which the altitude is to be divivided, to be distributed, according to the series of the unequal numbers, through the equal interval of hours. There were many kinds of clepsydræ among the ancients; but they all had this in common, that the water ran generally through a narrow passage, from one vessel to another, and in the lower was a piece of cork or light wood, which, as the vessel filled, rose up by degrees, and showed the hour.

CLERGY, a general name given to the body of ecclesiastics of the Christian church, in contradistinction to the laity. The privileges and immunities which the clergy of the primitive Christian church enjoyed deserve our notice. In the first place, when they travelled upon necessary occasions, they were to be entertained by their brethren of the clergy, in all places, out of the public revenues of the church. When any bishop, or presbyter, came to a foreign church, they were to be complimented with the honorary privilege of performing divine offices, and consecrating the eucharist in the church. The great care the clergy had of the characters and reputations of those of their order appears from hence, that in all accusations, especially against bishops, they required the testimony of two or three witnesses of good character: nor was any heretic admitted as an evidence against a clergyman. With regard to the respect paid to the clergy by the civil government, it consisted chiefly in exempting them from some kind of obligations to which others were liable, and granting them certain privileges and immunities which others did not enjoy.

By the ecclesiastical laws, no clergyman was allowed to relinquish his station without just grounds and leave; but in some cases resignation was allowed of, as in old age, sickness, or other infirmities.

The privileges of the English clergy, by the ancient statutes, are very considerable; their goods are to pay no toll in fairs or markets; they are exempt from all offices but their own; from the king's carriages, posts, &c.; from appearing at sheriff's tourns, or frank pledges; and are not to be fined or amerced according to their spiritual, but their temporal, means. A clergyman acknowledging a statute, his body is not to be imprisoned. If he be convicted of a crime, for which the benefit of clergy is allowed, he shall not be burnt in the hand; and he shall have the benefit of the clergy *in infinitum*, which no layman can have more than once.

The clergy, by common law, are not to be burdened in the general charges of the laity; nor to be troubled nor incumbered, unless expressly named and charged by the statute; for general words do not affect them: thus, if a hundred be sued for a robbery, the minister shall not contribute; neither shall they be assessed to the highway, to the watch, &c.

The revenues of the clergy were anciently more considerable than at present. Ethelwolph, in 855, gave them a tythe of all goods, and a tenth of all the lands in England, free from all secular services, taxes, &c. The charter whereby this was granted them, was confirmed by several of his successors; and William the Conqueror, finding the bishoprics so rich, created them into baronies, each barony containing thirteen knight's fees at least; but since the reformation the bishoprics are much impoverished. The revenues of the inferior clergy, in the general, are small, a third part of the best benefices being anciently, by the Pope's grant, appropriated to monasteries, upon the dissolution whereof they became lay-fees. Indeed an addition was made, 2 Annæ, the whole revenues of first-fruits and tenths being then granted, to raise a fund for the augmentation of the maintenance of the poor clergy; pursuant to which a corporation was formed, to whom the said revenues were conveyed in trust, &c.

Clergy, *benefit of*. See Benefit.

CLERK, a word originally used to denote a learned man, or a man of letters; whence the term became appropriated to churchmen, who were from thence called clerks or clergymen; the nobility and gentry being usually bred up to the exercise of arms, and none left but the ecclesiastics to cultivate the sciences.

Clerk *of the affidavits*, the officer, in the Court of Chancery, who files all affidavits made use of in court.

Clerk *of the assize*, the person who writes all things judicially done by the justices of assize in their circuits.

Clerk *of the bails*, an officer in the court of King's Bench, whose business it is to file all bail-pieces taken in that court, where he always attends.

Clerk *of the check*, an officer belonging to the King's court, so called, because he has the check and controlment of the yeomen of the guard, and all other ordinary yeomen that belong to the king, queen, or prince. He likewise, by himself or deputy, sets the watch in the court. There is also an officer in the navy of the same name, belonging to the king's yards.

Clerk *of the crown*, an officer in the king's Bench, who frames, reads, and records all indictments against offenders, there arraigned or indicted of any public crime. He is likewise termed clerk of the crown-office, in which capacity he exhibits informations, by order of the court, for divers offences.

Clerk *of the crown*, in chancery, an officer whose business it is constantly to attend the Lord Chancellor, in person or by deputy, to write and prepare for the great seal special matters of state by commission, both ordinary and extraordinary; *viz.* commissions of lieutenancy, of justices of assize, oyer and terminer, gaol delivery, and of the peace; all general pardons, granted either at the king's coronation, or in parliament: the writs of parliament, with the names of the knights, citizens, and burgesses, are also returned into his office. He also makes out special pardons, and writs of execution on bonds of statute-staple forfeited.

Clerk *of the declarations*, he that files all declarations after they are ingrossed, in causes depending in the court of king's bench.

Clerk *of the deliveries*, an officer of the tower, whose function is to take indentures for all stores and ammunition issued from thence.

Clerk *of the errors*, in the court of Common Pleas, an officer who transcribes, and certifies into the king's bench, the tenor of the record of the action on which the writ of error made out by the cursitor is brought there to be determined. In the king's bench the clerk of the errors transcribes and certifies the records of causes by bill, in that court, into the Exchequer: and the business of the clerk of the errors in the Exchequer is, to transcribe the records certified thither out of the king's bench, and to prepare them for judgment in the Exchequer chamber.

Clerk *of the essoins*, in the court of Common Pleas, keeps the essoin roll, or enters essoins: he also provides parchment, cuts it into rolls, marks the number on them, delivers out all the rolls to every officer, and receives them again when written. See Essoin.

Clerk *of the estreats*, an officer in the Exchequer, who every term receives the estreats out of the Lord Treasurer's remembrancer's office, and writes them out to be levied for the crown.

Clerk *of the hamper*, or *hanaper*, an officer in chancery, whose business is to receive all money due to the king for the seals of charters, letters patent, commissions, and writs; also the fees due to the officer for enrolling and examining them.

Clerk *of the enrolments*, an officer of the court of Common Pleas, that enrols and exemplifies all fines and recoveries, and returns writs of entry.

Clerk *of the juries*, an officer of the Common Pleas, who makes out the writs called habeas corpus and distringas, for juries to appear either in that court, or at the assizes, after the pannels are returned upon the *venire facias*. He likewise enters into the rolls the awarding these writs, and makes all the continuances till verdict is given.

Clerk *comptroller of the king's household*, an officer of the king's court, authorised to allow or disallow the charges of pursuivants, messengers of the green cloth, &c. to inspect and controul all defects of any of the inferior officers, and to sit in the counting-house with the lord steward and other officers of the household, for regulating such matters.

Clerk *of the king's silver*, an officer of the Common Pleas, to whom every fine is brought after it has passed the office of the custos brevium; and who enters the effect of writs of covenant into a book kept for that purpose, according to which all the fines of that term are recorded in the rolls of the court.

Clerk *of the king's great wardrobe*, an officer who keeps an account of all things belonging to the wardrobe.

Clerk *of the market*, an officer of the king's house, to whom is given the charge of the king's measures and weights, the standards of those that ought to be used all over England.

Clerk *of the ordnance*, an officer that registers all orders concerning the king's ordnance in the tower.

Clerk *of the outlawries*, an officer of the Common Pleas, and deputy to the Attorney-General, for making out all writs of *capias utlagatum*, after outlawry, to which there must be the king's attorney's name.

Clerk *of the paper-office*, an officer belonging to the king's bench, whose business is to make up the paper-books of special pleadings in that court.

Clerk *of the Parliament-rolls*, an officer in the House of Lords, and likewise in the House of Commons, who records all transactions in parliament, and engrosses them fairly in parchment rolls.

Clerk *of the peace*, an officer belonging the sessions of the peace, whose business is to read indictments, inrol the proceedings, and draw the process; he likewise certifies into the king's bench transcripts of indictments, outlawries, attainders, and convictions, had before the justices of the peace, within the time limited by statute under a certain penalty. This office is in the gift of the *Custos Rotulorum*, and may be executed by deputy.

Clerk *of the pells*, an officer that belongs to the Exchequer, whose business is to enter every teller's bill into a parchment roll, called *pellis receptorum*, and to make another roll of payments, called *pellis exituum*.

Clerk *of the petty bag*, an officer of the court of chancery, whereof there are three, the master of the rolls being the chief: their business is to record the return of all inquisitions out of every shire, to make out patents of customers, gaugers, comptrollers, &c. liberates upon extents of statutes staple, *conge d'elires* for bishops, summons of the nobility, clergy, and burgesses to parliament, and commissions directed to knights, and others, of every shire, for assessing subsidies and taxes.

Clerk *of the pipe*, an officer of the Exchequer, who, having the accounts of all debts due to the king delivered out of the remembrancer's office, charges them in a great roll, folded up like a pipe. He writes out warrants to sheriffs, to levy the said debts on the goods and chattels of the debtors: and if they have no goods, then he draws them down to the treasurer's remembrancer, to write estreats against their lands.

Clerk *of the pleas*, an officer of the Exchequer, in whose office all the officers of the court, having special privilege, ought to sue or be sued in any action. In this office also actions at law may be prosecuted by other persons, but the plaintiff ought to be tenant or debtor to the King, or some way accountable to him. The under clerks are attorneys in all suits.

CLERKS *of the privy-seal,* four officers that attend the Lord-privy-seal, for writing and making out all things that are sent by warrant from the signet to the privy-seal, and to be passed the great-seal; and likewise to make out privy-seals, upon special occasions of his Majesty's affairs, as for loan of money, or the like.

CLERK *of the rolls,* an officer of the chancery, whose business is to make searches after and copies of deeds, offices, &c.

CLERK *of the rules,* an officer of the court of King's Bench, who draws up and enters all the rules and orders made in court, and gives rules of course in divers writs.

CLERK *of the signet,* an officer continually attendant upon his Majesty's principal secretary, who has the custody of the privy signet, as well for sealing the King's private letters, as those grants which pass the king's hand by bill signed. There are four of these officers, who have their diet at the secretary's table.

CLERKS, *six,* officers in chancery, next in degree below the twelve masters, whose business it is to enrol commissions, pardons, patents, warrants, &c. which pass the great seal; they were anciently clerici, and forfeited their places if they married. They are also attorneys for parties in suits depending in the court of chancery.

CLERK *of the supersedeas,* an officer of the Common pleas, who makes out writs of supersedeas, forbidding the sheriff to return the exigent upon a defendant's appearing thereto on an outlawry.

CLERK *of the treasury,* an officer belonging to the court of Common Pleas, who has the charge of keeping the records of the court, makes out all records of nisi prius, and likewise all exemplifications of records being in the treasury. He has the fees due for all searches; and has under him an under-keeper, who always keeps one key of the treasury door.

CLERK *of the warrants,* an officer of the Common Pleas, whose business is to enter all warrants of attorney for plaintiffs and defendants in suit; and to enrol deeds of bargain and sale, that are acknowledged in court or before a judge. His office is likewise to estreat into the Exchequer all issues, fines, estreats, and amercements, which grow due to the crown in that court.

CLERODENDRUM, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx five-cleft, bell-shaped; corolla with a filiform tube and funnel shaped, five parted, equal border; stamina very long, gaping very much between the segments. Berry one-seeded. There are eight species, natives of the East Indies, China, and Japan.

CLETHRA, in botany, a genus of the Decandria Monogynia class and order. Nat. order of Bicornes. Ericæ, Jussieu. Essential character: calyx five-parted; petals five; stigma trifid; capsule three-celled, three-valved. There are four species, natives of North America.

CLIBADIUM, in botany, a genus of the Monoecia Pentandria class and order. Natural order of Compositæ Oppostifoliæ. Corymbiferæ, Jussieu. Essential character: male common calyx imbricate; corolla of the disk five-cleft; female common calyx the same; corolla of the ray female three or four; seed an umbilicate drupe. There is but one species, *viz.* C. surinamense, native of Surinam.

CLIFFORTIA, in botany, so named in honour of George Clifford, a merchant at Amsterdam, and a considerable botanist, a genus of the Dioecia Polyandria class and order. Natural order of Tricoccæ. Rosaceæ, Jussieu. Essential character: male calyx three-leaved, superior; stamens about thirty. Female calyx three-leaved, superior; corolla none; styles two; capsule two-celled; seeds one. There are nineteen species, all shrubs from the Cape of Good Hope.

CLIMACTERIC, among physicians and natural historians, a critical year in a person's life, in which he is supposed to stand in great danger of death.

According to some every seventh year is a climacteric; but others allow only those years produced by multiplying 7, by the odd numbers 3, 5, 7, and 9, to be climacterical. These years, they say, bring with them some remarkable change with respect to health, life or fortune: the grand climacteric is the sixty-third year; but some, making two, add to this the eighty-first: the other remarkable climacterics are, the seventh, twenty-first, thirty-fifth, forty-ninth, and fifty-sixth. The credit of climacteric years can only be supported by the doctrine of numbers introduced by Pythagoras; though many eminent men, both among the ancients and moderns, appear to have had great faith in it.

CLIMATE, in geography, a space upon the surface of the terrestrial globe, contained between two parallels, and so far distant from each other, that the longest day in one differs half an hour from the longest day in the other parallel. The difference of climates arises from the different inclination or obliquity of the sphere; the ancients took the parallel wherein the length of the longest day is twelve hours and three quarters for the beginning of the first climate; as to those parts that are nearer to the equator than that parallel, they were not accounted to be in any climate, either because they may, in a loose and general sense, be considered as being in a right sphere, though, strictly speaking, only the parts under the equator are so; or because they were thought to be uninhabited by reason of the heat, and were besides unknown. The ancients, considering the diversity there is in the rising and setting of the heavenly bodies, especially the sun, and, in consequence thereof, the difference in the length of the days and nights in different places, divided as much of the earth as was known to them into climates: and instead of the method now in use, of setting down the latitude of places in degrees, they contented themselves with saying in what climate the place under consideration was situated. According to them, therefore, what they judged the habitable part of the northern hemisphere was divided into seven climates, to which the like number of southern ones corresponded. A parallel is said to pass through the middle of a climate, when the longest day in that parallel differs a quarter of an hour from the longest day in either of the extreme parallels that bound the climate: this parallel does not divide the climate into two equal parts, but the part nearest to the equator is larger than the other, because the farther we go from the equator the less increase of latitude will be sufficient to increase the length of the longest day a quarter of an hour.

Some of the moderns reckon the different climates by the increase of half an hour in the length of the longest day, beginning at the equator, and going on till they come to the polar circle towards the pole; they then count the climates by the increase of a whole natural day, in the length of the longest day, till they come to a parallel, under which the day is of the length of fifteen natural days, or half a month; from this parallel they proceed to reckon the climates by the increase of half or whole months in the artificial day, till they come to the pole itself, under which the length of the day is six months. Those between the equator and the polar circles are called hour climates: and those between the polar circles and the poles monthly climates. Vulgarly, the term climate is bestowed on any country or region differing from one another, either in respect of the seasons, the quality of the soil, or even the manners of the inhabitants, without any regard to the length of the longest day.

CLIMAX, in rhetoric, a figure, wherein the word or expression which ends the first member of a period begins the second, and so on; so that every member will make a distinct sentence, taking its rise from the next foregoing, till the argument and period be beautifully finished.

CLIMBING *plants*, in gardening, are such plants as ascend either spirally round supports, or by means of claspers and tendrils. They are either herbaceous or woody, and which, according to their mode of climbing, may be denominated twining climbers, cirrhous climbers, and parasitic climbers. The first sort includes all such as have winding stalks, and twist about any neighbouring support; such as scarlet kidney beans, hops, and some sort of honey-suckle. The second kind comprehends all such as ascend by means of spiral strings, issuing from the sides of the stalks and branches, or from the foot-stalks of the leaves, and even from the leaves themselves, twisting about any thing they meet with, by which their stalks are supported and arrive at their proper height; such as most of the pea-tribe, cucumber, vine, passion-flower, and various others. And the last plants are also of the same kind, but their claspers plant themselves as roots in the bark of the plants on which they ascend, or in the crevices of walls or pales, thereby supporting themselves, and mounting to their tops; as the ivy, Virginia creeper, radicant bignonia, and several others.

CLINCHING, in the sea-language, a kind of slight caulking used at sea, in a prospect of foul weather, about the ports: it consists in driving a little oakum into their seams, to prevent the waters coming in at them.

CLINK *stone*, in mineralogy, nearly

allied to BASALT, which see. It has received its name from the sound which it gives when struck. It occurs massive, and forms beds, and sometimes assumes the columnar form; its colour is grey, with shades of green and yellow. Its specific gravity is 2.5, and it is composed of

Silex	57.25
Alumina . . .	23.5
Oxide of iron .	2.25
Manganese . .	25
Soda	8.10
Water	3.
	94.35
Loss	5.65
	100

CLINOPODIUM, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: involucre many bristled under the whorl. There are five species.

CLIO, in natural history, a genus of Vermes Mollusca; body oblong, noyant, generally sheathed, and furnished with two dilated membranaceous arms or wing-like processes; tentacula three, besides two in the mouth. There are six species. The C. retuso uses its arms or wings, which are submembranaceous, like a pair of oars.

CLITORIA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminoseæ. Essential character: corolla inverted; standard very large, spreading, overshadowing the wings. There are five species.

CLITORIS. See ANATOMY.

CLOCK, in horology, is a machine which measures time with a degree of accuracy that gives it a just preference over the clepsydræ, and other methods anciently used for the same purpose. See CLEPSYDRÆ.

The sphere of Archimedes, made two hundred years before the birth of Christ, is usually considered as the first attempt at the formation of a clock; it had, indeed, a maintaining power, but, being without any kind of regulator, could only measure time as a planetarium exhibits the motion of the stars, with relative, but not with positive precision.

In 1232, a machine for measuring time was sent by the Sultan of Egypt to the Emperor Frederic II. but this, if it had any regulating part, most probably had none superior to the flyer of a common roasting jack. Wallingford, at the begining of the fourteenth century, and Dondi, at the end of the same, have each had the honour of being supposed the first inventors of clocks; the account given of Dondi's clock by Petrus Paulus Vergerius (in Vit. Princip. Carrar. tom. 16.) makes it nearly similar to our church clocks; as, like them, it was placed on the upper part of a turret, or steeple, and spontaneously pointed out each of the twenty-four hours in succession. There is still, however, some doubt whether Dondi was the original inventor.

Boethius, at the end of the fifth century, Pacificus, about the middle of the ninth, and Gerbert, at the end of the tenth, are also regarded as the inventors of clocks, but on rather doubtful authority.

There are many documents to prove the existence of clocks, with wheels and weights, in the middle of the fourteenth century, and therefore there is more reason for assigning this period to the invention than any other.

On comparing the various testimonies relative to the origin of the clock, the fairest conclusion seems to be, that it is neither of so ancient a date as some writers suppose, nor yet among those more recent inventions which are placed in the last two centuries; and that the first inventor is not certainly known.

The opinion of Fer. Berthoud, who has written more on the subject of clock-work than any other man, is evidently most just, which asserts, that the clock is not the invention of any one man, but an assemblage of successive inventions, each of which is worthy of a separate contriver. 1. Wheel-work, which was known in the time of Archimedes; 2. the application of the weight as a maintaining power; 3. the use of the fly as a regulator; 4. the ratchet wheel and click; 5. the substitution of the balance for the fly; and the escapement, which was necessarily introduced at the same time; 6. the application of the dial and hands: and 7. the addition of the striking part.

In the clock which was placed in a tower of the palace of Charles V. in 1364, by Henry de Wick, the regulating part consisted of a balance, which vibrated backwards and forwards by an escapement like that of common watches; it had no balance spring, but this deficiency was in some measure supplied by the mode in which it was made to move; its arbor was vertical, and instead of resting on its lower point was suspended from above by a double cord, or cat-gut; the twisting of this cord, caused by each vibration, tended to raise the balance, and its own weight made it descend again, and at the same time turn round in the opposite direction, when the impulse of the first pallet ceased to act on it. The balance was very heavy, as weight was necessary to make it act in the above manner; and this has caused the mode of its operation to be mistaken by many, who supposed that the cord was merely added to prevent the great friction on the lower end of the arbor, which the weight of the balance would cause.

The introduction of the spiral spring, as a first mover, instead of a weight, took place about the beginning of the sixteenth century. Mr. Peckett, of Old Compton-street, had one of this construction, which, from an inscription on it in the Bohemian language, was made by Jacob Lech, of Prague, in the year 1525.

Clocks with the balances above described, imperfect as they were, gave, however, some assistance to astronomy. Tycho Brahe had four of them, but of such a massy construction, that a single wheel in one of them, which had but three wheels, contained 1200 teeth, and was three feet in diameter. These clocks continued in use till about 1650, when a new æra in the art commenced, by the application of the pendulum as a regulator.

Bernard, one of the professors of astronomy at Oxford, in the last century, has asserted that the Arabians used pendulums in astronomy long before the above period, (as we know that Ricoli, Tycho Brahe, Langrenus, Vendelin, Mersenne, Kircher, Hevelius, Monton, and Galileo himself did,) in a detached state; but we do not find that any of them used it in conjunction with wheel work. According to professor Venturi, Sanctorius applied a pendulum to clock-work some time before the year 1625; and Becker mentions a native of Switzerland, called Juste Birge, who did the same in 1597; but these experiments, if really made, never were sufficiently made public to benefit the world.

The person to whom mankind is really indebted, for bringing this important discovery into universal notice, is the celebrated Christian Huygens, of Zuylichem, who, in his excellent treatise "De Horologio Oscillatorio," has described the construction of a pendulum clock, and proved that he made one before the year 1658.

Galileo is supposed to have claims to the priority of the invention of the mode of applying the pendulum to clock-work, and his son Vincentio Galilei is reported (Exper. del Acad. del Cimento) to have made a pendulum clock so early as in 1649, at Venice, suggested by his father's discoveries. But it is thought that Huygens' method was much more masterly and scientific; and that the world is not under any obligation to Galileo for the invention; for, if he really made it, the manner of performing it was kept so secret, that Huygens himself never heard of it, though one of the most philosophical characters of his time. There has another claimant appeared of late years for the honour of the invention, on the authority of Mr. Thomas Grignon, of Russel-street, Covent Garden, who produces a well authenticated writing of his father's, to prove his having seen the inscription on the great clock, formerly fixed in the turret of St. Paul's, Covent Garden, which ascertained that it was made by Richard Harris, of London, in 1641. This clock was regulated by a long pendulum; and, if the above information is correct, must have been one of the first made, as it precedes that said to have been constructed by Vincentio Galilei by eight years. Mr. Grignon senior was a very ingenious mechanist, and a man of excellent character, and brought to perfection the horizontal principle in watches, and the dead beat in clocks, which the celebrated Tompion and Graham were unable to effect. These circumstances render his testimony of considerable weight.

Huygens must, however, still be considered as the chief introducer of the invention, which no one disputes having been made by him, even though others may be supposed to have made it likewise, unknown to him. He also invented a clock with a centrifugal regulator, which is contrived to perform its movement in a curve that he has demonstrated will render its gyrations isochronal, and which, at least, is worthy of a farther investigation, before it be condemned to an oblivion that it probably does not merit. But his discovery of the isochronism of all vibrations made by a pendulum formed to move in a cycloidal curve is that which is the most noted, although it has never yet been really applied to use. Mr. Huygens' method of doing so has been shown clearly to be erroneous, by Mr. Alexander Cummings, in his "Treatise on Clock and Watch Making," published in 1766, who has also asserted that the cycloidal principle would not be of the benefit imagined, "as the inequality of the vibrations of the pendulum moving in a circular arc correct those caused by the alteration of its weight from the variations of atmospherical gravity, so as mutually to balance each other, while in those moving in cycloidal curves there is no principle to counteract the variations of gravity." It must, however, be noticed, that Mr. Cummings is evidently not correct in his statement, that the loss of specific gravity in the pendulum, caused by an increase in the weight of the atmosphere, would equally tend to prolong its vibrations, as the increased resistance caused to its motion by the same means would tend to diminish them, as he has by no means proved the equality of those opposite effects. Mr. Cummings also mistakes the loss of relative gravity for the loss of real gravity; the momentum of a body in motion is generally considered to be the same in different mediums, except so far as the additional resistance from a denser medium retards it, and so far from Mr. Cumming's opinion in opposition to this being as evident as he supposes, it is well known that no proof has ever been advanced to support it.

Many very curious and useful theorems have been discovered relative to the pendulum, most of which originated with Huygens, among these one of the most noted is, that "the times wherein pendulums of different lengths perform their vibrations, are to one another in the same proportion with the square roots of the lengths of the pendulums."

The length of a pendulum vibrating

	Inches.	
in a second is	39.125	Halley.
	39.207	Newton.
in ½ a second is	9.781	Halley.
	9.801	Newton.

And from these data, and the above theorem, the lengths of pendulums to vibrate any other required time may be determined.

The next improvement of consequence on clocks, after the pendulum, was the escapement performed with anchor pallets, which Berthoud states to have been the invention of Clement, a London clock-maker, in the year 1680. The escapement used by Huygens, and still continued in many chamber clocks and all the wooden clocks, is that made by two flat pallets attached to an horizontal arbor, acting at opposite sides of the upper part of a horizontal crown wheel; the anchor pallets, on the contrary, act on a vertical swing wheel, and move in the plane of the wheel. The chief advantage of the anchor pallets is, that they will permit the escape to take place with a small angle of vibration, so as to prevent the maintaining power from acting on the pallets a long time by a direct push, as was the case with the crown wheel escapement.

Dr. Hooke also claimed the invention of the anchor escapement, which he asserted that he exhibited to the Royal Society in a clock of his construction in 1666.

At the same time with the anchor escapement, the mode of suspending the pendulum from a clock by a piece of watch spring was introduced.

The anchor escapement causes a recoil in the swing wheel, from the same face of the pallet striking the tooth of the wheel in its descent, which is afterwards impelled by the same tooth in its ascent; this occasions the clock, in which it is used, to go faster, when the maintaining power is increased, or when the weight of the pendulum ball is diminished.

The advantage gained by the anchor escapement shewn above may be considered in reality an approximation to a detached escapement; a farther step was made towards this improvement about the year 1715, by the celebrated George Graham, in the contrivance of the dead-beat escapement, which is principally distinguished from the anchor escapement by having no recoil. This is effected by increasing the depth of the pallets in the line towards the centre of the swing wheel, and so forming the teeth of that wheel, that the pallet in action, in its descent, does not touch the teeth at all, but lies between them, and the tooth that impels it only comes in contact with its inclined plane at the instant previous to its ascent, when the opposite pallet becomes free. To avoid the wearing out of the parts most in action, and the influence of friction, the best clocks of this construction have swing wheels of hardened steel, with pallets of ruby or agate.

The detached escapement completed the improvement of this part of clock-work. Its object is, to make the pendulum perform the greatest part of each vibration entirely free from contact, or connection, with any part of the train. To effect this, a catch, or locking piece, restrains all the motion of the swing wheel, till the instant when the pallet is to be impelled by it, when it raises the catch, sets the wheel free, and is driven forward by its impulse; immediately after which, the catch again falls into its place. A great variety of escapements have been contrived on this principle by various ingenious men: those in which springs are used in the locking pieces instead of pivots, invented by Arnold, seem now most preferred.

The detached escapement was applied first to chronometers, or time-pieces, but is now used for astronomical clocks. From the best accounts, Julien Le Roy invented the first about 1748; since that time, Grignon, Mudge, Cummins, Nicholson, and Arnold, have contrived various escapements of this kind in England; and Peter Le Roy, Sully, Du Tertre, De Bethune, Le Paute, Arnaut, Robin, Berthoud, &c. on the continent. See Chronometer.

In the year 1715, Mr. George Graham, before mentioned, made a most material improvement in pendulums, by affixing an apparatus which tended to raise the centre of gravity of the whole, as much as the lengthening of the rod by heat tended to depress it: this he performed by substituting a glass cylinder, containing mercury, for the pendulum ball. He afterwards suggested the idea of using the opposite expansions of different metals, as a compensation for the effects of variation of temperature of the air in pendulums, which was directly afterwards adopted by Harrison, at that time an obscure carpenter in the village of Barton, Lincolnshire, who surprised the world with the invention of the gridiron pendulum on this principle.

In Harrison's pendulum five bars of steel and four of brass were so arranged, that they produced two expansions of brass upwards, and three of steel downwards, so proportioned to each other, that the ascending expansions fully compensated those in the contrary direction. This pendulum has been since its invention generally used, where very accurate measurement of time was necessary. A further description of it, of Elliot's pendulum, (which was the next made on this plan, and differs little from it,) and of the others here mentioned, will be inserted under the article Pendulum.

It has been supposed by several, that the tubular pendulum (which is also a modification of Harrison's compensation) is but a very recent invention: but the writer of this article having met with one by accident, which was made upwards of thirty years ago, thinks it but justice, both to the public, and the ingenious artist who directed its construction, to oppose this opinion. This pendulum is in possession of Mr. Patoureaux, watch and clock-maker, 15, Wardour-street. It was made by Mr. William Brown, a clock-maker well known to the trade, who has been dead upwards of five years, and who formerly resided near the Seven Dials. His brother, a jeweller, residing in 15, Coventry Court, Hay-market, was his executor, and sold the pendulum to Mr. Barrett, clock-maker, of Compton-street, some years ago, from whence Mr. Patoureaux bought it. Mr. Brown, the jeweller, informed the writer that this pendulum had been made by his brother upwards of thirty years ago, just after he had served his time to Mr. Chandler, then of King-street, Seven Dials, (whom he afterwards succeeded in his business;) and that it was made by direction of Mr. Chandler, who, as far as he knew, was the inventor of it: and in corroboration of this assertion, Mr. Hampson, working clock-maker, 22, Greek-street, Soho, declares, that he made several pendulums of the same construction for Mr. Brown, upwards of seven years ago. This tubular pendulum, which at present we must attribute to the ingenuity of Mr. Chandler, is composed of two tubes and a rod of iron, and two tubes of brass. The iron rod is about a quarter of an inch in diameter, and is suspended by a spring in the common manner; it is inclosed by the first brass tube, to which it is connected at bottom: an iron tube, supported by the top of the brass tube, then descends a little below it, and supports by its lower extremity the second brass tube, which rises a little above the former tubes, and from the top of it the second iron tube descends below all about two inches, into the substance of the pendulum bob, which is very large and heavy: the bottom of this last tube contains a nut, into which a screw (having a milled head beneath that sustains the bob) passes from below, and raises or lowers the bob, as required for the adjustment of the rate of going of the clock. We may date the invention of the tubular pendulum, from the foregoing information, about the year 1775, though it may yet be found to be of a still earlier period. The foreman of Mr. Villaumy, clock-maker to the Prince of Wales, Pall Mall, declares, that he remembers a tubular pendulum to have been made by Mr. Finney, a well known clock-maker of Liverpool, upwards of forty years ago, and that it is now in the possession of Mr. De Membry, of Richmond, but time will not permit the farther investigation of this point at present.

The last modification of the longitudinal compensation made public is that of Mr. Troughton, mathematical instrument maker; it differs from Chandler's tubular pendulum, in having but two tubes of brass, which afford the ascending compensations, while the descending ones are performed by five wires of steel. The order of brass and steel is the same as in Chandler's pendulum; but all the steel wires pass downwards through the internal brass tube. The last pair of wires connect the whole with the bob by a short cylindrical piece of brass, to which the bob is suspended by its centre.

Mr. Troughton made this pendulum in July, 1804, and published the first account of it in December same year, in Nicholson's Philosophical Journal: we believe he knew nothing of the priority of Chandler's tubular pendulum to his, and that, in thinking and declaring himself the first inventor of tubular pendulums, he only fell into an error common to many other ingenious men on similar occasions; and this error is the more excusable, as, at the time Chandler made his pendulum, there were no periodical works in existence, which professedly recorded the improvements of arts and manufactures, and artists were in general more careful to conceal their discoveries, than to acquire reputation by making them public.

Before concluding the enumeration of various sorts of pendulums, one suggested by Mr. Troughton should be noticed, which seems worthy of trial. He proposes that its rod should be made of baked potter's earth, of the same composition of Wedgewood's thermometer, and furnished with a metallic cap, by which it should be sustained by the knife-edge suspension, which the celebrated Berthoud affirms has less friction than the spring suspension.

The chief advantages which tubular pendulums have over those of the gridiron construction are, that they admit of being much lighter above the bob, with equal strength; that they experience less resistance from the air in their vibrations; and that they are less liable to those shakes and irregular motions in their expansions which the others experience: on the other hand, as the outside tube alone in them comes in contact with the air through which it passes in its vibrations, the inner tubes can receive much less of its influence as to temperature which arises from this motion, and which Cummings has shewn to be of considerable consequence. In Troughton's pendulum the great difference of the masses of matter between the ascending and descending parts must be another source of error, as the small wires of which the latter consist will indubitably much sooner experience the influence of a change of temperature in the air, than the more bulky substance of the tubes. In this latter respect Chandler's tubular pendulum seems superior to Troughton's, all its parts being much more nearly of the same magnitude.

More accurate comparative trials between these gridiron and tubular compensating pendulums, than any which have yet been made, seem, however, necessary to determine the superiority of either; and the preference which many are now inclined to give the tubular construction seems more to arise from the greater neatness of its appearance, than from any sufficient experience of its higher merit.

That it may be superior is very possible: we only aver that this has not been yet proved. But if equal apertures were made at both sides of tubular pendulums, through all the tubes, it would obviate the chief objection to them, by admitting the air to act on all their parts at once.

In the year 1803, the Society for the Encouragement of Arts gave a premium of 20 guineas to Mr. Massey, of Hornley, in Staffordshire, for a new striking part of a clock; the principal difference in which from the common movement was, that a pendulum about nine inches long, and which therefore vibrated pretty nearly half seconds, was used to regulate the interval of time between the strokes, instead of the common fly wheel. The other parts of the mechanism were also of a simpler construction than those of the striking parts of the clocks in common use.

Mr. Prior, of Nessfield, in Yorkshire, also obtained a premium from the abovementioned society, in the same year, of 30 guineas, for another contrivance for the striking part of a clock; of which the advantage consisted in the simplicity of its structure, and the precision of its performance, and which therefore possessed considerable merit as a piece of mechanism; but neither of those inventions being of any service to the great object of horological machinery, namely, the precise and accurate measurement of time, we have thought a farther description of them needless here.

Clocks being considered in this point of view, as they doubtlessly should be, no great estimation can be attached at present to those clocks on the continent, which were formerly so famous, whose chief object seems to have been to set a number of puppets in motion at stated times. Of these the clocks of Strasburgh and of Lyons were the most noted. In the former a cock claps his wings, and proclaims the hour; and puppets, intended to represent an angel, the Virgin, and the Holy Spirit, appear: the angel opens a door, and salutes the virgin, and the Holy Spirit descends on her. In the clock of Lyons two horsemen encounter, and beat the hour on each other; a door opens, and there appears on the theatre the image of the Virgin, with that of Jesus Christ in her arms; the Magi, with their retinue, marching in order, and presenting their gifts; two trumpeters sounding all the while, to proclaim the procession. Clocks with chimes are of the same nature with those described.

In nearly the same rank with the foregoing must be classed the clocks made to register the motions of the heavenly bodies: they can be only considered as objects of curiosity, since in point of utility, in noting the position of the heavenly bodies, the common nautical almanacs are so superior, as to render it in some degree ridiculous to compare them together. The clock of the royal palace at Hampton Court is one of the most noted of those which have movements of this nature; but other considerations render this clock an object of great interest. According to Dr. Derham, it is the oldest English clock extant, having been constructed in the year 1540, in the reign of Henry VIII. It shews the time of the day, and the motion of the sun and of the moon through all the degrees of the zodiac, together with the day of the month, the moon's southing, and other matters. These motions are the more deserving attention, as, at the time the clock was made, Copernicus, then living, had not published his book "On the Revolutions of the Celestial Orbs." And besides this, the pendulum was not applied as a regulator of clocks for nearly a century afterwards.

A few clocks have been constructed with a view directly contrary to those described, in which simplicity of parts was as much studied as great variety of movements were in the others. Of the clocks of this simple structure, none have as yet exceeded that contrived by the celebrated Dr. Franklin: it shows the hours, minutes, and seconds, and yet consists of but three wheels, and two pinions. The lowest wheel contains 160 teeth, and goes round once in four hours; it carries the hand on its axle, which points out both the hours and the minutes, as will be described; and it turns a pallet above it of ten leaves, on the same axis with which is a wheel of 120 teeth, that gives motion to a pallet of eight leaves. The second hand is annexed to the same axis with this latter pallet, as also the swing wheel, which carries 30 teeth, that gives motion to the pallets of an anchor escapement, and to its pendulum that vibrates seconds. The dial of this clock is of a singular formation. The external circle on it contains 240 divisions, numbered from 1 to 60, in four successive notations. This circle shews the minutes: within it the hours are arranged in four concentric circles, or in a volute of four revolutions, along four radii, which form right angles with each other. By this arrangement, while the point of the hand shews the minute, its side exhibits the hour; or, more strictly speaking, shews that the hour is one of three; but so that it will hardly ever happen that any doubt will remain of which it may be, as there are four hours difference between the figures next to each other on the same radial line. A small circle is placed above the great one, and divided into 60 parts for the seconds. This clock was wound up by a line going over a pulley and ratchet on the axis of the great wheel, by which the weight was drawn up in the same manner as in the common wooden clocks. Many of these clocks have been made, which are found to measure time exceedingly well.

The small imperfection in this clock, of its leaving the uncertainty mentioned as to which of three hours it denotes, though so easily corrected by the judgment, has given rise to some ingenious contrivances to obviate it.

That of Mr. Ferguson is best known, in which the hours were engraved on the face of the lower great-wheel; the seconds on that of the upper or swing-wheel; and the minutes were shown in a fixed dial, outside all, through holes cut, in which certain small portions of the other two moveable dials were exhibited; the minute hand was attached to the axle of the second great wheel, which contained 120 teeth, as well as the first great wheel; the swing wheel had 90 teeth, the axis of the second great wheel carries a pinion of 10 leaves, and that of the swing wheel a pinion of 6 leaves. But this clock had several imperfections, from which Dr. Franklin's clock is free. The smallness of the teeth of the swing wheel caused the pendulum to describe smaller arcs than it should do; the weight of the flattering, on which the seconds were engraved, loaded the axis of the swing wheel, so as to cause much friction in this part, which should be as free from it as possible, and there was a considerable difficulty in adjusting the hour plate so as to correspond with the minute hand.

Another very ingenious contrivance for the same purpose has been made in a clock, on Dr. Franklin's principle, in the possession of Mr. Patoureaux, clock-maker, Wardour-street, to which the tubular pendulum, on Chandler's plan, before mentioned, is annexed. To the axis of the great wheel of this clock two concentric plates are annexed, the external one of which has a groove cut through it, along the line of a volute of four revolutions. This groove forms a trough, in which a metal ball is placed, part of which is seen through its excavations. As the plate and groove turn round, the ball rolls along the volute, still approaching nearer the centre as it proceeds; and when at last it arrives at the centre, it falls into another trough, by which it is again conveyed to the external part of the volute; the hours are engraved between the revolutions of the volute, and the minutes are marked on an external fixed circle, to which an index, annexed to the volute plate, points. We have not been able to discover who is the author of this ingenious invention. It is certainly a superior method to Ferguson's; the moveable dial being in it annexed to the axle of least motion, where of course its weight is of least consequence; and the adjustment for the hours and minutes being performed in it at the same time. This clock is formed with a dead beat escapement, and is intended for a regulator.

The description of the parts of an eight day clock, moved by weights, inserted a little farther on, with reference to the annexed plate, may serve, with a little addition, to give an idea of the mechanism of a clock moved by a main spring.

The spring, by which a clock is moved, consists of a long flat plate of steel coiled up in a spiral form; it is inclosed in a cylindrical box, to which its external extremity is attached, while its internal end is connected to a fixed axis, round which the spring-box revolves. As the strength of the spring is greater the more it is coiled up by the turning round the box, its action would be unequal in impelling the work of the clock; and to remedy this inconvenience the fusee wheel has been contrived. The fusee consists of a conical barrel, round which an heliacal groove is cut, that receives a chain or catgut, previously wound round the spring box, by which, as it is turned round, it coils up the spring; the groove receives the chain first near the base of the cone, and, as the barrel revolves, gradually brings it nearer the axis; by this means, the stronger the spring is coiled up, the shorter is the lever by which it acts on the work; and as it gradually uncoils and becomes weaker, on the contrary, the lever of action becomes longer.

If instead of the barrel, in figure 2, on which the catgut from the weight is coiled, the fusee wheel described be supposed to be substituted, and the spiral spring, and its barrel and chain, to be added, a good idea will be obtained of a spring-clock; as all the rest of the work may be the same as in the figure.

Spring-clocks are generally used in chambers, in places where weight-moved clocks would take up too much room. They are often so constructed, that their frames do not hide any part of the work, and are then inclosed with glass covers, so that all their movements may be seen; as they are designed for ornament as well as use, very elegant and expensive decorations are frequently added to them.

The invention of moving time-pieces by springs first gave rise to portable time-pieces, or watches, for which see the articles Chronometer and Horology.

Spring clocks are sometimes called

portable clocks, but improperly, for no pendulum clocks can be made so as to be portable: for this purpose the balance wheel and its spring must be substituted for the pendulum, and it is this point that makes the grand distinction between clocks and watches, or chronometers: the properties of the balance spring, as a regulating power, will be found in the articles before mentioned.

Clocks for astronomical purposes, in which extraordinary nicety in the exact measurement of time is necessary, have (besides the compensation pendulums, detached escapements with jewelled pallets, and other improvements before mentioned) a contrivance added to continue their movement, while the weight is winding up, which was first used in spring-moved chronometers. For this purpose, a second larger ratchet wheel is added on the same arbor with that which admits the clock to be wound up, but with teeth pointing the contrary way; a strong spring, usually the greatest portion of a circle, connects this large ratchet wheel with the great wheel of the clock, which is on the same axis with it; one end of this spring being attached to the great wheel, and the other end to the large ratchet; and a catch proceeds from the inner face of the back plate to the teeth of the ratchet, which prevents its moving back when the clock is winding up, and serves as a support for the reaction of the maintaining spring. When the clock is left to the operation of the weight, the small ratchet turns round the large one, and contracts or coils up the spring, till it has strength sufficient to impel the great wheel and train; amd when the action of the weight is suspended, as in winding up, the spring, freed from the contracting power of the weight, expands itself, and forces round the great wheel; its action in the contrary direction on the great ratchet being prevented by the catch before mentioned. Le Roy is generally supposed to have invented this improvement for his chronometers; but as he has proved that the fusee is unnecessary when a detached escapement is used, the same purpose might be answered, in a much simpler manner, in those time-pieces which are moved by springs, by turning round the arbor to which the internal end of the main-spring is attached, in order to wind it up, instead of turning round the spring-box in the customary manner.

Though Le Roy was the first who contrived the spring impeller, to prevent loss of time in winding up, Huygens was in reality the person with whom the idea originated; for he contrived a method, by which the weight of his clock should continue to act on the train while it was drawing up, the weight in his clock having been made to draw up in a similar manner to that used in the common wooden clocks, instead of being wound up as in our metallic clocks. Patouréaux's clock has this contrivance.

The following description of an eight day clock, with reference to the plate, will, it is hoped, sufficiently shew its construction; and the plate will, it is presumed, assist in elucidating the various parts of clocks, and improvements, before described.

Plate Clock-work, is a representation of an ordinary eight day clock, with repeating, striking mechanism.

Fig. 1, Clock-work, is an elevation of the clock, sideways, shewing the pendulum and going part; the striking movements are omitted in this figure, to avoid confusion; fig. 2, is a projection of the wheel-work of both going and striking part; and fig. 3, is the dial-work, or mechanism immediately under the dial, (which is removed,) and is that part which puts the striking train in motion every hour. A clock of this kind contains two independent trains of wheel-work, each with its separate first mover; one is constantly going, to indicate the time by the hands on the dial-plate; the other is put in motion every hour, and strikes a bell, to tell the hour at a distance. *a*. figures 1 and 2, is the barrel of the going part; it has a catgut band *b* wound round it, suspending the weight which keeps the clock going; 96 is a wheel, (called the first or great wheel,) of that number of teeth upon the end of the barrel, turning a pinion of eight leaves on an arbor which carries the minute hand. 64 is a wheel of 64 teeth on the same arbor, (called the center wheel,) turning the wheel 60 by a pinion of eight leaves on its arbor; this last wheel gives motion to the pinion of eight, on the arbor of the swing wheel 30, of 30 teeth; *d*, *h*, are the pallets of the escapement fixed on an arbor *e*, fig. 1, going through the back plate of the clock's frame, and carrying a long lever *f*; this lever has a small pin projecting from its lower end, going into an oblong hole, made in the rod B of the pendulum. The pendulum consists of an inflexible metallic rod, suspended by a very slender piece of steel-spring, D, from a brass bar E, screwed to the frame of the clock, having a weight or bob at its lower end, in the present case 39.125 inches from the suspension D; when this pendulum is moved from the perpendicular line in either direction, and suffered to fall back again, it swings nearly as much beyond the perpendicular on the contrary side, and then returns; this it will continue to do for some time, and each of these vibrations will be performed in one second of time, when the pendulum is of the above length. This is the measurer of the time; and the office of the clock is only to indicate the number of vibrations it has made, and give it a small impulse each time, to keep it going, as the resistance of the air and elasticity of the spring D would otherwise in a few hours cause it to stop. By the action of the weight applied to the cord *b*, (which is called the maintaining power,) the wheels are all turned round, and if the pallets *d h* were removed, the spring wheel 30 would revolve with great velocity in the direction from 30 to *d*, until the weight reached the ground: the teeth of these pallets are so made, that one of them always engages the wheel, and prevents its turning more than half a tooth at a time. In the drawing the pallet *d* has the nearest tooth of the wheel resting on it, and the pendulum is on the side *k* of the perpendicular; when it returns it moves the pallet *d*, so as to allow the tooth of the wheel to slip off; but in the mean time the pallet *h* has interposed its point in the way of the tooth next it, and stops the wheel till the next vibration or second; the distance between the two pallets *d h* is so adjusted, that only half a tooth of the wheel escapes at each vibration; and as the wheel has 30 teeth, it will revolve, once in 60 vibrations of one second each, or one minute; consequently a hand on the arbor of this wheel will indicate seconds on the dial-plate F, a circle divided into 60; the pinion of eight on its arbor is turned by a wheel of 60, which consequently will turn once in seven turns and a half of the other, or in seven minutes 30 seconds, or one-eighth of an hour; its pinion of eight is moved by a wheel of 64, or eight times itself, which will turn in one-eighth part of the time; this will be an hour; the arbor of this wheel therefore carries the minute hand of the clock. The great wheel of 96, being 12 times the number of the pinion eight, will turn once in 12 hours, and the barrel *a* with it. The gut goes round 16 times, so that the clock will go eight days. The hour hand of the clock is turned by the wheel-work shewn in fig. 3: on the end of the arbor of the centre wheel 64 a tube is fitted, so as to go round with it by friction; this carries the minute hand, but if the clock should require correction, the hand may be slipped round without moving the wheels; this tube has a pinion of 40 teeth on its lower end, indicated by a dotted circle; this turns another wheel 40, of 40 teeth, which has a pinion of six teeth on its arbor, turning a wheel 72, of 72 teeth; the two wheels 40 will both turn in an hour; and 72 in 12 hours: the arbor of this wheel has the hour-hand, and is a tube going over the arbor of the minute-hand, so that the two hands are concentric. The barrel *a* is fitted to an arbor coming through the plate of the clock, and is filed square, to put on a key to wind up the weight; the great wheel 96 is not fixed fast to the arbor, but has a click on it, which takes the teeth of a ratchet wheel cut upon the barrel; so that the barrel may be turned in the direction to wind up the weight without the wheel: but by the descent of the weight, the wheels will be turned by the click.

Having now described the going part of the clock, it remains to describe the mechanism by which the hours are struck. 78, fig. 2, is a great wheel of 78 teeth, with a barrel and click the same as 96; it turns a pinion of eight; 64 is a wheel on the same arbor turning a pinion of eight on the arbor of the wheel *o* of 48; this turns another pinion of eight, and wheel *p* of 48, which turns a pinion of six, on the same arbor with a thin vane of metal, which is called the fly, and by the resistance of the air to its motion regulates the velocity of the wheels. The wheel 64 has eight pins projecting from it; these raise the tail *n* of the hammer, as they revolve; the hammer is returned violently, when the pins leave its tail, by a spring *m* pressing on the end of a pin put through its arbor, and strikes the bell, (the hammer and bell are behind the plate, and therefore unseen,) *l* is a short spring, which the other end of the pin through the arbor touches just before the hammer strikes the bell; its use is to lift the hammer off the bell the instant it has struck, that it may not stop the sound. The eighth pin in the wheel 64 must pass by the hammer tail 78 times in striking the 12 hours, $1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 + 11 + 12 = 78$, and as its pinion has eight leaves, each leaf of the pinion answers to a pin in the wheel 64; now as the great wheel has 78 teeth, it will turn once in 12 hours, the same as the other great wheel 96. In the wheel 64 eight of its teeth correspond to one of the pins for the hammer, and as the pinion of the wheel *o* has eight teeth, it (wheel *o*) will turn once for each stroke of the hammer. By the remaining wheels, one, *o*, multiplying six, and the other, *p*, eight times, the fly will turn $6 \times 8 = 48$ times for one turn of $o =$ one stroke of the hammer. Fig. 3. is also mechanism relating to the striking part: *r* is a small pinion of one tooth, called the gathering pallet, on the arbor of wheel *o*, and consequently turns once for each stroke of the hammer; *s* is a segment of a large wheel which it turns (called the rack); *t* is an arm attached to the rack, whose end rests against a spiral plate V, called the snail; this is fixed on the tubular arbor before described of the hour hand and wheel 72, and turns round with it once in 12 hours. The plate is divided into 12 equal angles, 30 degrees each, and as it turns, each of these answers to an hour; the circular arcs forming the circumference of the snail are struck from the centre of the arbor between each division with a different radius, decreasing a certain quantity each time in the order of the hours. The circular part of the rack *s* is cut into teeth, each of which is of such a length, that every step upon the snail shall answer to one of them; *w* is a spring pressing against the tail of the rack, and acting to throw the arm of the rack against the snail; *g* is a click, called the hawk's bill, taking into the teeth of the rack, and holding it up in opposition to the spring *w*: *i k* is a three-armed detent, called the warning piece; the arm *k* is bent at its end, and passes through a hole in the front plate of the clock, so as to catch a pin placed in one of the arms of the wheel *p*, fig. 2, and which describes the dotted circle in fig. 3; the other arm *i* stands so as to fall in the way of a pin in the wheel 40. In the present position of the figure, the wheels of the striking train are in motion, and would continue turning until the gathering pallet *r*, which turns once at each stroke of the hammer, by its tooth lifts the rack *s* in opposition to the spring *w* one tooth each turn; and the hawk's bill *g* retains the rack, until a pin in the end of the rack is brought in the way of the lever of the gathering pallet *r*, and stops the wheels from turning any further: it is in this position with the rack wound up, till its pin arrests the tail *r*, that we shall begin to describe the operation of the striking of the clock. The wheel 40, as we have said before, turns once in an hour, and consequently at the expiration of every hour the pin in it takes the end *i*, and moves it towards the spring near it; this depresses the end *k* until it falls in the circle of the motion of the pin in the wheel *p*, fig. 2, at the same time the short tail depresses one end of the hawk's bill, and raises the other *g*, so as to clear the teeth of the rack *s*; immediately the spring *w* throws the rack back, until the end of its tail *t* touches that part of the snail which is nearest it; when the rack falls back, the pin in it is moved clear of the gathering pallet *r*, and the wheels set at liberty; the maintaining power puts them in motion; but in a very short time before the hammer has struck, the pin in the wheel *p* falls against the end of *k*, and stops the whole; this operation happens a few minutes before the clock strikes, and this noise of the wheels turning is called the warning: when the hour is expired, the wheel 40 has turned so far as to allow the end of *i* to slip over its pin, as in the figure; the small spring pressing against it raises the end *k* so as to be within the circle of the pin in the wheel *p*, fig. 2: every obstacle is now removed, and the wheels run on the pinion; the wheel 64 raises the hammer *r*, and it strikes on the bell, the gathering pallet *r* takes up the rack, a tooth at each turn, the hawk's bill *g* retaining it until the pin in the rack comes under the gathering pallet *r*, and stops the motion of the whole machine, till the pin in the wheel 40 at the next hour takes the warning piece *i k*, and repeats the operation we have now described. As the gathering pallet turns once for each blow of the hammer, and its tooth gathers up one tooth of the rack at each turn, it is evident the number of teeth the rack is allowed to fall back limits the number of strokes the hammer will make. This is done by the rack's tail *t* resting on the snail; each step of the snail answers to one tooth of the rack, and one stroke of the hammer; at each hour a fresh step of the snail is turned to the tail of the rack, and by this means the number of strokes is made to increase one at each time from one to twelve.

Clock-*work*, in the limited meaning of the word used by artists, denotes only the machinery employed in the striking part of a clock; that used for giving motion to the hands being called watch-work. In its more extensive sense, it is generally understood to mean any combination of wheel-work, for any purpose, whose parts do not much exceed in size those of a common clock.

CLOSE, in heraldry. When any bird is drawn in a coat of arms with its wings close down about it, (*i. e.* not displayed,) and in a standing posture, they blazon it by this word close; but if it be flying, they call it volant.

Close *hauled*, in marine language, the arrangement of a ship's sails, when she endeavours to make progress in the nearest direction possible towards that point of the compass from which the wind blows; in this manner of sailing the keel of square rigged vessels commonly makes an angle of six points with the line of the wind, but cutters, luggers, and other fore and aft rigged vessels, will sail much nearer.

Close *quarters*, strong barriers of wood stretching across a merchant ship, in several places: they are used as a place of retreat when a ship is boarded by her adversary, and are therefore fitted with loop-holes, through which to fire the small arms. An English merchant ship of 16 guns, properly fitted with close quarters, has defeated the united efforts of three French privateers who boarded her.

CLOTH, a woven fabric, composed of wool, flax, cotton, or hemp, either separate or mixed. Woollen cloths consist chiefly of broad cloths, kerseymeres, flannels, shalloons, serges, baizes, &c.: the two former are the most valuable, and will be chiefly noticed. The wool should be of the best quality, and in the best state of preparation, before it is sent to the loom. Formerly Spanish wool bore a very high price with us, but of late years we have, by obtaining some of the sheep of that country, established a breed, which is found to yield a finer sample than even the pure Marino. The justly celebrated Dr. Parry, of Bath, has sedulously attended to this point, and has produced fleeces, which, in regard to fineness and length of staple, are obviously superior, being as six to five when compared with the Spanish. Hence our woollens have latterly been less indebted to importation, and we may fairly expect to see our flocks become doubly valuable. The cloths are woven in a common loom, and the superfluous nap is taken off by a very ingenious contrivance, called the shearer, not unlike the blade of a scythe, which, with a regular motion given by various machinery, completely levels the surface, and fits it for the last process: this is done by the teazel, a kind of thistle, which grows in hedge rows, but is in many parts cultivated for the supply of manufactories. The heads of the teazles are inserted into grooves in long battens, so as to appear, and to act, like brushes; these brushes extend the whole breadth of the cloth, and are set all around a cylinder, which brushes the cloth by its rotatory motion, rendering its surface beautifully glossy and smooth. The appearance is, however, greatly improved by pressing. The coarser kinds of cloth undergo little finishing. Linens are made of bleached flax; they are chiefly manufactured in Ireland and Scotland, both which countries derive essential advantages from their manufactures, especially as they produce the raw material. Cotton must be imported in its raw state; a circumstance which gives employ to many thousands of our poor; though the muslins, calicoes, &c. are generally made from the thread formed by machinery. Hemp makes Sail-cloth, Canvas, &c. which see. The manufactories for woollens and linens in the United Kingdoms are supposed to give bread to near a million of persons. The importation of foreign cloths is therefore very wisely prohibited. For further particulars, see Weaving.

CLOUD, a visible aggregate of minute drops of water, suspended in the atmosphere. It is concluded, from numerous observations, that the particles of which a cloud consists are always more or less electrified. The hypothesis, which assumes the existence of vesicular vapour, and makes the particles of clouds to be hollow spheres, which unite, and descend in rain when ruptured, however sanctioned by the authority of several eminent philosophers, does not seem necessary to the science of meteorology in its present state; it being evident that the buoyancy of the particles is not more perfect than it ought to be, if we regard them as mere drops of water. In fact, they always descend, and the water is elevated again only by being converted into invisible vapour. See Meteorology.

CLUE, in marine language, is the lower corners of square sails; but the aftmost only of stay-sails, &c. the other lower corner being called the tack.

Clues of a hammock, the combination of small lines by which it is suspended.

CLUPEA, the *herring*, in natural history, a genus of fishes of the order Abdominales. Generic character: head compressed; mouth compressed and internally rough; jaws unequal; tongue short and rough; with inverted teeth; side-plates of the upper mandible serrated;

gill-membrane eight-rayed ; gills setaceous internally; abdomen sharp, and generally serrated ; body compressed, elongated, and covered with moderate scales; ventral fins often nine-rayed ; tail forked. There are fifteen species, according to Gmelin, and according to Shaw, nineteen; of which the most deserving of notice are, C. harengus, or the common herring.

This fish does not appear to have been known by the Greeks and Romans, or at least to have attracted from them any particular attention. In modern times it constitutes an important article of commerce, and the herring fishery has for ages been considered as an important field for national industry, and a source of national wealth. Even in the twelfth century the Dutch were much occupied in taking herrings, and preserved a sort of monopoly on this subject for several ages. The art of pickling them was discovered in Flanders. The Dutch are uncommonly partial to the pickled herring, and on the arrival of the first vessel in port, laden with this article, resort to it with all the ardour of impatience and competition. This first vessel also is entitled to a considerable premium. The term herring is derived from a German word, meaning an army, and well expresses the immense multitude of this fish, which, after wintering within the arctic seas, where insect food abounds fully to the extent of their immense demands, direct their course in spring towards the south. In April they are generally seen off the isles of Shetland, and their progress is marked by the flocks of birds which accompany them, and prey upon them. There are, in general, several columns of this mighty host, extending about five miles in length and three in breadth, and reflecting, by their advance to the very surface of the water, that pearly lustre and lively variety of colour, which, in clear weather, give to the spectacle extraordinary interest. From the isles of Shetland they divide to the eastern and western shores of Great Britain; in the former case passing through the English Channel, after visiting every gulf and creek within its limits; in the latter, visiting the coast of Ireland, and furnishing the inhabitants with a cheap and valuable article of subsistence. Some naturalists, however, have doubted of the extensive migrations ascribed to the herring, and consider the time allotted for its accomplishment as totally inadequate for this purpose. They suppose them in winter to shelter themselves in the profound retreats of the ocean, and amidst its soft and muddy bottoms, near those very shores, in their approach to which they are first seen in spring. The food of the herring consists chiefly of sea insects and worms, and itself becomes food, not only, as before intimated, to various birds, who follow their track with unceasing vigilance and voracity, but to innumerable fishes also: of these the whale is its most formidable enemy, and thins its columns with the most destructive and consuming havock.

The C. pilchardus, or the pilchard. This is somewhat smaller than the last; its scales also are larger; and its body is thicker, rounder, and more oily. It abounds in the summer months on the coast of Cornwall; and in the port of St. Ives nearly two hundred and fifty millions were once enclosed by a single draught. The supply of this fish being very frequently far superior to any regular demand, it has in some cases been employed merely as manure, for which it is found admirably applicable.

C. alosa, or shad. This is considerably like the pilchard; but is larger and thinner ; distinguishable particularly by the scales upon its belly, which form a sharp keel along it. It is found in the Mediterranean and in the Baltic, and ascends rivers periodically to deposit its spawn, which it always does in the deepest parts. The longer it continues in fresh water, the fatter it becomes; it feeds principally on insects and young fish, and can live but a few moments after being taken from the water. It is little valued for the table, being coarse and tasteless. It is found in the rivers of England, and principally in the Severn.

C. sprattus, or sprat, resembles the herring, and might easily be taken for its young. There are, however, decided differences. During the winter months sprats are caught in abundance in the Thames, and are a very valuable resource for the poor inhabitants of the metropolis. In some places they are pickled with great advantage ; in others they are cured like the herring, and are scarcely less relished.

C. encrasicolus, or anchovy. This was well known to the ancients, who prepared from it a sauce in high estimation. Its bones are soluble in boiling water, which renders it of great convenience in condimental preparations.

CLUSIA, in botany; so called in memory of Carolus Clusius, an eminent French botanist; a genus of the Polygamia Monoecia class and order. Natural order of Guttiferæ, Jussieu. Essential character: male, calyx four or six-leaved; leaflets opposite, imbricate; corolla four or six-petalled: stamina numerous: female, calyx and corolla as in the males; nectary formed by the coalition of the anthers, including the germ; capsule five-celled, five-valved, stuffed with pulp. There are six species. These are trees abounding in a tenacious, glutinous juice. C. rosea, rose-coloured balsam tree, is from twenty to thirty feet in height, a native of the Bahama islands, St. Domingo, and other American islands, between the tropics, on rocks, and often on the trunks and limbs of trees, occasioned by birds scattering or voiding the seeds, which, being glutinous like those of misletoe, take root in the same manner; but the roots, not finding sufficient nutriment, spread on the surface of the tree till they find a decayed hole or other lodgment, where there is some portion of soil; the fertility of this being exhausted, a root is discharged from the hole till it reaches the ground, though at forty feet distance; here again it fixes itself, and becomes a larger tree.

CLUYTIA, in botany, in memory of Augerius Clutius, professor of botany at Leyden, a genus of the Dioecia Gynandria class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: calyx five-leaved; corolla five-petalled: female, styles three; capsule three-celled; seed one. There are ten species, all natives of hot climates.

CLYPEOLA, in botany, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ. Cruciferæ, Jussieu. Essential character: silicle emarginate, or biculate, compressed, flat, deciduous. There are three species. These are low plants, that have little beauty, and are preserved chiefly in botanic gardens.

CLYSTER is a liquid remedy, to be injected chiefly at the anus into the larger intestines.

CNEORUM, in botany, a genus of the Triandria Monogynia class and order. Natuarl order of Tricoccæ. Terebintaceæ, Jussieu. Essential character: calyx three-toothed; petals three, equal; berry tricoccous. There is but one species; *viz.* C. tricoccum, willow-wail, or sponge olive; native of the south of France, Italy, and Spain, in hot, dry, barren, and rocky soils.

CNICUS, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx ovate, imbricate with branch-thorny scales, guarded with bractes; corollets equal. There are nine species.

COACH, a convenient carriage suspended on four or more springs, and moving on four wheels, originally intended for the conveyance of persons in the upper circles of society, but now beeome so common as to stand in our streets plying for fares. The first coach ever seen in England was introduced by the Earl of Arundel from the continent, in the year 1581; since that time their numbers have been gradually increasing, insomuch that every family of easy fortune keeps its carriage; while no less than 1100 hackney coaches are registered within the bills of mortality. See COACHES, *hackney*. Such coaches as are the property of private persons, or are kept for hire, pay a high duty, and produce a total of several hundreds of thousands to the Exchequer. The fashions, with regard to form and ornament of coaches and other carriages for pleasure, are perpetually changing, and many varieties are occasionally presented. The principal kinds now in use are, the close coach; the landau, which can lower its roof and part of its sides, like the head of a phaeton; the barouche, or open summer carriage, made on the lightest construction; the chariot, which is intended only for two or three persons; the landaulet, or chariot whose head enfolds back; the phaeton and caravan, which have only a head and no windows, with a leather apron rising from the foot-board to the waist: all of these run upon four wheels. Of the two-wheeled vehicles, we have the curricle, drawn by two horses, each bearing on a narrow saddle the end of a sliding bar or yoke, that upholds a central pole. These cannot be considered as very safe machines, but are admirably calculated for ease of draught; and their bodies being upon four pliant springs, must generally have a very easy motion. The gig, chaise, or whiskey, has but one horse, which moves between a pair of shafts, borne nearly horizontal by means of a leather sling passing over the saddle tree; when another horse precedes, so as to drive one before the other, the machine is called a tandem; a pun upon that word, which in Latin signifies "at length." Those chaises which do not go upon springs, and are in other respects calculated for the use of the poorer classes, pay less duty, but must bear the words "taxed cart" in some conspicuous part, and in letters of not less than an inch in depth: their cost must also be under 12*l.* Our stage coaches, which travel to every part of the kingdom, are, beyond compare, superior to those of any other nation, both for speed of travelling and accommodation. The legislature has wisely restricted the numbers of inside and of outside passengers. On the whole, they perform their journies at the rate of 5 miles in the hour during summer, and about 4½ during the winter season. Taken on an average, the rates are from 4½*d.* to 6*d.* per mile for inside passengers; though in cases of competition they have gone so low as 2*d.* The mail-coaches, which carry the letters to and from the General Post-Office, are of a very strong build, and usually run 8, or even 9, miles within the hour; they are limited as to the time in which each stage is to be performed; and the guard makes remarks as to the condition of the cattle, the performance of their duty, the accidental delays and deviations, upon a printed way-bill delivered with the bags at the post-office; he notes every matter relating to time, according to his time-piece, which is always adjusted before he takes leave. The mail-coaches are restricted to four inside and two outside passengers, besides the coachman and the guard, both of whom wear the king's livery; and the royal arms are borne upon the centre pannels of the coach. All the mail-coaches pass in review at Buckingham-house, and St. James's, on his Majesty's birth-day; the guards and drivers dressed in their new uniforms, and the horses decked with ribbons. Every mail-coach, so soon as it arrives in town, is sent to the overseer and contractor at Mill-Bank, Westminster, where it is strictly examined, the screws tightened, axles greased, and every precaution taken to guard against accident.

Coaches, *hackney:* commissioners are appointed to license and regulate them: the proprietor of each coach to pay 10*s.* per week. Each coach is to be numbered on both sides, the altering of which incurs a penalty of 5*l.* The same penalty is incurred by driving or letting to hire a coach without a license. Mourning-coaches and hearses are within the act. The horses in hackney-coaches must be fourteen hands high. Coachmen compelled to go in the day ten miles; after dark but two miles and a half on turnpike-roads; to have check-strings, under the penalty of 5*l.*

The rate for a mile and a quarter, or less, is 1*s.* from that to two, 1*s.* 6*d.* and for each additional half mile entered upon, 6*d.*

In reckoning by time, three quarters of an hour, or less, is 1*s.* between that and an hour 1*s.* 6*d.* one hour and twenty minutes 2*s.* and for each additional twenty minutes entered upon, 6*d.* For a day of twelve hours, 14*s.* 6*d.* and 6*d.* for each twenty minutes over.

A coachman refusing to go, or exacting more than his fare, forfeits from 10*s.* to 3*l.* By misbehaviour or impudence he incurs the same penalty, and subjects his license to be revoked, and himself to be committed to the house of correction. Persons refusing to pay the fare, or defacing the coach, may be compelled by a justice to make satisfaction. The penalties may be recovered before the aldermen of the city, and justices of the peace, as well as before the commissioners. 4, 7, 10, 11, 12, 24, 26, and 32, Geo. III.

Coaches, *stage:* every person keeping any public stage-coach shall pay, annually, 5*s.* for a license; and keeping any such public stage without a license, he shall forfeit for every time such carriage is used 10*l.* No person licensed shall, by virtue of one license, keep more than one carriage, on penalty of 10*l.* Every licensed stage-coach shall pay 2½*d.* for every mile it travels. Every person licensed shall paint, on the outside pannel of each door, his christian and surname, with the name of the place from whence he sets out, and to which he is going, on pain of 10*l.* Should he discontinue such carriage, he shall give seven days previous notice, and have such notice indorsed upon his license, and from thenceforth shall be no longer chargeable.

Drivers of stage-coaches are not to admit more than one outside passenger on the box, and four on the roof of the coach, on the penalty of 5*s.* for each passenger at every turnpike-gate.

COADUNATÆ, in botany, the 52d order of plants in Linnæus' "Fragments of a Natural Method," so named from the general appearance of the seed-vessels, which are numerous, and, being slightly attached below, form altogether a single fruit, in the shape of a sphere or cone, the parts of which are easily separated from one another.

COAGULATION, is the property of certain liquids becoming solid without evaporation, and without their assuming a crystalline form. The hardening of the white of an egg, by mere heat, is an example of this kind: the characteristic properties of the substance are completely changed. In their first state it is soluble in water; but coagulated, water, neither hot nor cold, has any power over it. See ALBUMEN.

COAL, in mineralogy, a most important genus of mineral inflammables, in which is included the carbonaceous and carbono-bituminous fossils. In the excellent dictionary by Messrs. A. and C. Aikin, this genus is divided into the families of brown coal, black coal, and mineral carbon. The first, or brown coal, is imperfectly bituminous, of a brown colour and vegetable texture: of this there are four species. The second, or black coal, is perfectly bituminous, of a black colour, and contains three species, of which one is the slate coal, which is soft and easily frangible: specific gravity 1.2 to 1.24: it contains from 57 to 64 of carbon, and from 33 to 43 of bitumen, being a mixture of maltha and asphalt, and from 3 to 6 of earth and oxide of iron. Most of our common coals belong to this species, and from the different phenomena which they exhibit during combustion, a great number of varieties are known in the market. The canal coal is of this family. See AMPELITES. The third sort, or mineral carbon, is destitute of bitumen, and consists of charcoal, with various proportions of earth and iron. There are three species, of which one is plumbago, or black lead. See BLACK-LEAD.

Coal, of all the substances which naturalists have arranged in the class of inflammables, is by far the most serviceable to mankind. Nature has dealt it to us with an unsparing hand, and has provided mines of this mineral which seem to defy the power of man to exhaust. England and France, where the different branches of manufacture are carried to a greater extent and perfection than in the other countries of Europe, are, at the same time, the most abundantly provided with mines of coal, as if nature was determined to second the exertions of an industrious people by giving them the best possible assistance. Coal is always found in masses, sometimes in a heap, most frequently in beds; but rarely in veins. The beds are disposed within the earth with different degrees of inclination, and in almost every possible direction. These beds of coal are supposed by most naturalists to be a deposit formed by the waters of the ocean, which once covered our continent. They are never found single, but generally disposed in strata one above another. The beds of coal are separated by layers of stone, which are nearly of the same nature in all coal mines. Those which form the side and the top of a stratum of coal are a sort of friable slate, containing more or less of bitumen, while the bottom is generally more compacted, and mixed with micaceous sand. It is remarkable that this slaty kind of stone, which so generally accompanies the coal, should frequently contain the impressions of plants, and particularly ferns, some of which are met with in the finest state of preservation.

In Scotland, the mines of Carron, of Edinburgh, and of Glasgow, are chiefly distinguished for their produce. There are three beds of coal at Carron, the first of which is about 40 fathoms below the surface, the second 50, and the third 55. Only two beds are worked at Edinburgh, and one of them is remarkable for its situation, the opening of the mine being hardly forty fathoms from the sea, and only three fathoms above high water mark. The mines of Glasgow stretch from the north-east to the south-west, and occupy a considerable space of ground. Here are several beds of coal, placed on each other, and continued nearly from the surface of the ground to the depth of three hundred feet; but of these beds there are only two or three that are worth the trouble of working.

The principal mines of this useful mineral in England are those of Newcastle and Whitehaven. The town of Newcastle absolutely stands on beds of coals, which extend to a considerable distance round the place. There are seven or eight beds of this mineral, one above the other, and all inclined in a south-east direction; the lowest is a hundred fathoms from the surface of the earth. But the mines near Whitehaven will afford the best idea of these wonderful places. We learn that these coal mines are perhaps the most extraordinary of any in the known world. The principal entrance for men and horses is by an opening at the bottom of a hill, through a long passage hewn in the rock, which, by a steep descent, leads down to the lowest vein of coal. The greatest part of this descent is through spacious galleries, which continually intersect each other; all the coal being cut away, except large pillars, which, in deep parts of the mine, are three yards high, and twelve square at the base. The mines are sunk to the depth of a hundred and thirty fathoms, and are extended under the sea to places, where, above them, the water is of sufficient depth for ships of large burthen. These are the deepest coal mines that have hitherto been wrought, and perhaps the miners have not in any other part of the globe penetrated to so great a depth below the surface of the sea; the very deep mines in Hungary, Peru, and elsewhere, being situated in mountainous countries, where the surface of the earth is elevated to a great height above the level of the ocean. There are here three strata of coal, which lie at a considerable distance one above another; the communication between each is preserved by pits. The vein is not always regularly continued in the same inclined plane, but is sometimes interrupted by hard rocks, and in those places the earth seems to have sunk downwards from the surface, while the part adjoining hath retained its ancient situation. These breaks the miners call dykes, and when they meet with one of them, they first observe whether the direction of the strata is higher or lower than in the part where they have been working. If, to employ their own terms, it is cast down, they sink a pit to it with little trouble; but should it, on the contrary, be cast up to any considerable height, they are frequently obliged to carry a long level through the rock, with much expense and difficulty, till they again arrive at the vein of coal.

In these deep and extensive works, the greatest care is requisite to keep them continually ventilated with perpetual currents of fresh air, to expel the damps and other noxious exhalations, and supply the miners with a sufficiency of that vital fluid. In the deserted works, large quantities of these damps are frequently collected, and often remain for a long time without doing any mischief: but when, by some accident, they are set on fire, they produce dreadful and destructive explosions, and burst out of the pits with great impetuosity, like the fiery eruptions from burning mountains. The coal in these mines hath several times been set on fire by the fulminating damp, and continued burning many months, until large streams of water were conducted into the mines, and suffered to fill those parts where the coal was on fire. Several collieries have been entirely destroyed by such fires: of these there are instances near Newcastle, and in other parts of England, and in the shire of Fife in Scotland; in some of which places the fire has continued burning for ages. To prevent as much as possible the collieries from being filled with these pernicious damps, it has been found necessary to search for those crevices in the coal whence they issue, and then confine them within a narrow space, from which they are afterwards conducted through long tubes into the open air, where, being set on fire, they consume in perpetual flames, as they continually arise out of the earth. The late Mr. Spedding, who was the great engineer of those works, having observed that the fulminating damp could only be kindled by flame, and was not liable to be set on fire by red hot iron, nor by the sparks produced by the collision of flint and steel, invented a machine, in which, while a steel wheel is turned round with a very rapid motion, flints are applied to it, and, by the abundance of fiery sparks emitted, the miners are enabled to carry on their work in places where the flame of a lamp or candle would occasion dreadful explosions. Without some intervention of this sort, the working of these mines would long ago have been impracticable, so greatly are they annoyed by these inflammable damps. Fewer mines, however, have been ruined by fire than by inundations; and here that noble piece of mechanism the steam-engine displays its beneficial effects. When the four engines belonging to this colliery are all at work, they discharge 1228 gallons of water every minute at thirteen strokes; and, after the same rate, 1,768,320 gallons every twenty-four hours.

The road from the Whitehaven coal-mines to the water side is mostly on a gentle descent, and provided with an iron railway: this, by removing much of the friction, exceedingly facilitates the carriage of the coals to the shipping, which are laid alongside of the quay to receive them. When the waggons are loaded, they run without any assistance on the railway till they arrive at the quay, where the bottom striking out, the waggon discharges its contents into a large flue, or, as the workmen term it, a hurry, through which it rattles into the hold of the vessel with a noise like thunder. A man is placed in each waggon to guide it, who checks its progress, if necessary, by pressing down one of the wheels with a piece of wood provided for the purpose. When the waggons are unloaded, they are carried round by a turn-frame, and drawn back to the pits by a single horse along another road. The coal trade is supposed to maintain nearly 15,000 mariners, and to employ about 2000 coal-heavers, who are allowed a fixed sum on clearing each ship, according to her tonnage. These are supposed to be the hardest working men in the kingdom: they often earn six, seven, or eight shillings in the day; of which at least one-third, or perhaps one half, is spent in porter. By a late act coals are permitted to be landed at Paddington, in the parish of Mary-le-bone, not, however, exceeding a specified quantity within the year. These coals come by the canals from the inland counties, generally in large masses and free from coal-dust. A patent has been granted within these few years for the formation of coal-dust into balls, which are compacted by the admixture of soft clay, tanner's bark, and various other materials, all of which tend to swell the mass and form a tolerable fuel: it brings much rubbish to an excellent use. A patent was also granted about twenty years back to Lord Dundonald for making tar from coal. This tar has been found to answer many useful purposes, being an admirable coating for wood or other work exposed to the weather; but, on account of its being peculiarly subtile, must be carefully kept away from articles of provision, to which it communicates a most unpleasant, bituminous flavour. The cinders and ashes from coal are in much estimation, as a manure for particular soils, and are highly obnoxious to worms. They are likewise employed in the making of bricks.

There are different opinions among geologists respecting the origin of coal. Some suppose this combustible substance to be produced by the decomposition of the soft parts of the immense quantity of organized bodies, of which we find almost every where the solid remains. But unfortunately this conjecture, which appears so natural, is liable to several strong objections. One is, the presence of vegetables scarcely decomposed, which are often met with in the middle of beds of coal. The others, the want of direct experiments to prove that organized bodies give out bitumen during their decomposition. Without stopping to discuss these points, we shall merely give the general conclusions of naturalists, as they are mentioned by Brogniart. 1. That coal was formed, either at the same time, or after the existence of organized bodies. 2. That this mineral when first formed was liquid, and of a great degree of purity. 3. That the cause which produces this deposit is several times renewed in the same place, and nearly under the same circumstances. 4. That the cause, whatever it may be, is nearly the same over all the earth, since the beds of coal always exhibit nearly the same phenomena in their structure and accidental circumstances. 5. That these beds have not been deposited by any violent revolution; but, on the contrary, in the most tranquil manner; since the organized bodies that are found in them are often entire, and the leaves of vegetables impressed in the slate which covers the coals are hardly ever bruised or otherwise deranged.

COASTING, that part of navigation where the places assigned are not far distant, so that a ship may sail in sight of land, or within soundings, between them. In this there is only required a good knowledge of the land, the use of the compass and lead, or sounding line.

Coasting *pilot*, one who, by experience, has became sufficiently acquainted with the nature of any particular coast, to conduct a ship or fleet from one part of it to another.

COAT *of arms*, in heraldry, a surcoat reaching to the waist, open at the sides, and ornamented with armorial bearings, worn by the ancient knights in times of war, or at tournaments, over their armour, being the principal characteristic by which they were distinguished from one another, the face being covered with the helmet. During the period of five centuries after the conquest, the variation in the mode of exhibiting coat-armour was very trivial.

The Norman in the field, being closely invested in armour which exactly fitted his shape, threw over it an ornamented surcoat without sleeves, at first loose; but during the successive reigns of the three first Edwards, it was confined to the body in narrow folds. After that the mixed armour (composed of mail and plates) became common, and the steel boddice was gilt, and otherwise ornamented. This armour did not, however, long continue in fashion, but was succeeded by tabards of arms larger than the original surcoat, and made of the richest silk stuffs, sumptuously embroidered; which afterwards became the dress worn by the nobility and gentry, till the commencement of the sixteenth century: since that time they have been continued only as the state dress of the officers of arms.

Coats, in a ship, are pieces of tarred canvas put about the masts at the partners, to keep out water. They are also used at the rudder's head, and about the pumps at the decks, that no water may go down there.

COATING, in chemistry, is used principally for the purpose of defending certain vessels from the immediate action of fire; thus, glass retorts, and the inside of some furnaces, are coated with various compositions.

COATING, in electricity, means the covering of electric bodies with conductors, or the latter with the former, or, lastly, electrics with other electrics. Electrics are coated with conductors for the purpose of communicating to, or removing from their surfaces, the electric fluid in an easy and expeditious manner; otherwise an electric body, on account of its non-conducting property, cannot be electrified or deprived of the electric fluid, without touching almost every point of its surface with an electrified or other body. This coating generally consists of tin-foil, sheet-lead, gilt-paper, gold-leaf, silver-leaf, or other metallic body, either in the form of a thin extended lamina, or in small grains, such as brass filings and leaden shot. The coating may be fastened to the surface of the electric by means of paste, glue, wax, or other adhesive matter.

COBALT, in chemistry, a metal, when pure, of a white colour, inclining to bluish or steel grey. At the common temperature its specific gravity is more than 8.5. It is attracted by the magnetic needle, and is itself capable of polarity. For fusion it requires nearly the same intensity of heat as cast iron. In a state of oxide, it tinges the saline vitreous fluxes of a deep blue colour. It is soluble in nitro-muriatic acid, and the diluted solution forms a blue sympathetic ink. Cobalt occurs in nature alloyed with other metals, and mineralized by oxygen, and by arsenic acid. The white cobalt ore is an alloy of cobalt and arsenic, with a little sulphur, and in some specimens a little iron, the two latter being probably accidental. One variety, analyzed by Klaproth, gave 44 of cobalt, 55.5 of arsenic, and 0.5 of sulphur. Its colour is tin-white, liable, however, to tarnish, and thus to assume a grey or reddish tinge: its lustre is weakly shining and metallic.

The grey cobalt ore, as it has been named, is an alloy of cobalt with arsenic and iron; sometimes, also, as has been affirmed, with small portions of nickel and bismuth. Its colour is light grey, but very liable to tarnish; its lustre weakly shining and metallic. Exposed to the flame of the blow-pipe, it gives an arsenical odour and smoke, but without melting: to borax it gives a blue colour, and is reduced to a metallic globule. The native oxide of cobalt occurs in a powdery form, or of various degrees of induration, but always dull, and earthy in its fracture, soft, and easily broken. It is also of different colours, from the intermixture of oxide of iron and perhaps other metallic oxides: whence even species have been formed and distinguished by the names of black cobalt ochre, brown cobalt ochre, and yellow cobalt ochre. Of these the black appears to be the oxide of cobalt in its purest state. They all give a blue colour to glass, or to borax, when fused with it by the blow-pipe. Sometimes also they exhale an arsenical odour. The last species is that in which cobalt is mineralized by arsenic acid, the principal variety of which has been named peach-bloom cobalt ore. This name it derives from its colour, which is a beautiful red, similar to that of the peach blossom, passing, however, into other shades of red, and from decomposition into other colours. The ores of cobalt are easily distinguished from all others, by their property of communicating to borax or to glass, when fused with them, a deep blue colour; and by their solution in nitro-muriatic acid, being a sympathetic ink, lines traced with it on paper not being visible when cold, but becoming visible on exposure to a moderate heat.

On a large scale, cobalt is extracted from its ores only in the state of an oxide, without being reduced to the metallic form, not only as this reduction is difficult, but also as the metal is not applied to any use. The ore is roasted, by which the sulphur and arsenic are expelled, and any fusible metal mixed with it is melted out. The cobalt remains in the state of an impure oxide, named zaffre. The zaffre of commerce is always mixed with silicious earth; hence, if exposed to a strong heat, it vitrifies; a glass of a dark blue colour is thus formed, named smalt, which is used on account of its colour in various arts. It is from the zaffre of commerce that the chemist obtains cobalt; to obtain it pure, however, is extremely difficult. The common process is, to mix the zaffre with three times its weight of black flux, a small quantity of oil, and a little sea salt, and expose the mixture in a crucible to a strong white heat for some hours. A metallic button is thus obtained, on cooling, at the bottom of the crucible ; but the cobalt procured is generally alloyed with arsenic and nickel, and sometimes with other metals, particularly iron.

A number of the acids oxydise cobalt, and combine with its oxide. The concentrated sulphuric acid scarcely acts on it in the cold, but when boiled on the metal, sulphurous acid gas is disengaged, and a saline matter is obtained, which, when lixiviated, forms a solution of sulphate of cobalt. Nitric acid is decomposed by cobalt, and the metal is oxydized and dissolved. The solution is of a red colour, and by gentle evaporation affords minute prismatic crystals of the same colour, which are deliquescent and decomposed by heat. Muriatic acid does not act on cobalt, but with the assistance of heat ; a small portion of the metal is then dissolved. The solution of muriate of cobalt affords a celebrated sympathetic ink. When much diluted, if letters are traced with it on paper, and allowed to dry, they are invisible ; but when the paper is exposed to a moderate heat, they appear of a lively green : they disappear again when cold, and the experiment may be repeated for any number of times, taking care only to avoid too strong a heat, by which they are rendered permanent. The cause of this phenomenon has been ascribed to the muriate of cobalt fixed upon the paper attracting, when cold, moisture from the atmosphere, by which it is, as it were, dissolved, and rendered invisible : when heated, this moisture is evaporated, and the green colour of the salt appears. This explanation appears to be confirmed by the fact, that the characters are rendered visible by confining the paper in a vessel with quicklime, or sulphuric acid, either of which attracts humidity powerfully. The green colour cannot, however, be ascribed entirely to the concentration, but is owing to the temperature ; for the solution itself becomes green when moderately heated in a close phial, and loses this green colour as it cools ; nor is it easy to explain how the temperature does produce this change of colour.

Cobalt combines with many of the metals. Its alloys are generally brittle, and none of them has been applied to any use; nor have they been much examined. The principal, or, indeed, almost all the sole use of cobalt, is in communicating a blue colour to glass, enamel, and porcelain.

COBBING, in sea language, a punishment sometimes inflicted on a sailor : it is performed by striking him a certain number of blows on the breech, with a flat piece of wood, called the cobbing-board.

COBITIS, the *loche*, in natural history, a genus of fishes of the order Abdominales. Generic character: eyes in the upper part of the head ; mouth in the greater number of species bearded ; body almost equally thick throughout, and covered with easily deciduous and small scales ; tail rounded; air bladder hard or osseous. There are five species, of which we shall notice :—C. barbatula, or bearded loche. This is an inhabitant of the streams of Europe and Asia, and lives upon worms and insects, which it finds on the gravel at the bottom of the water, from which it rarely ascends near the surface. It is extremely prolific, and most highly valued for the table in several places in Europe, where it is cultivated with extreme attention. It dies almost immediately on being taken from the water. To preserve the exquisite flavour of it, it is considered by the dealers in this fish as of great importance frequently to shake the vessel of water in which it is placed. C. fossilis, or yellow-brown loche. This inhabits the stagnant and muddy waters of the midland parts of Europe, and in winter completely shelters itself in mud. It is restless before storms, quitting its retreat, and ranging about in various directions near the surface. When preserved in a vessel of water, with some earth at the bottom, it invariably indicates the approach of storms by peculiar agitation, and is on this account not unfrequently kept to answer the purpose of a barometer.

COCCINELLA, in natural history, a genus of insects of the order Coleoptera. Generic character : antennæ subclavated and truncated ; feelers with semi-cordated tip : body hemispheric, with the abdomen flat beneath. This genus is easily distinguished by its hemispheric form, having the upper parts convex, and the lower flat. The insects of this genus are known by the name of lady-birds. C. septempunctata, or seven-spotted lady-bird, is seen in every garden and field in the summer. It proceeds from a larva of a lengthened oval shape, with a sharpened tail, of a black colour, varied with red and white specks, and of a rough surface ; it resides on various plants ; and changes to a short blackish, oval crysalis, spotted with red, which gives birth to its beautiful inmate in the months of May and June. There are, according to Gmelin, nearly 200 species, distinguished, 1. into those whose shells are red or yellow, with black dots: 2. shells red, with yellow dots: 3. shells red or yellow, spotted with white: 4. shells yellow, spotted with red. They all feed, both in their larva and complete state, on the aphides or plant-lice, and are very serviceable in purifying vegetables of the myriads with which they are often infested.

COCCOCYPSELUM, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: calyx four-parted, superior; corolla funnel-form; berry inflated, two-celled, many seeded. There is but one species; *viz.* C. repens, a native of Jamaica.

COCCOLITE, in mineralogy, a species of the flint genus, of a green colour; occurs in large, coarse, and small granular distinct concretions; it is hard, scratches glass, and gives sparks with steel; specific gravity 3.3; it is infusible without addition; with carbonate of soda it melts into an olive green, vesicular, slaggy glass; and, with borax, into a pale-yellow, semi-transparent glass; its constituent parts are,

Silica	42
Alumina	15
Calcareous earth	13
Oxide of iron	8
Manganese	14
Water	3
	95

COCCOLOBA, in botany, a genus of the Octandria Trigynia class and order. Natural order of Holoraceæ. Polygoneæ, Jussieu. Essential character: calyx five-parted, coloured; corolla none; berry calycine, one seeded; drupe. There are fourteen species.

COCCULUS *indicus*, the name of a poisonous berry, supposed to be used by brewers in their malt liquors; particularly in porter, to give it an intoxicating quality. But as the use of it is forbidden by the laws of the land, it would be unfair to impute the practice of it to any respectable house.

COCCUS, in natural history, a genus of insects of the order Hemiptera. Generic character: snout pectoral; abdomen bristled behind: wings two, upright in the males: females wingless. There are about fifty species; extremely fertile and troublesome in hot-houses and green-houses; the male is very active; the female has a body nearly globular, and is slow, inactive, and fixed to different parts of plants. The most important species is the coccus cacti, or cochineal coccus, celebrated for the beauty of the colour it yields when properly prepared. It is a native of South Amerca, and feeds on the cactus opuntia. The female, or officinal cochineal insect, in its full grown or torpid state, swells or grows to such a size, in proportion to that of its first or creeping state, that the legs, antennæ, and proboscis are so small, with respect to the rest of the animal, as hardly to be discovered, except by a good eye, or with the assistance of a glass; so that on a general view it bears as great a resemblance to a seed or berry as to an animal.

When the female cochineal insect is arrived at its full size, it fixes to the surface of the leaf, and envelopes itself in a white cottony matter, which it is supposed to spin or draw through its proboscis, in a continued double filament, it being observed, that two filaments are frequently seen proceeding from the tip of the proboscis in the full grown insect. The male is a small and rather slender dipterous fly, about the size of a flea, with jointed antennæ, and large white wings in proportion to the body, which is of a red colour, with two long filaments proceeding from the tail. It is an active, lively animal, and is dispersed in small numbers among the females, in the proportion of one male to 150 females. When the female has discharged all its eggs, it becomes a mere husk, and dies: so that great care is taken to kill the insects before that time, to prevent the young from escaping, and thus disappointing the proprietor of the beautiful colour. The insects, when picked or brushed off the plants, are killed by the fumes of heated vinegar, or by smoke, and then dried, in which state they are imported into Europe. It is said the Spanish government is annually more enriched by the profit of the cochineal trade, than by the produce of all its gold mines. Cochineal is used in the large scale by dyers, and it is the fine colour so much esteemed in painting, known by the name of carmine: when properly mixed with hair-powder, it is what ladies use as rouge.

C. ilicis, or kermes, is a species adhering, in its advanced or pregnant state, to the shoots of the quercus coccifera, under the form of smooth reddish-brown grains or balls, of the size of small peas. The tree or shrub grows plentifully in many parts of France, Spain, Greece, and the islands of the Archipelago. The cocci are found adhering in groups of five, six, or more, together, or pretty near each other. Woollen cloth dyed with kermes was called scarlet in grain; the animal having been popularly considered as a grain.

A very small species of this genus is often seen, in its torpid state, on the surface of different kinds of apples, particularly on the golden pippin. It is not more than the tenth of an inch in length, and is of a long oval shape, gradually decreasing to a point at one end. It contains thirty or forty oval white eggs, enveloped in a silky matter.

COCHLEA, in anatomy, the third part of the labyrinth of the ear. See ANATOMY.

COCHLEARIA, in botany, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ, or Cruciferæ, Jussieu. Essential character: silicle emarginate, turgid, scabrous; valves gibbous, obtuse. There are eight species.

COCKET, is a seal belonging to the King's Custom-house, or rather a scroll of parchment sealed and delivered by the officers of the customs to merchants, as a warrant that their merchandizes are customed. It is also used for the office, where goods, transported, were first entered and paid their custom, and had a cocket or certificate of discharge.

COCKPIT, in a man of war, a place on the lower floor, or deck, abaft the main-capstan, lying between the platform and the steward's room, where are partitions for the purser, surgeon, and his mates.

COCKSWAIN, or COXSON, an officer on board a man of war, who has the care of the barge and all things belonging to it, and must be also ready with his crew to man the boat on all occasions; he sits at the stern of the boat and steers.

COCOS, in botany, a genus of the Monoecia Hexandria class and order. Natural order of Palms. Essential character: male calyx three-parted; corolla three-petalled: stamens six; female calyx five-parted; corolla three-petalled: stigmas three; drupe coriaceous. There are five species, of which C. nucifera, cocoa-nut-tree, is common almost every where within the tropics, and is cultivated in both Indies; it is found in a wild state in the Maldives and Ladrones, also in the islands of the South Seas. The roots are slender, simple, and flexible: they rise separately from the bottom of the trunk, and spread in all directions; some running to a great depth, while others creep almost parallel to the surface. The trees grow to a great height; their stems are composed of strong fibres, like net-work, which lie in several laminas over each other, out of which come the branches, or rather leaves, which grow 12 or 14 feet long. The flowers come out round the top of the trunk of the tree in large clusters: they are inclosed in a sheath, and the nuts afterwards are formed in large clusters, ten or twelve together. The fruit is properly a drupe; the skin is thin and very tough, the substance under this investing the shell is extremely fibrous; the shell is of a bony substance; the kernel adheres all round the inner wall of the shell, and the cavity is filled with a milky liquor. Besides the liquor in the fruit, there is a sort of wine drawn from the tree, called toddy, and from which is obtained a spirit called arrack.

The coat of the tree is composed of strong fibres, which are made into sail-cloth, cordage, &c. The trunk of the tree is used in all kinds of building; and the leaves are wrought into mats, baskets, and many other things, for which osiers are employed in Europe: they serve also as coverings to their houses.

COD. See GADUS.

CODE, a collection of the laws and constitutions of the Roman Emperors, made by order of Justinian.

The code is comprised in twelve books, and makes the second part of the civil, or Roman law. There were several other codes before the time of Justinian, all of them collections or abridgments of the Roman laws. The most ancient code, or digest, was styled "Jus Papirianum," from the first compiler, Papirius, who flourished about the time of the Regifugium.

CODE, *military*, rules and regulations for the good order and discipline of an army. Of this description are the articles of war.

CODIA, in botany, a genus of the Octandria Digynia class and order. Essential character: calyx four-leaved; petals four; common receptacle involucred. There is but one species, *viz.* C. montana, a shrub, found in New Caledonia.

CODICIL, a schedule, or supplement to a will, or other writing. It is used as an addition to a testament, when any thing is omitted which the testator would add, explain, alter, or retract; and is of the same nature as a testament, except that it is without an heir or executor. So that a codicil is a less solemn will, of one that dies either testate or intestate, without the appointment of an heir; testate, when he that hath made his codicil hath either before or afterwards made his testament, on which that codicil depends, or to which it refers: intestate, when one leaves behind him only a codicil without a testament, wherein he gives legacies only to be paid by the heir at law, and not by any heir instituted by will or testament. A codicil, as well as a will, may be either written, or nuncupative. Some authors call a testament a great will; and a codicil a little one. But there is this further difference between a codicil and a testament, that a codicil cannot contain the institution of an heir; and that in a codicil, a man is not obliged to observe strictly all the formalities prescribed by law for solemn testaments.

CODON, in botany, a genus of the Decandria Monogynia class and order. Essential character: calyx ten-parted, permanent; leaflets alternately shorter; corolla bell-shaped, ten-cleft; nectary ten-celled, composed of ten scales; pericarpium two-celled, containing several seeds. There is but one species, *viz.* C. royeni.

CŒCUM, in anatomy, the first of the three large intestines, called intestina crassa.

COEFFICIENTS, in algebra, such numbers, or given quantities, as are put before letters, or unknown quantities, into which letters they are supposed to be multiplied; thus, in $3\ a$, or $b\ x$, or $c\ x\ x$; 3 is the co-efficient of $3\ a$, b of $b\ x$. and c of $c\ x\ x$. When no number is prefixed, unit is supposed to be the co-efficient; thus 1 is the co-efficient of a or of b.

CŒLESTIAL *globe*. See Globe.

CŒLIAC *artery*, that artery which issues from the aorta, just below the diaphragm. See Anatomy.

Cœliac *passion*, in medicine, a kind of flux, or diarrhœa, wherein the aliments, either wholly changed, or only in part, pass off by stool.

CŒMETERY, or Cemetery, a place set apart or consecrated for the burial of the dead. Antiently, none were buried in churches or church-yards: it was even unlawful to inter in cities: instead of which they had cœmeteries without the walls. These were held in great veneration among the primitive christians.

COFFEA, in botany, in France, *caffe*, so named from Caffa in Africa, where it grows abundantly; a genus of the Pentandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla salver-shaped; stamens upon the tube; berry inferior, two-seeded; seeds arilled. There are ten species, of which C. arabica, Eastern Coffee-tree, is seldom more than eighteen feet high in its native country, or more than twelve in Europe. The main stem grows upright, and is covered with a light brown bark; branches horizontal, opposite, brachiate at every point; leaves opposite; when fully grown, they are nearly five inches long, and an inch and half broad in the middle, ovate lanceolate. They generally continue three years. The flowers are produced in clusters at the base of the leaves, sitting close to the branches; they are of a pure white, with a very grateful odour, but of short duration; they are succeeded by berries which are well known, as well as the use of them. This species of coffee is greatly superior to the C. occidentalis, Western Coffee-tree, which rarely exceeds six feet in height; the corolla is white and sweet scented; it is a native of Domingo, about Cape Francois, where it flowers in December. As the Coffee-tree is an evergreen, it makes a beautiful appearance at every season in the stove, and particularly when in flower, and also when the berries are red, which is generally in the winter; as they continue a long time in that state, there is scarcely any plant that deserves a place more than this.

COFFER, in fortification, a hollow lodgment athwart a dry moat, from six to seven feet deep, and from sixteen to eighteen broad, the upper part being made of pieces of timber, raised two feet above the level of that moat, which little elevation has hurdles, laden with earth, for its covering, and serves as a parapet with embrasures.

COFFERER *of the King's household*, a principal officer in the court, next under the Comptroller, who, in the compting-house, and elsewhere at other times, has a special charge and oversight of other officers of the house, for their good demeanor and charge of their offices, to all which he pays their wages.

COFFIN, the case in which a dead body is interred; usually made of elm, or oak. It consists of a bottom, two ends, and two sides; the latter being sawed half through, at right angles with their length, so as to give a pliancy to the boards; whereby the shoulder bend is made to suit the corps: the lid is afterwards screwed down. Coffins are sometimes plain, but generally are covered with black serge, &c. and ornamented with white, or yellow escutcheons and handles. It is necessary, that, whatever cloth is used, not only in lining and covering the coffin, but in the shroud, &c. it should be of woollen: this is done for the benefit of our manufacturers. Persons of property are sometimes cased in lead, well soldered, and afterwards put into richly ornamented coffins, for the purpose of laying in state, or for being deposited in vaults. We have, among other ingenious inventions, patent coffins, which effectually preclude the depredations of that abominable crew, that obtain a livelihood by robbing cemeteries. The security of this contrivance arises chiefly from making the coffin so very strong, as to resist the instruments usually employed by what are termed "Resurrection-men," and by making the lid to fit on with spring plugs, fitting into hitched sockets; so that being once closed, they never can be severed, except by breaking the coffin to pieces. It is to be lamented, that such practices are considered to be at all necessary, under the plea of the bodies being subjects for dissection, and considerably aiding to anatomical and pathological researches. Were all who suffer under the sentence of the law to be devoted to that purpose, many good effects might arise, and the obnoxious resource, now referred to, be discontinued. Our ancestors generally used stone coffins. The nations of Asia, Africa, and America, as well as the Turks in general, do not use any case for the interment of their dead It is, however, to be tcmembered, that the shroud used by the Musselmans, both in Europe and throughout Asia, is called "Kauffin;" whence we may be led to conjecture that to have been the origin of our designation.

Coffins are by no means to be recommended; they cause a long continuance of that fermentation which is the parent of putrefaction, aiding the retention of infectious diseases for many months, and debarring the access of the surrounding soil, whereby the noxious particles would be absorbed and neutralized. Every coffin ought to be filled up with quick lime, whence the putrefaction would be accelerated, and the danger of infection be, at least, lessened. The Emperor of Germany, about 30 years back, prohibited coffins, and caused quick lime to be immediately used. Strange to say, such was the offence given to his superstitious and bigoted subjects, that this regulation, in itself wise, and intended for their safety, was the cause of very serious discontents, and, to prevent insurrection, was shortly after repealed.

COGNIZANCE, in law, has divers significations; sometimes it is an acknowledgment of a fine, or confession of something done; sometimes the hearing of a matter judicially, as to take cognizance of a cause; and sometimes a particular jurisdiction, as cognizance of pleas is an authority to call a cause or plea out of another court, which no person can do but the King, except he can shew a charter for it. This cognizance is a privilege granted to a city or town, to hold pleas of all contracts, &c. within the liberty; and if any one is impleaded for such matters in the Courts at Westminster, the Mayor, &c. of such franchise may demand cognizance of the plea, and that it be determined before them.

In a military sense, it implies the investigation to which any person or action is liable. During the suspension of civil authority, every offence comes under military cognizance, is subject to military law, and may be proceeded upon according to the summary spirit of its regulation. The strongest instance of military cognizance is a drum-head court martial.

COHESION, one of the species of attraction, denoting that force by which the parts of bodies stick together.

This power was first considered by Sir Isaac Newton as one of the properties essential to all matter, and the cause of all that variety observed in the texture of different terrestrial bodies. He did not, however, absolutely determine that the power of cohesion was an immaterial one, but that it might possibly arise, as well as that of gravitation, from the action of another. His doctrine of cohesion is thus expressed: "The particles of all hard homogeneous bodies, which touch one another, cohere with a great force; to account for which, some philosophers have recourse to a kind of hooked atoms, which in effect is nothing else but to beg the thing in question. Others imagine that the particles of bodies are connected by rest, *i. e.* in effect, by nothing at all; and others by conspiring motions, *i. e.* by a relative rest among themselves. For myself, it rather appears to me that the particles of bodies cohere by an attractive force, whereby they tend mutually toward each other; which force, in the very point of contact, is very great; at little distances is less; and at farther distances is quite insensible."

But, whatever the cause of cohesion may be, its effects are evident and certain. The different degrees of it constitute bodies of different forms and properties. Thus, Newton observes, the particles of fluids which do not cohere too strongly, and are small enough to render them susceptible of those agitations which keep liquors in a fluid state, are most easily separated and rarefied into vapour, and make what the chemists call volatile bodies; being rarefied with an easy heat, and again condensed with a moderate cold. Those that have grosser particles, and so are less susceptible of agitation, or cohere by a stronger attraction, are not separable without a greater degree of heat; and some of them not without decomposition.

Modern chemists have agreed to consider the attraction of cohesion as the instrument of aggregation, or the union of similar compounds, and are careful not to confound it with the elective attractions, though there may, in strictness, be no difference between them. See CHEMISTRY.

This kind of attraction is evinced by a variety of familiar experiments; as, by the union of two contiguous drops of mercury; by the mutual approach of two pieces of cork floating near each other in a basin of water; by the adhesion of two leaden balls, whose surfaces are scraped and joined together with a gentle twist, which is so considerable, that if the surfaces are about a quarter of an inch in diameter, they will not be separated by a weight of 100*lb*; by the ascent of oil or water between two glass planes, so as to form the hyperbolic curve, when they are made to touch on one side, and kept separate at a small distance on the other; by the depression of mercury, and by the rise of water in capillary tubes, and on the sides of glass vessels; also in sugar, sponge, and all porous substances. And where this cohesive attraction ends, a power of repulsion begins.

It is uncertain in what proportion this force decreases as the distance increases. Desaguliers conjectures, from some phenomena, that it decreases as the biquadratic or 4th power of the distance, so that at twice the distance it acts 16 times more weakly, &c.

To determine the force of cohesion, in a variety of different substances, many experiments have been made, and particularly by professor Muschenbroek. The adhesion of polished planes, about two inches in diameter, heated in boiling water, and smeared with grease, required the following weights to separate them.

	Cold Grease. *lb.*	Hot Grease. *lb.*
Planes of Glass	130	300
Brass	150	800
Copper	200	850
Marble	225	600
Silver	150	250
Iron	300	950

But when the brass planes were made to adhere by other sorts of matter, the results were as in the following table:

	oz.
With Water	12
Oil	18
Venice Turpentine	24
Tallow Candle	800
Rosin	850
Pitch	1400

In estimating the absolute cohesion of solid pieces of bodies, he applied weights, to separate them according to their length: his pieces of wood were long square parallelopipedons, each side of which was 26 of an inch, and they were drawn asunder by the following weights:

	lb.
Fir	600
Elm	950
Alder	1000
Linden tree	1000
Oak	1150
Beech	1250
Ash	1250

He tried also wires of metal, 1-10th of a Rhinland inch in diameter: the metals and weights are as follow:

	lb.
Of Lead	29¼
Tin	40¼
Copper	299¼
Yellow brass	360
Silver	370
Iron	450
Gold	500

He then tried the relative cohesion, or the force with which bodies resist an action applied to them in a direction perpendicular to their length. For this purpose he fixed pieces of wood by one end into a square hole in a metal plate, and hung weights towards the other end till they broke at the hole: the weights and distances from the hole are exhibited in the following table:

	Distance. inc.	Weight. oz.
Pine	9½	36½
Fir	9	40
Beech	7	56½
Elm	9	44
Oak	8½	48
Alder	9¼	48

See his "Elem. Nat. Philos."

COIF, the badge of a sergeant at law, who is called sergeant of the coif, from the lawn-coif they wear under their caps when they are created sergeants.

COIL, in naval affairs, the manner in which all ropes are disposed aboard ships, for the conveniency of stowage. Coiling is a sort of serpentine winding the ropes, by which they occupy a small space, and are not liable to be entangled among one another in working the sails. The small ropes are frequently coiled by hand, and hung up, to prevent them from being entangled among one another, in traversing, contracting, or extending sails.

COIN. Among the impediments to commerce, the greatest, undoubtedly, is the charge of conveyance from place to place. This is the great obstacle, which limits the exchange of commodities from one extremity of the world to the other. Whenever the charges of carriage arise to such an amount as to equal the effectual return in any remote market, the motive for conveying merchandize to that place ceases. If goods were always exchanged for goods, it is clear that the conveyance, under the uncertainty of disposal, would take place to a very small distance indeed; and the labour required to discover the persons willing to exchange would greatly enhance the charge. It would require a volume to enumerate and describe the expedients, moral as well as mechanical, by which these difficulties are in part subdued, and still more to deduce their origin and general effects. One of the chief of these expedients consists in the use of some article of merchandize as the medium of exchange, which shall be acceptable to every man, and will therefore be received and held by the seller of any commodity, until he shall meet with another individual, who he knows will again take it for the article he wants.

In the island of Madagascar, it is said, that the exchangeable value of goods is reckoned in hatchets, bullocks, and slaves; these commodities being universally vendible, and for that reason every where received. Smith affirms, that nails answer the same purpose in some parts of Great Britain. These, and other instances, may serve to shew how a preferable medium of exchange becomes adopted; and it will without difficulty be seen, that the scarcest and least destructible metals must have at length become the universal substitutes: for their value does not depend on their figure; they may be subdivided and joined again without loss; they receive no injury by keeping; and the labour of conveying them from place to place forms a less part of their value than of any other article.

The first monies were mere quantities of metals ascertained by weight, as the names of most species still indicate. The interference of government was found necessary to assure the weight, and more particularly the fineness of determinate portions of metal; and this has given rise to an opinion, that a part of the value of coin must depend on the edict of the state which issues it. Whether statesmen themselves have in reality thought this to be the case, is little to the purpose; but it is certain that they have, from time to time, yielded to the temptation of diminishing the quantity of precious metals issued under a given denomination, either by openly deducting from the weight, or secretly debasing the coin. Transactions of this kind must have operated to the loss of all the creditors in the state: but they have never deceived the sellers, who have always regulated their prices by their knowledge of the real quantities of the metal, and not by the denomination, or the supposed weight or fineness, it might denote. The imaginary coin, or money of account, to be found in the mercantile books of almost every commercial nation, must have arisen partly from this cause.

This diminution has taken place throughout Europe. With us the pound of money, which about the year 1087 contained a pound weight of silver, has continued at less than one third (or $\frac{20}{62}$) of that quantity, ever since the reign of Elizabeth. Our neighbours, however, have universally exceeded us in this respect. Thus the pound Flemish is less than eleven shillings, the French livre is ten pence, and the Italian lire is less than 2½*d*.

The Chinese still use fine silver, which they actually cut and weigh at every single payment. They are said to have formerly possessed silver coin; but whether they were urged to their present practice by the uncertain variation in its value caused by their rulers, or by the difficulty of otherwise resisting the artifices of coiners, we know not.

The metals used for coinage are, gold, silver, and copper. According to the exchangeable value of gold, half a grain of this metal would purchase as much bread as a man could eat at one meal. This small piece of gold, if as thin as paper, would not measure the tenth part of an inch in breadth, and would therefore be perfectly inconvenient for use. It has, in fact, been found that the gold coin of the weight of 32 grains (or the quarter guinea) was too small to be conveniently used. The same observations will apply to the smaller subdivisions of the shilling of silver; whence, upon the whole, it appears that coins of all the three metals are required, to facilitate our commerce of buying and selling.

Gold, silver, and copper, like every other product of human industry, depend for their value principally on the labour employed in producing and bringing them to market, and in a considerable degree on the actual demand. As these articles are not employed merely in the fabrication of coins, the demand will vary in each, according to circumstances, which admit of no permanent ratio of exchange between them. If the state were to coin certain pieces of known weight and fineness out of each of these metals, and determine that a certain number of the silver pieces, for example, should in all cases be equivalent to one piece of the gold, it would naturally follow, supposing the individual to pay nothing for the coinage, that a debt might be discharged with more facility to the debtor, and consequently loss to the creditor, in the cheapest of these two metals, whenever, by the fluctuation of the market, either of them should come to represent a larger portion of the other than the edict of the government had determined. This consequence of fixing the relative value of coins would shew itself in a variety of ways, which need not be enumerated; because it is certain that the dearer metal would occupy the greater part of the circulation, while the cheaper pieces would either be melted down, or diminished, if their rated value were too high, and they would be fabricated by individuals, if it were too low, in defiance of every public regulation which might be adopted. If we therefore admit, from considerations of this nature, that no government does in reality possess the means of fixing a ratio between two articles of commerce, intended to be applied as the tickets of transfer, or the mediums of exchange, we shall be naturally led to the adoption of one of the metals only, as the representative sign, while the two others are applied merely as instruments of accommodation, for the convenient subdivision of value.

With regard to the question of preference in these three metals, experience has shewn that society is disposed to assume the dearest; namely, gold. With the single standard of value the fluctuations of the market price of the metal, when compared with commodities, will be nearly imperceptible, because they confound themselves with the rise and fall in the prices of all other articles to which the standard is thus applied. If a cheaper metal were to be adopted by the state, and gold were left to circulate at election of individuals, the changes of price in this metal of high value would operate so as to produce an uncertainty in the amount of large sums, and greatly disturb the general transactions of commerce. Merchants would therefore consider the gold coin as mere bullion, and the community would in a great measure be deprived of its use as a coin; as actually is the case in Holland and other countries, where silver is the legal medium. A more defective scheme was proposed in France in a report presented by Prieur, from a committee of the Council of Five Hundred, of which a very full abstract is given in the Moniteurs of 6 and 7 Floreal, in the year vi. Nos. 216, 217. It is, that silver coin should be unchangeable in weight and denomination of value; but that the price of gold (also coined) should be settled every six months by a declaration from the national treasury, deduced from the medium price of that metal during the preceding half year. It was rejected by the Council of Ancients. It appears most eligible, that gold, in pieces of determinate weight and fineness, should constitute the effective coin of the state, or legal tender of payment; that silver and copper should be formed into money, for the purpose of representing fractions of the smallest gold coin; and that the creditor or seller should have the option to refuse all payments in these last metals, of any sum exceeding the smallest unity of the gold coin.

By this distribution, though the coins of silver and copper would, in strictness, be subject to some fluctuations, arising from the state of the market with regard to those metals, yet the difference would be disregarded in the discharge of accounts, because it would never amount to a sum of any importance. The only inconvenience which offers itself under such an arrangement is, that these subordinate coins would also be melted and sold when the metal was dear, and they would be fabricated, if the metal ever happened to be so cheap as to afford an adequate motive of profit to the illegal coiner. The state, in its deliberations on this subject, might determine that the coins of silver and copper should pass either for more or for less than the medium market price of the metal, or for that value precisely. It is evident that the first of these dispositions would afford coin, which would continually vanish into the melting-pot, and is therefore altogether unadvisable. The medium rate of intrinsic value would produce a similar effect, whenever the market price was low. Whence it follows, that the metal contained in such auxiliary money ought to be of less value than the gold it represents; and, to prevent the introduction of a similar coinage from private manufacturers, it would be necessary that the difference between the value of the metal and that represented by the coin should be somewhat less than the cost of workmanship. Under these circumstances, the public would be supplied with an useful implement or ticket of exchange, which would operate as a pledge of value, very nearly to the amount of its denomination, and would be afforded cheaper from the extensive manufactories of government, than it could possibly be made by private workmen.

Coin, like every other utensil or tool, is subject to wear, and will, in process of time, be more or less deprived of its distinctive figure, and rendered less valuable by the loss of weight. When new, it is the real pledge of measure it pretends to be; but, if it be suffered to circulate after its weight is considerably diminished, it may become a desirable object to the coiner to fabricate new pieces apparently in the worn state, or otherwise he may exercise his industry in speedily reducing the new coin to that state, for the sake of the precious metal he may thus acquire.

If, on the contrary, the legislature should forbid the currency of pieces worn beyond a certain small or moderate loss, the consequence will be, that all such pieces will return to the mint to be coined; and the charge of coinage may become so heavy, as to absorb a considerable part of the value of the whole circulating medium in the course of a few years.

To diminish this last inconvenience as much as possible, it becomes necessary to attend to the nature of the metal, as well as the figure of the piece. Whether the Dutch ducat, of fine gold, or the English guinea of 22 carats, may, under like circumstances, be most disposed to lose by wear, has not, we believe, been determined; but it seems to be generally understood, that our standard gold, in watch cases and other trinkets, is less durable than the coarser and harder gold allowed to be wrought in France and Geneva. If this be true, it should seem that there exists no motive for raising the standard of our gold: and perhaps the same argument may apply still more to our silver; and the advantage, if any, in lowering the standard, without diminishing the intrinsic value, has not yet been shewn, with sufficient evidence to justify the offence against established use and public prejudice, which such a proceeding might afford. Admitting the observations to be conclusive against altering the standard, it would follow, that the greater durability of coin must be sought for in its figure.

Let us imagine a coin to possess the figure of an equilateral triangle; let it be thin, in order that it may present a large surface; let its edges have the figure of a saw, and its faces that of a file. Under these conditions, we should fabricate one of the worst or least durable coins that could be chosen: for the angles would be easily broken and worn, and the edges and faces would mutually operate on each other with a degree of rapidity, which, it may be concluded, would very soon take away all the sharp prominences, and greatly diminish the weight; on the other hand, let us suppose the least possible surface, and we shall obtain the spherical figure. The pagoda and fanam of India are the only coins, which we recollect, that approach towards this figure. Against this, it appears an objection, that if it be nearly perfect, the impressions descriptive of its purity and denomination must be indented, and will not therefore sufficiently limit its apparent magnitude; and if they be prominent, it will no longer be a sphere, but a figure presenting sharp angular parts, with small bearings, very liable to destruction. What then is the figure that shall partake so much of the plane, as to present surfaces of broad contact or bearing, and afford the quantity of angular prominence? It is evidently the cylinder: and this is the figure most generally adopted for money. The edge of the cylinder affords the smallest bearing; it therefore must be very short and flat, in order that the weight of the piece may be disposed to rest on the base, and not the edge.

If the whole surface of a piece of metal were covered with figures or impressions, it would immediately be seen whether any part had been abraded by accident or design. If the impressions were concave, they might easily be renewed by the punch or the graver; but if they were in relief, it would be almost impossible, when once worn or obliterated. For this reason the preference, in coinage, has mostly been given to figures in relief.

It is, however, a very serious inconvenience, that, when the distinctive marks are thus rendered prominent, the face of the coin no longer sustains the pressure and wear of the piece; but the marks themselves are made to support the whole. Thus, in our gold money, particularly of the last coinage, the edge is a saw, and the numerous minute prominences of the face constitute a file; the operations of both which are felt in the rapid destruction of the piece.

To place this in a more striking light, it may be observed, that the amount of gold coined between the years 1762 and 1772, both inclusive, was 8,157,233*l.* 15*s.* 6*d*; and between 1782 and 1792, both inclusive, was 19,675,666*l.* 14*s.* 6*d*; and between 1773 and 1777, both inclusive, was 19,591,833*l.* 1*s.* During the middle period, last mentioned, the great coinage of gold took place. We are aware that other causes may have occasioned a demand for coin, besides the mere wear of the old pieces, and that the increase of commerce and manufactures has in fact produced such a demand; but as this last event (distinguishable by its gradual progress) does not appear, from the numbers in the account, to have influenced the coinage in any great proportion; we shall disregard it in this present rough statement. With this liberty, we may proceed to remark, 1st. That as most of the old pieces disappeared during the middle term of time, the number of nineteen, or say twenty millions, must nearly represent the whole of our gold money. 2d. That the national loss by wear in the first period, when the gold was old and smooth, reckoned at one half per cent. on the sum recoined, was 3708*l.* per ann.; and in the latter period 8943*l.* per ann. And, 3d. That the whole national stock of gold coin, under the regulations and figure of the last period, wears out, it is reckoned, every eleven years. This account of the coinage is to be found in the "Report of the Lord's committee of Secrecy," printed April 28, 1797.

Hence we may observe, that neither kind of mark alone is suited for a coin intended to possess durability, and at the same time to be difficult either to imitate or diminish. A combination of both methods is necessary. If a coin be struck with indentations, or parts depressed beneath the common surface, and in these there be prominent objects or designs not more elevated than that surface, the general advantage, with regard to wear, will approach towards that of the plain surface itself; and the impression will be at least as difficult to imitate, if not more so, than that of a design raised totally above the common surface. Few coins have been made of this figure. The Chinese coin, of mixed copper, called the cash, is the most remarkable, and perhaps the only one of extensive circulation. The late copper coinage of pieces of one and two pennies are of this kind.

To sum up the foregoing conclusions in a few words, we may remark, that, 1. The state is unable (from the natural impracticability of things) to appoint two distinct articles of commerce as the circulating mediums of exchange. 2. The measure of value, or legal tender, ought to consist in the metal which bears the highest price, namely, gold. 3. Coins of silver and copper are required for smaller fractions than the actual subdivisions of the gold coin, but should be optional in the receipt of any larger sums. 4. These last mentioned coins ought to represent a value in gold equal to their own quantity of metal, at the highest (or perhaps medium) market price, added to the charge of fabrication. 5. No sufficient reason had yet been given to shew that the standard of gold coin should be changed, to render it more durable. 6. The best figure of coin is a short cylinder, or flat round plate. And, 7. The distinctive marks or impressions should be made neither altogether hollow, or altogether in relief, but by combination of both forms, so as to leave a flat bearing face on each side.

Sir ISAAC NEWTON'S TABLE of the Value of foreign Coins.

SILVER.	Assay.	Weight.	Value.
	dwts.	*dw. gr.*	*d.*
The piastre, or piece of 8 reaus now 10 reaus - - -	*w.* 1	17 12	54.
New Seville piece of eight - - - - - - - - - -	1½	14	43.11
Mexico piece of eight - - - - - - - - - - - - -	1	17 10$\frac{5}{9}$	53.83
Pillar piece of eight - - - - - - - - - - - - -	*Stan.*	17 9	35.87
Peru piece of eight of uncertain alloy - - - - -			
Old ecu of France of 60 sols, Tournois - - - - -	*w.* 1	17 12	54.
New ecu of France 100 sols, 2*dwt. w.* by law - - -	1½	19 14½	60.39
Crusado of Portugal of 400 reas, now 480 reas - - -	2	11 4	34.31
Patacks, or patagons of 500 reas, now 600 reas - - -			
Ducaton of Flanders, of 60 sols, or patars - - - -	*b.* 4½	20 22	66.15
Patagon, or cross dollar of 48 patars - - - - - - - -	*w.* 12	18 1	52.91
Ducaton of Holland of 63 styvers - - - - - - - -	*b.* 3	20 21	65.59
Patagon, leg dollar, or rix dollar of 50 styvers - - -	*w.* 4	18	52.28
The three guilder piece of 60 styvers - - - - - - -	2	20 8	62.46
Guilder florin of 20 styvers - - - - - - - - - - -	2	6 18½	20.08
The ten skelling piece of Zealand of 60 styvers - -	2	20 6	62.21
Lyon dollar of Holland of 42 styvers - - - - - - -	44	17 14	43.07
Ducatoon of Cologn - - - - - - - - - - - - - -	*b.* 3	20 8	65.92
Rixdollar, or patagon of Cologn - - - - - - - -	*w.* 13	18 0	52.53
Rixdollar, or patagon of Bishop of Liege - - - - - -	12	17 22	55.48
Rixdollar of Mentz - - - - - - - - - - - - - -	6½	18 8	55.27
Rixdollar of Frankfort - - - - - - - - - - - - -	9	18 8	54.53
Rixdollar of the Elect. Palatine, before 1620 - - -		18 5	
Rixdollar of Nuremburg - - - - - - - - - - - -	6	18 10	55.55
Rixdollar of Lunenburg - - - - - - - - - - - -	10	18 11	54.65
Rixdollar of Hanover - - - - - - - - - - - - -	8	18 12	55.03
Double gulden of the Elect. Hanover - - - - - -	7	18 18	56.29
Double gulden, or piece of two-thirds - - - - - -	*b.* 17½	8 10	28.14
Half gulden, or piece of one-third - - - - - - - -	17½	4 5	14.07
Gulden of Zell, or piece of 16 gutz grosh - - - - -	*w.* 43	11 2	27.07
Gulden of Hildesheim of 24 manen grosh, now 26 - -	40½	11 22	30.21
Rixdollar of Madgburgh - - - - - - - - - - - -	10	18 12	54.27
Gulden, or guelder - - - - - - - - - - - - - -	44	11 14	28.67
Old rixdollar of the Elect. Brandenburgh - - - - -	9	18 13	55.17
Old gulden of 24 manen, grosh, now 26 - - - - - -	43	12 4	30.41
Gulden or piece of two-thirds - - - - - - - - - -	43	11 3	27.81
Half gulden, or piece of one-third - - - - - - - -	43	5 13	13.09
Gulden, of the Elect. Saxony, of two-thirds - - - - -	41	11 3	28.12
Old bank dollar of Hamburgh - - - - - - - - - -	8	18 9	54.92
Old rixdollar of Lubec - - - - - - - - - - - - -	8½	18 16	55.54
The 4 mark piece of Denmark - - - - - - - - - -	21	11 13½	32.45
The 8 mark piece of Sweden - - - - - - - - - -	*Stan.*	20 0	62.00
The 4 mark piece of Sweden - - - - - - - - - -	*w.* 58	13 12	30.92
The 2 mark piece of Sweden - - - - - - - - - -		6 19	
Old dollar of Dantzic - - - - - - - - - - - - -	10½	18 9	54.27
Old rixdollar of Thorn, near Dantzic - - - - - - -	12	18 8½	53.85
Rixdollars of Sigismund III. and Uladislaus IV. kings of Poland - - - - - - - - - - - - - - - -	10	18 9	54.04

SILVER.	Assay.	Weight.	Value.
	dwts.	*dw. gr.*	*d.*
Rixdollar of the late Emperor Leopold	10½	18 9	54.27
Rixdollar of the late Emperor Ferdinand III.	10½	18 9	54.27
Rixdollar of Ferdinand, Archduke of Austria	10½	18 5	53.78
Rixdollar of Bazil	7½	18 18½	56.24
Rixdollar of Zune	13	18 1	52.65
Old ducat of Venice, stamped "Ducatus Venetus"	23½	14 15	40.50
The half ducat	23½	7 7½	20.25
The new ducat, stamped 124, of 6*l.* 4*s.* de picoli		18 2	
The half thereof		9 1	
The crusado croisat, or St. Mark, stamped 140, of 7 livres de Picoli		20 6	
The half and quarter crusado, in proportion			
Another coin of Venice	*w.* 46	17 10	42.08
The piece of 2 jules	*b.* 6	3 15	11.05
Ducat de Banes of Naples of 100 grains	*w.* 3	14 0¾	40.43
The half ducat	3	7 0⅛	20.21
The tarin, or fifth part of a ducat	3	2 19¼	8.09
The carlin, or tenth part	3	1 9½	4.04
Escude ecu, or crown of Rome, of 10 julios		20 14½	
Teston, of 3 julios	1	5 21½	18.32
Ducat of Florence and Leghorn of 10 julios	*b.* 8	20 3	64.62
Julios of Rome		2 5	
Piastre ecu, or crown of Ferdinand II. Duke of Tuscany	*w.* 1	17 12	54.
Piastre ecu, or crown of Cosmus III.	1	16 18	51.69
Croisat of Genoa of 7½ lires	*b.* 7	24 15	78.74
Ecu d'argent of 7 lires, 12 sols			
Piastre ecu, or crown of Milan		17 21	
Philip of Milan of 7 lires		20 20	
Livre of Savoy of 20 sols		3 22	
The 10 sols piece		1 23	
A roupee	16½	7 10	24.07
Goud gulden, or florin d'or of 28 styvers	75	12 19	26.26
Another	48	11 0	26.72
Another	48	12 0	29.15

TABLE OF GOLD COINS UNWORN.	Assay.	Weight.	Value.
	ca. gr.	*dw. gr.*	*s. d.*
Old Lewis d'or, the half and quarter in proportion	*w.* 0 0½	4 8	16 9.3
New Lewis d'or, the half and quarter in proportion	0 1½	5 5⅖	20 0.6
Old Spanish double doubloon	0 0½	17 8	67 1.4
New Spanish double pistole, half in proportion	0 0½	8 16	30 6.7
New Seville double pistole, half and quarter in proportion		8 16⅕	
The double moeda of Portugal, new coined	0 0¼	6 22⅗	26 10.4
Ditto, as they come to England	0 0¼	6 21¾	26 9.9
The moeda	0 0¼	3 11	13 5.1
Half moeda	0 0¼	1 17½	6 8.5
Hungary ducat	*b.* 1 2	2 5⅔	9 3.6
Ducats of Holland and of Bishop of Bamburgh	1 2	2 5½	9 5.2
Double ducat of the Duke of Hanover	1 2	4 10½	18 4.8
Ducat of the Duke of Hanover	1 2	2 5¼	9 2.7
Ducats of Brandenburgh, Sweden, and Denmark	1 2	2 5½	9 3.2
Ducat of Poland	1 2	2 5	9 2.1
Ducat of Transylvania	1 1½	2 4¾	8 11.6
Sequin, Chequin, or Zeachein, of Venice	1 3½	2 5¾	9 5.7
Old Italian pistole	*w.* 0 0¼	4 6¾	16 7.6
Double pistole of Pope Urban, 1634		8 14½	
Half pistole of Innocent II. 1685		2 4	

TABLE OF GOLD COINS UNWORN.	Assay.	Weight.	Value.
	ca. gr.	dw. gr.	s. d.
Double pistole of Placentia		8 10	
Double pistole of Genoa, 1621		8 16	
Double pistole of Milan		8 13½	
Single pistole of Milan		4 6¾	
Single pistole of Savoy		4 8½	
Double ducat of Castile, Genoa, Portugal, Florence, Hungary, and Venice	b. 1 2½	4 11	18 17.7
Single ducats of the same places	1 2½	2 5½	9 3.8
Double ducats of several forms in Germany	1 1	4 11	18 4.
Single ditto	1 1	2 5¼	9 2.
Double Ducat of Genoa	1 2	4 11	18 6.5
Single ducat of Genoa, Besançon, and Zurich	1 2	2 5½	9 3.2
Pistoles of Rome, Milan, Venice, Florence, Savoy, Genoa, Orange, Trevon, Besancon	w.0 0¼	4 6	16 6.7
Ducat of Barbary, with Arabic letters	2 1½	2 16¼	9 3.5

COIN, *laws relating to.* Counterfeiting the king's money, or bringing false money into the realm counterfeit to the money of England, clipping, washing, rounding, filing, impairing, diminishing, falsifying, scaling, lightening, edging, colouring, gilding, making, mending, or having in one's possession, any puncheon, counter puncheon, matrix, stamp, dye, pattern, mould, edger, or cutting engine: all these incur the penalty of high treason. And if any person shall counterfeit any such kind of gold or silver, as are not the proper coin of the realm, but current therein by the king's consent, he shall be guilty of high treason.

If any person shall tender in payment any counterfeit coin, he shall, for the first offence, be imprisoned six months; for the second offence, two years; and for the third offence shall be guilty of felony without benefit of clergy.

Blanching copper or other base metal, or buying or selling the same; and receiving or paying money at a lower rate than its denomination doth import; and also the offence of counterfeiting copper half-pence and farthings; incur the penalty of felony, but within clergy. Counterfeiting coin not the proper coin of this realm, not permitted to be current therein, is misprision of treason. A person buying or selling, or having in his possession, clippings or filings, shall forfeit 500*l.* and be branded in the cheek with the letter R. And any person having in his possession a coining-press, or casting bars or ingots of silver, in imitation of Spanish bars or ingots, shall forfeit 500*l.*

A reward of 40*l.* is given for convicting a counterfeiter of the gold or silver coin; and 10*l.* for a counterfeiter of the copper coin.

COINING, the art of making money, which has hitherto been performed by the hammer or the mill. The first operations are the mixing and melting of the metal, because there is no species of coin of pure gold or silver but requires a quantity of alloy. See ALLOY. For gold coin the alloy is a mixture of silver and copper, as silver alone would make the coin too pale, and the copper alone would give it too high a colour. The alloy is used for the purpose of rendering the coins harder, and less liable to wear, or to be diminished by art. When the gold and silver are completely melted and mixed, they are cast into long, flat bars, nearly of the thickness of the coin to be cast. In coining by the mill, which has been the only method in use for the last 250 years, the bars are taken out of the moulds, and scraped, brushed, flattened in a mill, and brought to the proper thickness of the species to be coined. The plates, thus reduced as nearly as possible to the proper thickness, are cut into round pieces, called blanks, or planchets, with an instrument fastened to the lower end of an arbor, whose upper end is formed into a screw, which, being turned by an iron handle, turns the arbor, and lets the steel, well sharpened in form of a punch-cutter, fall on the plates; and thus a piece is punched out. The pieces are now to be brought to the standard weight by filing or rasping, and what remains of the plate between the circles is melted again. The pieces are next weighed in an accurate balance, and those that prove too light are re-melted; but those that are too heavy are filed to the standard weight. When the blanks are adjusted, they are carried to the blanching-house, where the blanks are brought to their proper colour. They are next milled, by means of a machine which consists of two plates of steel in form of rulers, on which the edging is engraved, half on the one and half on the other. Being thus edged, the impression is given them by the mill, which is so contrived, that the metal receives at once an impression on each side, and becomes money as soon as it has been examined and weighed. The process for coining medals is nearly the same with that of money: there is, however, this difference, that money, from the smallness of the relievo, receives its impression at once, whereas medals require several strokes. The figures of the coining-mill have been so frequently given, that it seemed to us needless to insert them here, especially as a new method of coining has been introduced by Messrs. Bolton and Watt, which is shortly to be the only mode used in this country. For this purpose buildings are erecting on Tower-Hill. This machinery, invented by these able mechanicians, has been long used in the manufacture of copper money; it works the screw-presses for cutting out the circular pieces of copper, and coins both the edges and faces of the money at the same time, with such superior excellence and cheapness of workmanship as will prevent clandestine imitation. By this machinery, four boys are capable of striking 30,000 pieces of money in an hour; and the machine acts at the same time as a register, and keeps an unerring account of the number of pieces struck.

COINING, in the tin-works, is the weighing and stamping the blocks of tin with a lion rampant, performed by the king's officer; the duty for every hundred weight being four shillings.

COIX, in botany, a genus of the Monoecia Triandria class and order. Natural order of grasses. Essential character: males in remote spikes; calyx glume two-flowered, awnless; corolla glume awnless; female, calyx glume two-flowered; corolla glume awnless; style two-parted; seeds covered by the calyx ossified. There are three species.

COKE, a preparation of fossil coal, whereby it is deprived of the naphtha, bitumen, or asphaltum, it may contain, so that, when applied to certain purposes, it may not communicate a bad flavour or bad qualities. Coke is made in very large ovens, principally from the refuse or brush-coal, with which some pits abound; the coal in them being extremely brittle, and rarely coming away in large pieces. The ovens have vents and mouths that are occasionally stopped, in part, for the purpose of regulating the heat, which in no case should be such as to consume, but merely to char. The ovens being closed at a proper time, the fire is gradually extinguished, and the coke is compacted into large masses, requiring to be broken before they can be taken out. In this state it will burn with a clear and steady heat, free from fumes, and consequently without occasioning malt (which is usually dried with coke, where coal pits are at hand) to partake of a bituminous or smoky flavour. Good coke should be light, rather little, and more close than cellular; that which is of a deep ash colour is in general preferable: when black, or at all glossy, it is a certain sign of the want of due preparation: it ought to be equally charred, and in large lumps, from the size of a quartern loaf to a bushel: the small refuse is not profitable, and often is too much burnt.

COLCHICUM, in botany, *meadow saffron*, a genus of the Hexandria Trigynia class and order. Natural order of Spathaceæ. Junci, Jussieu. Essential character: spathe; corolla six-parted, with a rooted tube; capsule three, connected, inflated. There are three species. One of them, *viz.* C. autumnale, has been supposed by Mr. Want to be the base of the *Eau medicinale* d'Hussor.

COLD. When we leave a room at the temperature of 60°, and go into the air in a frosty day at the temperature of 30°, we say it is cold; or when the hand is held in water at the temperature of 100° for a few minutes, and then suddenly plunged into water at the temperature of 40°, the latter is said to be cold. This, however, is merely an expression of the sensation excited in the body, which depends solely on the abstraction of its heat. This may be proved by the following experiment. If three quantities of water are taken, the first at the temperature of 30°, the second at the temperature of 50°, and the third at the temperature of 98°. Immerse the right hand into the water at the temperature of 98°, and the left into the water at the temperature of 30°. Let them both remain for a minute, and then suddenly plunge both hands into the water at the intermediate temperature of 50°, to the right hand it will feel cold, and to the left warm : thus different sensations are produced by the same body at the same time, and at the same temperature. But this depends entirely on the previous state of the hands, and on the absorption or abstraction of the caloric. The right, which was placed in the water at the temperature of 98°, absorbed caloric, because the temperature of the water is above that of the body. This excites the sensation of heat: but when the same hand is placed in the water at the temperature of 50°, it is deprived of caloric, because the surrounding medium is far below its temperature, and thus the sensation of cold is produced. But from the left, placed in the water at 30°, caloric is abstracted, which gives the sensation of cold, and the same hand placed in the water at 50°, receives caloric, and this entering the body, excites the sensation of heat Thus the term cold is expressive of the relative temperature of two bodies. There have, however, been persons who would account for the phenomena of cold by the existence of frigorific particles, supposed to be floating in the air, and by mixing with liquid bodies convert them to solids, and there are facts which seem to support this doctrine.

Nothing appears at first sight more directly contradictory to the common opinion of cold being only relative, and only a negative term implying the abstraction of heat, than the facts which shew the apparent radiation, absorption, and reflexion of cold ; the evidence of which stands on the same ground as the corresponding motions of heat, namely, on the rise or fall of the thermometer. If the rise of the liquor on the scale of a thermometer, whose bulb is placed in the focus of a mirror, be considered as a proof of the propulsion of certain calorific rays from a distant heated surface, and their subsequent reflexion according to the laws of catoptrics, the sinking of the same thermometer liquor under similar circumstances of position, when the surface, which before was sensibly hotter than the atmosphere, is now sensibly colder, would seem, from a parity of reasoning, to indicate the propulsion and reflexion of frigorific rays. Nor can we consider this question as at all determined, though an ingenious hypothesis has been advanced by M. Prevost, which goes a considerable way to reconcile the apparent contradiction of the doctrine of the unity of heat and cold.

It is singular, that the reflection of cold should have been accidentally discovered, and decidedly announced about the year 1667, by the members of the Florentine Academy del Cimento, without any further prosecution of so curious a fact. The experiment is the following: a mass of ice of about 500*lb.* was set some distance before a concave glass mirror, and the bulb of a spirit thermometer put in the focus, to try whether cold would be reflected. Immediately the spirit of the thermometer began to sink, and fell several degrees. To prove that this was not merely owing to the contiguity of the ice, the surface of the mirror was covered with a cloth, to prevent the reflexion, and the thermometer again rose. No further inference is drawn from this experiment, and the author of it seemed even to doubt of the reality of the reflexion, and to be disposed to impute it to some other unknown cause. This experiment was repeated in a much more accurate way by M. Pictet. The apparatus which he used was the same as that before described, as employed for the reflection of heat; that is, two tin mirrors placed directly opposite each other at some distance, in the focus of one of which was placed the bulb of a very sensible thermometer, and in the other, the vessel intended to produce the heat or cold. In this instance, this latter was a mattrass full of snow : the mirrors were separated to the distance of 10½ feet. At the instant the mattrass was placed in one focus, the thermometer in the opposite focus began to sink, and descended several degrees. When stationary, nitrous acid was poured on the snow, which produced a cold of much greater intensity, and the thermometer in consequence immediately descended several degrees lower. When taken out of the focus, it again rose to the common temperature.

Mr. Leslie also found, not only the same effect in this experiment, but that the action of a cold radiating surface upon the tin reflector produced exactly the same proportional effect upon the differential thermometer as the hot radiating surface, only in the opposite direction of the scale. The differential thermometer, which is always at zero when both bulbs are equally heated, is beatifully calculated to shew this striking experiment. Thus, if the difference of temperature, between the heat-radiating substance and the atmosphere be 60 degrees, and if this raises the thermometer 45 degrees, the same difference between the cold radiating substance and the atmosphere will sink the thermometer 45 degrees, and so in proportion; so that a cold of 16 degrees will sink the thermometer 12 degrees; for 60 : 45 : : 16 : 12.

Great degrees of cold are produced by mixing together those substances which dissolve rapidly. The reason of this will appear, by recollecting what has been said of the absorption of caloric, when a solid body is converted into a fluid. Mixtures to produce artificial cold are generally made of the neutral salts dissolved in water; of diluted acids and some of the neutral salts; and of snow or pounded ice with some of these salts. A great number of experiments were made upon this subject by Mr. Walker; also by Professor Lowitz, of Petersburgh; by Fourcroy and Vauquelin; and by Guyton. The following table exhibits the results of some of these experiments.

Table of freezing mixtures.

Mixtures.	Parts.	*Thermom. sinks.*
1. Muriate of ammonia	5	from 50° to 10°
Nitre	5	
Water	16	
2. Muriate of ammonia	5	from 50° to 3°.
Nitre	5	
Sulphate of soda	8	
Water	16	
3. Sulphate of soda	5	from 50° to 0°.
Diluted sulphuric acid	4	
4. Snow	1	from 52° to 0°.
Common salt	1	
5. Snow or pounded ice	2	from 0° to—5°.
Common salt	1	
6. Potash	4	from 32° to—51°.
Snow	3	
7. Muriate of lime	3	from 32° to—50°.
Snow	2	
8. Muriate of lime	2	from 0° to—66°.
Snow	1	
9. Muriate of lime	3	from—40° to—73°.
Snow	1	
10. Diluted sulphuric acid	10	from—68° to—91°.
Snow	8	

When any of these substances are to be employed as freezing mixtures, the salts should be used fresh crystalized, and reduced to fine powder; and it will perhaps be found most convenient to observe the proportions which are set down in the table. Suppose it is wanted to produce a degree of artificial cold equal to—50°, which is the temperature produced from 32° by the seventh freezing mixture. The substances employed, namely the muriate of lime and the snow, must be previously cooled down to the temperature of 32°, or any degree below it. This may be done by placing them separately in the third freezing mixture, the sulphate of soda and diluted sulphuric acid, which reduces the temperature from 50° to 30°; or in the fourth freezing mixture of snow and common salt, which reduces the temperature from 32° to 0°. The materials, thus cooled down, are then to be mixed together as quickly as possible, when, if the experiment succeed, the temperature will fall from 32° to —50°, as in the seventh freezing mixture. The vessels which are employed for these processes should be very thin, and made of the best conductors of heat. Vessels of tin plate answer the purpose, and when acids are to be used they may be lined with wax, which will secure them sufficiently against their action. They should be of no larger dimensions than just to contain the materials.

COLDENIA, in botany, so called in honour of C. Colden, a curious botanist of North America; a genus of the Tetrandria Tetragynia class and order. Natural order; Asperifoliæ. Borragineæ, Jussieu. Essential character: calyx four-leaved; corolla funnel formed; styles four; seeds two, two-celled. There is but a single species, *viz.* C. procumbens, an annual plant, whose branches trail on the ground; they extend nearly a foot from the root, and divide into many smaller branches. It is a native of the East Indies, but has been cultivated here for half a century.

COLEOPTERA, in natural history, an order of insects, which includes all those whose wings are guarded by a pair of strong, horny, exterior cases or coverings, under which the wings are folded up when at rest. In common language these insects are called beetles, though, in reality that term is now restricted to the Scarabæus genus. The wing-sheaths, or horny coverings, are sometimes called coleoptera, but more generally elytra.

This is a very extensive order, divided into four classes.

A. antennæ clavate, thicker towards the tip : in this class there are three subdivisions; *viz.*

a. Club lamellate; three genera.

Lucanus Scarabæus Synodendron.

b. Club perfoliate; seven genera.

Byrrhus	Dermestes	Hydrophilus
Melyris	Silpha	Tetratoma
Tritoma.		

c. Club solid or inflated; seven genera.

Anthrenus	Bostrichus	Coccinella
Curculio	Hister	Nitidula
Pausus		

B. antennæ moniliform; of which there are twelve genera; *viz.*

Attelabus	Brentus	Cassida
Chrysomela	Erodius	Horia
Meloe	Mordella	Opatrum
Staphylinus	Tenebrio	Zygia.

C. antennæ filiform; of these there are nineteen genera.

Alurnus	Apalus	Bruchus
Buprestis	Colopus	Cantharus
Carabus	Cryptocephalus	Cucujus
Elater	Gyrinus	Hispa
Lampyris	Lytta	Manticora
Necydalus	Notoxus	Pimelia
Ptinus.		

D. antennæ setaceous; of which there are eight genera.

Cerambyx	Cucindela	Dytiscus
Forficula	Leptura	Rhinomacer
Serropalpus	Zonitis	

COLE-SEED. See Brassica.

COLE-WORT, in gardening, a species of brassica. See Brassica.

COLIC, in medicine, a severe pain in the lower venter, so called, because the disorder was formerly supposed to be seated in the colon.

COLISEUM, or Colisæum, in ancient architecture, an oval amphitheatre at Rome, built by Vespasian, wherein were statues set up, representing all the provinces of the empire: in the middle of which stood that of Rome, holding a golden apple in her hand.

COLIUS, the *coly*, in natural history, a genus of birds of the order Passeres. Generic character: bill convex above, straight under, short and thick; the upper mandible curved downwards; nostrils small, placed at the base, and nearly hidden by the feathers; tongue jagged at the tip; tail long and wedged; toes divided throughout. There are four species, three of which are found in Africa, and the fourth in the Philippine islands. But little is known of their manners and habits.

COLLAR, in Roman antiquity, a sort of chain put generally round the neck of slaves that had ran away, after they were taken, with an inscription round it, intimating their being deserters, and requiring their being restored to their proper owners, &c.

Collar, in a more modern sense, an ornament consisting of a chain of gold, enamelled, frequently set with cyphers or other devices, with the badge of the order hanging at the bottom, wore by the knights of several military orders over their shoulders, on the mantle, and its figure drawn round their armories.

Thus, the collar of the order of the garter, consists of S S, with roses enamelled red, with a garter enamelled blue, and the George at the bottom.

COLLATERAL, in genealogy, those relations which proceed from the same stock, but not in the same line of ascendants or descendants, but being, as it were, aside of each other. Thus uncles, aunts, nephews, nieces, and cousins, are collaterals, or in the same collateral line: those in a higher degree, and nearer the common root, represent a kind of paternity, with regard to those more remote.

Collateral, in a legal sense, is taken for any thing that hangeth by the side of another, whereto it relates; as a collateral assurance is that instrument which is made over and above the deed itself, for the performance of covenants between man and man: thus called, as being external, and without the nature and essence of the covenant.

COLLATION, in the common law, the giving or bestowing of a benefice on a clergyman by a bishop, who has it in his own gift or patronage. This differs from presentation, in that the latter is properly the act of a patron, offering the clerk to the bishop, to be instituted into a benefice, whereas the former is the act of the bishop himself. The collator can never confer a benefice on himself. Anciently, the right of presentation to all churches was in the bishop; and now, if the patron neglects to present to the church, his right returns to the bishop by collation. If the bishop neglects to exercise his right of collation in six months, the archbishop may confer. If he neglects it for other six months, it falls to the crown.

COLLECTOR, in electricity, is a small appendage to the prime conductor of the electrical machine, generally consisting of pointed wires, affixed to that end of the prime conductor which stands contiguous to the glass globe, or cylinder, or other electric of the machine. Its office is to receive the electricity, whether positive or negative, from the excited electric, much more readily than the blunt end of the prime conductor would be able to receive it without that appendage.

COLLEGE, a particular corporation, company, or society of men, having certain privileges founded by the King's licence.

Colleges in the universities are generally lay corporations, although the members of the college may be all ecclesiastical. And in the government thereof, the King's courts cannot interfere, where a visitor is specially appointed.

The two Universities, in exclusion of the King's courts, enjoy the sole jurisdiction over all civil actions and suits, except where the right of freehold is concerned; and also in criminal offences or misdemeanours under the degree of treason, felony, or maim. Their proceedings are in a summary way, according to the practice of the civil law. But they have no jurisdiction, unless the plaintiff or defendant be a scholar or servant of the university, and resident in it at the time. An appeal lies from the Chancellor's court to the congregation, thence to the convocation, from thence to the delegates.

College *of Civilians,* commonly called Doctor's Commons, founded by Dr. Harvey, Dean of the Arches, for the professors of the civil law residing in the city of London. The judges of the arches, admiralty, and prerogative court, with several other eminent civilians, commonly reside here. To this college belong thirty-four proctors, who make themselves parties for their clients, manage their causes, give licenses for marriages, &c. In the common Hall of Doctor's Commons are held several courts, under the jurisdiction of the civil law, particularly the High Court of Admiralty, the Court of Delegates, the Arches Court of Canterbury, and the Prerogative Court of Canterbury, whose terms for sitting are much like those at Westminster, every one of them holding several court days, most of them fixed and known by preceding holy days, and the rest appointed at the judge's pleasure.

College *of Physicians,* a corporation of physicians in London, whose number, by charter, is not to exceed eighty. The chief of them are called fellows, and the next candidates, who fill up the places of fellows as they become vacant by death, or otherwise. Next to these are the honorary fellows, and lastly the licentiates, that is, such as being found capable upon examination, are allowed to practise physic.

This college has several great privileges granted by charter and acts of parliament. No man can practise physic in or within seven miles of London, without license of the College, under the penalty of *5l.* Also, persons practising physic in other parts of England are to have letters testimonial from the president and three elects, unless they be graduate physicians of Oxford or Cambridge. Every member of the College is authorized to practise surgery in London, or elsewhere: and that they may be able at all times to attend their patients, they are freed from all parish offices.

The College is governed by a president, four censors, and twelve electors. The censors have, by charter, power to survey, govern, and arrest all physicians, or others, practising physic in or within seven miles of London; to fine, amerce, and imprison them at discretion; to search apothecaries' shops, &c. in and about London; to see if their drugs, &c. be wholesome, and the composition according to the form prescribed by the College in their dispensaries; and to burn, or otherwise destroy, those that are defective or decayed, and not fit for use. They are judges of record, and not liable to action for what they do in their practice but by judicial powers; subject nevertheless to appeal to the College of Physicians. By law, if any person, not expressly allowed to practise, take upon him the cure of any disease, and the patient die under his hand, it is deemed felony in the practiser.

College *Royal of Physicians,* is also a corporation of physicians in Edinburgh, erected by King Charles II. granting them, by patent under the great seal, an ample jurisdiction within this city and liberties, commanding the courts of justice to assist them in the execution of their orders. These have the sole faculty of professing physic here, and hold conferences once a month for the improvement of medicine. This College consists of a president, two censors, a secretary, and the ordinary society of fellows, who, upon St. Andrew's day, if it falls on a Thursday, if not, on the first Thursday after, elect seven counsellors, who chuse the president and the other officers for the ensuing year. By their charter, the president and censors have power to convene before them all persons that presume to practise physic within the city of Edinburgh, or the liberties thereof, without the license of the College; and to fine them in five pounds sterling. They are also impowered to visit apothecaries' shops, and examine apothecaries themselves; with several other rights and privileges.

College *Sion*, or the College of the London clergy, was formerly a religious house, next to a spittal, or hospital, and now it is a composition of both, *viz.* a college for the clergy of London, who were incorporated in 1631, at the request of Dr. White, under the name of the president and fellows of Sion College; and an hospital for ten poor men, the first within the gates of the house, and the latter without. This College consists of a president, two deans, and four assistants, who are annually chosen from among the rectors and vicars in London, subject to the visitation of the bishop. They have one of the finest libraries in England, built and stocked by Mr. Simpson, chiefly for the clergy of the city, without excluding other students on certain terms; they have also a hall with chambers for the students, generally filled with the ministers of the neighbouring parishes.

College, *Gresham*, or College *of philosophy*, a College founded by Sir Thomas Gresham, who built the Royal Exchange, a moiety of the revenue whereof he gave in trust to the Mayor and Commonalty of London, and their sucessors for ever, and the other moiety to the Company of Mercers; the first, to find four able persons to read in the College, divinity, astronomy, music, and geometry; and the last, three or more able men to read rhetoric, civil law, and physic; a lecture upon each subject is to be read in termtime, every day, except Sundays, in Latin, in the forenoon, and the same in English in the afternoon: only the music lecture is to be read alone in English.

College *of Heralds*, or College *of Arms*, commonly called the Heralds Office, a corporation founded by charter of King Richard III. who granted them several privileges, as, to be free from subsidies, tolls, offices, &c. They had a second charter from King Edward VI.; and a house built near Doctors' Commons by the Earl of Derby, in the reign of King Henry VII. was given them by the Duke of Norfolk, in the reign of Queen Mary, which house is now rebuilt. This College is subordinate to the Earl Marshal of England. They are assistants to him in his court of chivalry, usually held in the common hall of the College, where they sit in their rich coats of his Majesty's arms.

College *of Heralds*, in Scotland. The principal person in the Scottish Court of Honour, is Lyon King at Arms, who has six heralds and six pursuivants, and a great number of messengers at arms under him, who, together, make up the College of Heralds. The Lyon is obliged to hold two peremptory courts in the year, at Edinburgh, on the 6th of May and the 6th of November, and to call officers of arms and their cautioners before him upon complaints; and, if found culpable upon trial, to deprive and fine them and their cautioners. Lyon and his brethren, the heralds, have power to visit the arms of noblemen and gentlemen, and to distinguish them with differences, to register them in their books, as also to inhibit such to bear arms, as by the law of arms ought not to bear them, under the pain of escheating to the King the thing whereon the arms are found, and of a hundred marks Scots to Lyon and his brethren; or of imprisonment during Lyon's pleasure. The College of Heralds are the judges of the malversation of messengers, whose business is to execute summonses and letters of diligence for civil debt, real or personal.

College *of Cardinals*, sometimes called the Sacred College, a body composed of the three orders of Cardinals.

COLLETIA, in botany, a genus of the Pentandria Monogynia class and order. Corolla campanulate, furnished with five scale-like folds; calyx none; fruit three grained. One species, found in the Brazils.

COLLIERS, vessels employed to carry coals from one port to another, principally from the northern parts of England to the capital, and more southern parts, and foreign markets. Their trade is known to be an excellent nursery for seamen.

COLLINSONIA, in botany, a genus of the Diandria Monogynia class and order. Leaves ovate, glabrous; stem glabrous. Two species, found in North America.

COLLYRIUM, in pharmacy, a topical remedy for disorders of the eyes.

COLOGNE *earth*, a substance used in painting, much approaching to amber in its structure, and of a deep brown. It has generally been esteemed a genuine earth, but has been discovered to contain a great deal of vegetable matter, and, indeed, is a very singular substance. It is dug in Germany and France: the quantities consumed in painting in London are brought from Cologne, where it is found very plentifully; but our own kingdom is not without it, it being found near Birmingham, and on the Mendip-hill, in Somersetshire; but what has been yet found there is not so pure or fine as that imported from Cologne.

COLON, the second of the three large intestines, called intestina crassa. See Anatomy.

Colon, in grammar, a point or character marked thus (:), shewing the preceding sentence to be perfect or entire; only that some remark, farther illustration, or other matter connected therewith, is subjoined. See Pointing, Period, Comma, &c.

COLONEL, in military matters, the commander in chief of a regiment, whether horse, foot, or dragoons.

Colonel, *lieutenant*, the second officer in a regiment, who is at the head of the captains, and commands in the absence of the colonel.

COLONNADE, a range of insulated columns. See Architecture.

COLONY. A colony is a settlement formed by the inhabitants of any nation, in some part of the world unoccupied by any other civilized nation. The motives for forming them have been various.

In colonies there is generally abundance of good land; hence the necessaries of life are usually to be had in plenty, by any one who will take the trouble necessary to produce them; and, consequently, population usually has a tendency to increase with great rapidity. The inhabitants of some parts of the United States are said to have doubled in fifteen years, at the time those countries were colonies of Great Britain.

The policy of the mother countries with regard to colonies has usually been intended to make the colonists buy the goods of the mother country as dear as possible, and sell their own productions as cheaply as possible. Hence the trade of colonies usually has been confined, by strict commercial laws, wholly to the mother country.

The consequence of these regulations has probably been, that in the colonial trade the merchants and manufacturers have sold their goods dearer, and bought colonial produce cheaper, than they otherwise might have done, though even this may be doubted; but most certainly the inhabitants of the colony have bought dearer, and sold cheaper, than they otherwise would. The prosperity of the colony therefore has been impeded; their progress towards opulence has been less rapid than it would have been under other circumstances; and the mother country has always had a poorer and smaller market for her commodities than she otherwise would have had. The profits per cent. have been perhaps greater, but the whole amount of profit derived from the colony trade has most certainly been less.

COLORIFIC *earths*, in mineralogy, a class or tribe of earths, in the arrangement of Kirwan, described by him as strongly staining the fingers. Of these he enumerates four families, *viz.* red, yellow, black, and green; the red is the reddle, of dark cochineal red colour, or intermediate between brick and blood red, having neither lustre nor transparency; fracture, earthy, sometimes conchoidal; fragments, 1; hardness, 4; sp. gr. inconsiderable; adhering pretty strongly to the tongue; feeling rough; assuming a polish from the nail; strongly staining the fingers; falling immediately into powder in water, and not becoming ductile; not effervescing, nor easily dissolving in acids. When heated to redness, crackling and growing black; at 159° the specimen melted into a dark greenish yellow frothy enamel. It differs from red ochres only by containing more argil. The red colour proceeds from oxygenation, and the absence of acid. The more air of water is expelled by heat, the browner it grows. The yellow is of an ochre yellow colour; as to lustre, externally it often has some gloss, but internally none; it is not transparent; fracture earthy, often inclining to the conchoidal; no specific gravity; fragments, inconsiderable; adheres strongly to the tongue; feels smooth, or somewhat greasy; takes a high polish from the nail; strongly stains the fingers; in water it immediately falls to pieces with some hissing; and afterwards to powder, without diffusing itself through it; does not effervesce with acids, nor is easily soluble in them; heated to redness it crackles, hardens, and acquires a red colour, and gives a reddish streak. At 156°, Mr. Kirwan melted a specimen into a liver-brown porous porcelain mass. This yellow earth differs from ochres only in containing a greater proportion of argil; the yellow colour proceeds from the calx of iron, highly oxygenated, and probably containing both water and acid. Those earths which contain a large proportion of iron have rather an orange colour. According to the analysis of M. Sage of Paris, who has the merit of preserving to his countrymen the immense gains acquired by the Dutch from converting this yellow earth into what is there called "English red," it contains 50 per cent. argil, 40 oxide of iron, 10 of water, acidulated by sulphuric acid. The 3d family, or black; black chalk is of a greyish black colour; fracture imperfectly curved slaty: fragments partly flat, partly long splintery; adheres slightly to the tongue, feels smooth, assumes a polish from a knife; gives a black streak, and marks black: in water does not readily moulder, but if taken out cracks in a short time; does not effervesce with acids, nor easily dissolve in them; heated to redness, it crackles and becomes reddish grey, and contains somewhat vitriolic. The 4th family, green earth, is of a greyish green colour; found generally in lumps in the cavities of other stones, or externally investing them: fracture, earthy, sometimes uneven, sometimes verging to the conchoidal; sp. gr. 2.637, sometimes feels smooth, does not assume a polish from the knife, nor adhere to the tongue, nor stain the fingers, nor mark while dry, and when wet but lightly in water, it often crumbles after standing about half an hour; does not effervesce with acids, nor is easily soluble in them; heated to redness, it crackles and becomes of a dark reddish cream colour; at 147°, a specimen was melted into a black compact glass, resembling that of basalt; which shews it to consist of silex, argil, iron, not much oxygenated, and oxyde of nickel, from which the green colour is derived, besides water.

COLOSSUS, a statue of enormous or gigantic size. The most eminent of this kind was the colossus of Rhodes, one of the wonders of the world, a brazen statue of Apollo, so high, that ships passed with full sails betwixt its legs. It was the workmanship of Chares, a disciple of Lysippus, who spent twelve years in making it: it was at length overthrown by an earthquake, B. C. 224. after having stood about sixty-six years. Its height was a hundred and five feet: there were few people who could encompass its thumb, which is said to have been a fathom in circumference, and its fingers were larger than most statues. It was hollow, and in its cavities were large stones employed by the artificer to counterbalance its weight, and render it steady on its pedestal.

On occasion of the damage which the city of Rhodes sustained by the abovementioned earthquake, the inhabitants sent ambassadors to all the princes and states of Greek origin, in order to solicit assistance for repairing it; and they obtained large sums, particularly from the kings of Egypt, Macedon, Syria, Pontus, and Bythinia, which amounted to a sum five times exceeding the damages which they had suffered. But instead of setting up the Colossus again, for which purpose the greatest part of it was given, they pretended that the oracle of Delphos had forbidden it, and converted the money to other uses. Accordingly the Colossus lay neglected on the ground for the space of 894 years, at the expiration of which period, or about the year of our Lord 653, or 672, Moawyas, the 6th caliph or emperor of the Saracens, made himself master of Rhodes, and afterwards sold their statue, reduced to fragments, to a Jewish merchant, who loaded 900 camels with the metal, so that, allowing 800 pounds weight for each load, the brass of the Colossus, after the diminution which it had sustained by rust, and probably by theft, amounted to 720 thousand pounds weight. The basis that supported it was of a triangular figure: its extremities were sustained by sixty pillars of marble. There was a winding staircase to go up to the top of it; from whence one might discover Syria, and the ships that went to Egypt, in a great looking-glass, that was hung about the neck of the statue. This enormous statue was not the only one that attracted attention in the city of Rhodes. Pliny reckons 100 other colossuses not so large, which rose majestically in its different quarters.

COLOUR means that property of bodies which affects the sight only; thus the grass in the fields has a green colour, blood has a red colour, the sky generally appears of a blue colour, and so forth: nor can those colours be distinguished by any of our other senses besides the sight. The variety of colours, as they are presented to us by the substances that surround us, is immense, and from them arises the admirable beauty of the works of nature in the animal, in the vegetable, and in the mineral kingdom, or, more properly speaking, in the universe. The science which examines and explains the various properties of the colours of light and of natural bodies, and which forms a principal branch of optics, has been properly denominated chromatics. See CHROMATICS.

COLOUR, in *heraldry*, the heraldic colours are nine, and were anciently expressed by the word tincture; *viz.* or, argent, azure, gules, sable, vert, purpure, tenney, and sanguine; and also by precious stones and planets; the armorial colours are blazoned in different terms, according to the rank and dignity of the person whose arms are described as follows:

Colours.	For commoners by tinctures.	For peers by precious stones.	For emperors, kings, and princes, by planets.
Yellow - - - -	Or - - - - -	Topaz - - - -	Sol.
White - - - -	Argent - - -	Pearl - - - -	Luna.
Blue - - - - -	Azure - - - -	Sapphire - -	Jupiter.
Red - - - - -	Gules - - - -	Ruby - - - -	Mars.
Black - - - - -	Sable - - - -	Diamond - -	Saturn.
Green - - - -	Vert - - - - -	Emerald - -	Venus.
Purple - - - -	Purpure - - -	Amethist - -	Mercury.
Orange - - - -	Tenney - - -	Jacinth - - -	Dragon'shead.
Dark red - - -	Sanguine - -	Sardonix - -	Dragon's tail.

Or and argent are metals; and it is an invariable rule in heraldry not to put colour upon colour, or metal on metal: that is, if the field be of a colour, the charge or bearing must be of a metal.

COLOUR, in law, is a probable or plausible plea, though in reality false at bottom, and only calculated to draw the trial of the cause from the jury to the judge; and therefore colour ought to be matter of law, or doubtful to the jury.

In pleading, it is a rule that no man be allowed to plead specially such a plea as amounts only to the general issue; but in such case he shall be driven to plead the general issue, in terms by which the whole question is referred to a jury. But if a defendant in an assize, or action of trespass, be desirous to refer the validity of his title to the court rather than to the jury, he may state his title specially, and at the same time give colour to the plaintiff; or suppose him to have an appearance or colour of title, bad indeed in point of law, but of which the jury are not competent judges.

COLOUR, in calico-printing. The term colour in calico-printing is applied not only to those vegetable, animal, and mineral solutions, which impart their own colour to the cloth on which they are applied, but also improperly to those earthy or metallic solutions, which, possessing little or no tingent properties themselves, yet retain or fix the qualities (colours) of other substances, when afterwards applied to the cloth. Thus the acetite of alumina, or printer's red liquor, when pure, is almost colourless, and only becomes red by the process of dyeing, as will be explained hereafter. The acetite of iron, or iron liquor, in like manner, when used of a determinate strength, is called black colour, and when weaker, purple colour, though the cloth impregnated with these solutions becomes black or purple, only as being raised like the other in the dye-copper. 1. The colours produced by means of these earthy or metallic solutions (which in the language of science are called mordants) form the most valuable and important series, whether considered with regard to the almost infinite variety of shades, or to their solidity and durability. These colours, from the mode in which they are produced, (the mordant being first applied to the cloth, and the colour afterwards raised by dyeing,) are called dyed colours. 2. Sometimes the mordant is previously mixed with a solution of colouring matter, and in that state applied to the cloth, so as to paint or stain it at one operation and without the process of dyeing. Thus another class of colours is produced, many of them possessing great brilliancy indeed, but much inferior to the former in durability. The colours called chemical by calico-printers belong chiefly to this class. 3. In the third and last class we may place all those, where the colouring matter is simply held in solution by an acid or alkali, and in this state applied to the cloth without the intervention of any mordant. To one or other of the foregoing classes may be referred all the colours used in calico-printing, with the exception, however, of those systems of colours which have been produced by calico-printers in this country, within a short period, by processes and upon principles which have hitherto not been made known. See CALICO-PRINTING.

COLOUR *of the clouds* is thus accounted for by Sir Isaac Newton. Concluding, from a series of experiments, that the transparent parts of bodies, according to their several sizes, reflect rays of one colour, and transmit those of another, he hence observes, that when vapours are first raised, they are divided into parts too small to cause any reflection at their surfaces, and therefore do not hinder the transparency of the air; but when they begin to coalesce, in order to form drops of rain, and constitute globules of all intermediate sizes, these globules are capable of reflecting some colours, and transmitting others, and thus form clouds of various colours, according to their sizes. Mr. Melville controverts this doctrine, in its application to the red colour of the morning and evening clouds. "Why," he says, "should the particles of the clouds become at that particular time, and never at any other, of such a magnitude as to separate these colours? And why are they rarely, if ever, seen tinctured with blue and green, as well as red, orange, or yellow? Is it not more credible, that the separation of rays is made in passing through the horizontal atmosphere, and that the clouds only reflect and transmit the sun's light, as any half-transparent colourless body would do? For since the atmosphere reflects a greater quantity of blue and violet rays than of the rest, the sun's light transmitted through it ought to incline towards yellow, orange, or red; especially when it passes through a long tract of air: and thus it is found, that the sun's horizontal light is tinctured with a deep orange, and even red; and the colour becomes still deeper after sun-set." Hence he concludes that the clouds, according to their different altitudes, may assume all the variety of colours at sun-rising and setting, by barely reflecting the sun's incident light as they receive it.

COLOURS. This very important article includes a variety of matters of peculiar interest to various professions, and requiring no inconsiderable portion of study. We have only seven natural colours, namely, red, orange, yellow, green, blue, indigo, and violet. See CHROMATICS.

The mathematical use of colours is more immediately under our present consideration. These are either what are called body, or transparent: the former applies to such as have a certain substance, being like very thin paste, and coating the object to which they are applied: these are again divided into oil and water colours. Transparent colours are made either of expressed juices, corrected by inspissation, or of the finer particles of earths, gums, &c. highly prepared by levigation, washing, &c.

Oil colours are made by mixing the colouring substances with prepared oils; that is, such as dry readily, and are at the same time so fine and transparent as not to injure the brilliancy or clearness of the colour. Nut-oil is on this account highly esteemed; but in a recent publication (the seventh number of the Agricultural Magazine) we are informed, that sun-flower oil possesses qualities of great moment to the painter, and to various other artists. The colouring matter must be minutely mixed with the oil, so that it may work perfectly free and smooth.

Body colours for the limner's use should be prepared of the purest materials, and be triturated in a mortar, and on a slab with water, until such time as the mixture is completely smooth, and leaves no roughness when rubbed between the thumb and fore-finger: not, however, without making allowance for some particular substances, especially minerals, which, however well they may have been prepared, will occasion a roughness to the touch. Body colours are usually sold in bottles, ready mixed to their proper consistence, and sometimes in cakes, with a small portion of gum Arabic dissolved in the water. Oil colours are most frequently sold in kegs, and ready ground, but requiring an addition of oil before they can be worked: these are generally for the use of house painters, &c.: those for the more delicate purposes are usually kept in bladders.

Transparent colours should be so clear, when mixed with abundance of water, as to communicate a strong tint, without in the smallest degree plastering or concealing the paper, &c.: hence their designation. The best of every kind are made from either vegetable or animal substances; minerals being extremely difficult to prepare, equally so to work with water, and many of them very subject to change. We shall give a concise account of the materials in general use; observing, that there are an immense number of compound colours, sold under various names, that may be made from the following list of simples:

REDS.

Carmine, or the extract of cochineal. Excellent.

Florentine lake, made from refuse cochineal, with a small addition of Brazil wood, precipitated by adding a solution of tin. Does not stand.

Madder lake, the same as the foregoing, but sometimes with the addition of extract of madder. Stands.

Rose lake, or rose pink, made of chalk tinctured with extract of Brazil wood. Does not stand.

Vermillion is a bright scarlet, made from levigated cinnabar. Very apt to turn black.

Red-lead, or minium, levigated, also turns black.

Indian red, an ochre brought from Asia, forms a beautiful bright brick red. Works freely and stands well.

Venetian red is a coarser substance, usually employed with size or oil, to imitate mahogany.

Light red. This is yellow ochre heated until it changes. Stands well, and is much used.

Red chalk is generally cut into slips, and used as a crayon. It must be very well ground, when it works and stands well, either with oil or water.

Burnt terra sienna, is raw sienna calcined till it becomes a fine mellow red. It is in high estimation for its richness, smoothness, and stability.

Orange is usually a compound colour, but may be made from red orpiment, and from an infusion of turmeric in spirits of wine, with a solution of tin.

YELLOWS.

Indian yellow, made from chalk impregnated with urine, whereby it in process of time acquires a very strong colour. It is offensive to the smell, and soon fades.

King's yellow is a strong poison; the basis being yellow orpiment, ground very fine. The colour is very rich, but does not stand.

Naples yellow comes from that country: is prepared from lead and antimony. It turns black, especially if in contact with iron.

Yellow ochre, or Roman ochre, an earth coloured by oxide of iron. It is dull, but stands well.

Massicot is oxide of lead—very dull, but stands.

Dutch pink is chalk coloured with French berries. The colour is beautiful, but soon flies.

Gamboge is a gum very acid, but highly useful. It stands well, mixes freely, and gives a rich gloss; but it does not answer with oil.

Gall-stones are calculi, or stones taken from the gall-bladders of animals. See Calculi. This colour may be obtained from the gall itself. It is superb, but apt to fly.

Turmeric and *Saffron* yield a pleasing colour, as does *annatto*, but very volatile.

BROWNS.

The finest we have is taken from a small bag found in the entrails of the cock-chaffer.

Bistre is the extract of soot from burnt wood. It stands admirably, and is a very useful as well as clear colour. It is much used for sketches, to which it gives a warm appearance.

Cologne earth, a deep brown, very useful, made from an ochre said to be from Cologne, but often spurious.

Raw umber, a light-brown ochre, that stands well.

Burnt umber, the former calcined, thence acquiring, a much richer tint, that stands admirably, and is much in use.

Asphaltum is a bituminous substance, which, being dissolved in turpentine, gives a rich deep brown, not unlike that of tar: it is used for finishing and for glazing pictures.

Brown pink is made of chalk, coloured with fustic, and heightened by fixed alkaline salts, which render it extremely volatile.

Tobacco juice makes a very rich colour, which, mixed with alum, will stand well: it is peculiarly warm and transparent.

BLACKS.

Indian ink is supposed to be made from the gall of the cuttle-fish, but by many is said to be nothing more than a peculiar kind of charcoal, or the soot collected from burning a species of the acacia. In fact, we only know that it should be black, smooth, and glossy, when broken; and that it makes remarkably fine black; some, indeed, have a brownish tint.

What is made in England is coarse, rough, gritty; and generally has a bluish cast.

Lamp black is the soot of oil collected by means of inverted vessels placed over the flames; it is incomparably smooth, and stands well; but is not very deep.

Ivory black is made of ivory, bones, &c. exposed to great heat in a well luted crucible. It is a very deep, but a cold colour.

Blue black is made from vine stalks prepared as above: its colour is deep, but with a bluish cast.

BLUES.

Indigo is the extract from a plant of that name: it is a cold but permanent colour: it is not miscible with water, but gives way to the sulphuric acid.

Prussian blue is made with two parts of purified potash well mixed with one of dried bullock's blood levigated: these are calcined in a covered crucible, with a moderate fire, until they cease to emit fumes.

Blue verditer is made by absorbing the copper dissolved in aqua fortis, by aid of whitening.

Smalt is pounded zaffre, made from the ore of zinc.

Brice is levigated smalt, and rather lighter.

All the above colours are very durable.

PURPLE.

The *Crocus-martis* gives a simple purple, which colour may also be obtained from logwood, with a solution of tin.

GREENS.

Verdigris is an incrustation of copper by the corrosion of acids: it is highly poisonous; but gives a beautiful green colour, with a very slight bluish tinge: when boiled with vinegar, in an earthen vessel, it gives a highly transparent colour, fit for washing brass, &c.; but this is very apt to fade.

Sap-green is the concreted juice of the buckthorn berry: it is a dull green, and is much in use, though apt to fade.

WHITES.

Flake-white is an oxide of lead, formed by corrosion of that metal with vegetable acids.

White-lead is the same as the above, but coarser; it is not so good as flake white, often turning black.

Pure carbonate of lime stands perfectly well, and is much used: it is by some called Spanish white, and is nearly the same as the pigments produced from egg shells, or oyster shells, calcined.

Calcined hartshorn is an excellent white.

The above catalogue of colours is intended for the service of those who apply them with the brush, as in oil-painting, and in limning. The colours used by dyers are very different, and are chiefly pastil, woad, and indigo, for blues; cochineal, carthamus, gum-lac, archil, logwood, madder, &c. for red; weld, savory, quercitron, fenu-greek, &c. for yellows; walnut bark, or rind, alder bark, sandal wood, sumach, and soot, are used for browns, or, as they are technically called, fawn colours; for black, galls, copperas, &c.; greens are generally compounds made from blue and yellow; purples from blue and red; orange colour from red and yellow; and many shades are made by the mixture of red and black, black and blue, &c.; yellow and red also give an olive colour. See DYEING.

COLOURS *diatonic*, or *musical scale of*. In the course of Sir Isaac Newton's experiments on the properties of light, he discovered the remarkable fact, that the spectrum of the sun's image, formed by refracted light, let into a darkened room, is longitudinally divided by the points separating the different colours; *viz.* violet, indigo, blue, green, yellow, orange, and red, into spaces, which are respectively equal to $\frac{1}{9}$, $\frac{1}{18}$, $\frac{1}{12}$, $\frac{1}{12}$, $\frac{1}{15}$, $\frac{3}{80}$, and $\frac{1}{16}$, parts of the double length of the spectrum; as, suppose the spectrum to be 360 parts in length, then $\frac{80}{720}$, $\frac{40}{720}$, $\frac{60}{720}$, $\frac{60}{720}$, $\frac{48}{720}$, $\frac{27}{720}$, and $\frac{45}{720}$, will represent the length of each colour respectively, and adding these successively in the reverse order, to $\frac{360}{720}$, we have $\frac{405}{720}$, $\frac{432}{720}$, $\frac{480}{720}$, $\frac{540}{720}$, $\frac{600}{720}$, $\frac{640}{720}$, and $\frac{720}{720}$, which, in their lowest terms, are $\frac{1}{2}$, $\frac{9}{16}$, $\frac{3}{5}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$, $\frac{8}{9}$, and 1, and appear to be the diatonic ratios answering to the octave, minor seventh, major sixth, fifth, minor fourth, minor third, major second, and key note.

From the experiments of Henry Broughton, jun. Esq., "Philosophical Transactions, 1796," it appears that, not only by refraction, but by inflection, deflection, and reflection, the rays of light may be separated on a chart or screen: and he mentions numerous experiments, wherein the limits of the several colours on the spectrum were carefully marked with the point of a needle, after which the papers thus marked were put away, and a fresh paper substituted for other experiments, the measurement or comparison of the lengths of the intervals occupied by each colour on the different papers being purposely deferred, until the whole course of experiments was completed, in order to prevent any preconceived opinions from operating, in making the experiments: the results are represented as agreeing, in the spaces, $\frac{1}{9}$, $\frac{1}{18}$, $\frac{1}{12}$, $\frac{1}{12}$, $\frac{1}{15}$, $\frac{3}{80}$, and $\frac{1}{10}$, occupied by the violet, indigo, blue, green, yellow, orange, and red colours, being the very same, as to arrangement, as those by refraction above mentioned.

Colour *of office*, signifies some unjust action, done under countenance of an office, and is opposed to *virtute officii*, which implies a man's doing a right and just thing in the execution of his office.

Colours, in the military art, include the banners, flags, ensigns, &c. of all kinds, borne in the army or fleet. See Ensign, Flag, Pendant, and Standard.

COLOURING, in painting, one of the great component and essential parts of painting, is the art of giving to every object in a picture its true and proper hue, as it appears under all the various circumstances or combinations of light, middle-tint, and shadow; and of so blending and contrasting the colours, as to make each appear with the greatest advantage and beauty, at the same time that it contributes to the richness, the brilliancy, and the harmony of the whole. It likewise possesses powers, which, when judiciously applied, render it highly conducive to the character and expression of the subject represented. See Painting.

Colouring *matter*. It has been supposed that a peculiar proximate principle exists in vegetables, in which their colour frequently resides, and which has hence received the name of colouring matter.

The colouring matter of vegetables is scarcely ever found insulated, but is mixed or combined with other principles. In this state it exists in the leaves and flowers, in the bark, and in the wood of the stem and roots. It is extracted, and obtained more pure, by the action of those agents which are capable of dissolving it. In many cases, water, cold or warm, is sufficient for this purpose. If logwood, brazil wood, madder, weld, or quercitron bark, for example, be macerated in water, the matter on which the colour depends is dissolved; a transparent solution, more or less deeply coloured, is obtained; and, by repeating the maceration with water sufficiently, nothing at length remains but the mere ligneous fibre. Sometimes, however, the colouring matter is not soluble in water: it is then frequently soluble in alcohol; and, in a few substances, is even best dissolved by oils essential or expressed.

When the colouring matter is in solution, it may be attracted from the solvent by other substances with which it enters into combination: and this, in some measure, gives it a more appropriate character. There are some substances even which appear in general to exert strong affinities to colouring matter, particularly alumina and some of the metallic oxides. If alumina be diffused or boiled in a coloured vegetable infusion, it often happens, that the colouring matter combines with it, and leaves the water of the infusion perfectly colourless. Or if alum be dissolved in a coloured infusion, and it be decomposed by the addition of an alkali, the alumina, in the moment of its precipitation, attracts the colouring matter, forms a coloured precipitate, and, if the due proportions have been observed, the liquid will remain colourless. In like manner, if a coloured infusion be boiled with a metallic oxide, it often happens, that the colouring matter is attracted by the oxide. Thus Berthollet obtained combinations by this process of the colouring matter of logwood, and other dyestuffs, with oxide of copper, and oxide of tin. Or if certain metallic salts be dissolved in the infusion, and be then decomposed by an alkali, the oxide, in precipitating, equally attracts the colouring matter. It is from similar affinities to the colouring matter that it is often attracted by linen, cotton, silk, or wool, from its solutions; and even where the affinities of these are not sufficiently powerful, they may be rendered capable of attracting it, or the combination may be rendered more permanent by their being impregnated with another substance, which has towards it a still stronger attraction. See Dyeing.

COLPODA, in natural history, a genus of the Vermes Infusoria: worm, invisible to the naked eye, very simple, pellucid, flat sinuate. There are seven species, of which C. lamella, in water, resembles a long, narrow, pellucid membrane, narrower and obtuse behind, curved towards the top, with a ridge or fold going through the middle: it moves to and fro on its edge, and not so on the flat side.

COLUBER, in natural history, a genus of serpents, distinguished by having plates on the body, and scales on the under parts of the tail. The species of this genus are numerous. Linnæus describes, upon the testimony of various writers, above ninety; and that number even has been considerably augmented by naturalists since his time. The species differ greatly in size and habit; some, as the vipers, having the head large, flattish, and semi-cordated, with the body and tail of a moderate length, or rather short; while others, as the greater part of the harmless serpents, have small heads, with the body and tail much longer in proportion. In some, exclusive of the usual scales under the tail, are a few scuta or undivided lamellæ, either at the beginning or towards the tip of the tail.

Linnæus considered the number of abdominal plates and scales under the tail as a characteristic distinction of the different species of this genus; such, however, is the inconsistency of this criterion, that, in describing the same species, scarcely two writers agree. Characters taken from the number of those plates and scales in the serpent tribe, like those from the number of rays in the fins of fishes, are not be relied upon. The colours are liable to some variation; but the peculiar form and disposition of the spots, lines, and other markings, afford, in general, a character, by which the different species may be distinguished.

C. vipera. Somewhat ferruginous, spotted with brown; beneath whitish; tail short and mucronated. Abdominal scuta 118, subcaudal scales 22. Linnæus. This is the common viper of Egypt; it is imported in considerable quantities every year to Venice, for the use of the apothecaries. Its size is somewhat smaller than that of the common viper; the head not so flat on the top, but very protuberant on each side; snout very obtuse. The body is thick towards the middle, and somewhat quadrangular, but thin and cylindric towards the head and tail, which last is short, slender, conical, and terminated by a slightly incurved horny point or tip. The scales on the upper parts are oval and carinated. Hasselquist describes this species as being about two spans in length, exclusive of the tail, which measures only an inch. This is supposed by some to be the asp, by the bite of which the celebrated Cleopatra determined rather to die than submit to be carried captive to Rome, to grace the triumph of Augustus.

C. berus. On the head a bilobate spot; body above cinerous (or reddish) with a black flexuous zig-zag stripe down the back, and belly purplish. Coluber berus, abdominal scuta 146, subcaudal scales 39. Linnæus. This is the common English viper, and which is not only frequent in this country, but appears to be generally diffused over the rest of Europe, and some parts of Asia. If the varieties, described by Gmelin, are of the same species, it extends also as far as India.

Though the viper varies considerably in colour, from a pale cinereous or yellowish ferruginous, to deep or dull brown, the varieties agree in being marked with a continued series of confluent rhomboid blackish spots, extending from the head to the tail. The general length of the viper is from eighteen inches to two feet, and it is affirmed by some writers to grow even to the length of three feet. The fangs of the viper, like those of other poisonous serpents, are situated on each side the fore part of the upper jaw, and are generally two in number, with a few smaller ones situated behind. The poison, as usual, lies in a receptacle at the base of the fangs, and being perforated, when the animal bites, the compression of those receptacles forces out a drop of the poisonous fluid, which, passing through the aperture of the fangs, is immediately instilled into the wound. The tongue is forked, and, being soft and flexible, is susceptible of great extension: it may be, perhaps, superfluous to add, that this tongue is altogether incapable of inflicting any wound, or injecting poison, as some ancient writers credulously affirm; it may assist the animal in the capture of its insect prey. The French naturalists are inclined to believe it is intended by nature to supply some defect of transpiration in the skin. Hitherto the viper has been considered the most poisonous of the European serpents, and many instances are recorded of the fatal effects resulting from its bite. That the bite of this serpent is always productive of pain and temporary inflammation in the parts bitten is very evident; sometimes also the symptoms may become alarming, or in a few instances, through neglect or injudicious treatment of the wound, may even prove fatal; but, upon the whole, the bite of this creature does not appear pregnant with all those dangers which the terrors and prejudices of the vulgar lead them to suppose. In England the bite of the viper is rarely attended with fatal consequences. Fontana seems to doubt whether any well attested instance can be adduced of the viper having killed any person by its bite, even in the warm climate of Italy. The testimonies of authors, both as to the nature of the poison itself, and its effects on the animal frame, are, however, confessedly at variance.

The viper, though so much dreaded on account of its bite, has been very highly esteemed, both by the ancients and moderns, as a restorative and strengthening diet. The ancients used the flesh of this snake in leprous and other cases. The Greek physician Craterus cured, as Porphyrius relates, a miserable slave, whose skin in a strange manner fell off from his bones, by advising him to feed on vipers' flesh in the manner of fish. Galen says, that those afflicted with elephantiasis are wonderfully relieved by eating viper's flesh dressed like eels, and relates very remarkable cures of this disease performed by means of viper wine. In France and Italy, the broth, jelly, and flesh of vipers are in much esteem as a restorative medicine. In England we have to instance the well known circumstance of Sir Kenelm Digby, who caused his wife, Lady Venetia, to feed on capons fatted with vipers, to recover her from a consumption.

The viper abounds most in dry, stony, and chalky countries, or in the low herbage or underwood in thickets. It casts its skin twice in the year, namely, in spring and autumn, and is said to attain its full size at the age of six or seven years, but is capable of engendering when two or three years old.

COLUMBA, the *pigeon*, in natural history, a genus of birds of the order of Passeres. Generic character: bill weak, straight, descending towards the tip; nostrils oblong, and almost covered with a soft tumid membrane; tongue entire; legs short, and generally red; toes divided to their origin. Latham enumerates no less than 66 species, and Gmelin mentions even 82, besides considerable varieties. We shall confine our notices to the few which follow.

C. domestica, or the common pigeon. Of these birds vast flocks arrive in England every year from the northern climates, to which they return on the advance of spring. Many, however, remain in the wild and mountainous districts of this island during the whole year, and breed in the clefts of rocks, or the ruins of human habitations, or in the decayed parts of trees. From this wild state they are easily induced to inhabit the dove-house, which is the first stage of domestication, and near which they find, in vast abundance, and within a small compass, all those conveniences, which, in tracts far from human habitation, they can collect only from a considerable distance, and with extreme difficulty. From this accommodation by man, however, there is perpetual danger of their recurring to their former state of freedom, in which, though their means of subsistence are more scanty, they are less subject to alarms. The wild pigeon breeds only twice in a year, but its prolific tendencies increase in proportion to its degree of domestication; and when that is complete, it will lay even every month, but scarcely ever more than two eggs, containing generally a male and female bird. The flesh of this bird is highly valued for the table. Its dung is considered, for some species of land, as a most admirable manure, and it is of considerable service also in tanning skins for shoe leather. In Egypt, a pigeon-house is considered as an indispensable part of every complete farming establishment; and in the capital of Persia, there are reported to be 3000 of these buildings, the privilege of keeping which is denied to Christians in that country. An efficacious inducement for pigeons to remain in any particular spot is furnished by a mixed heap of loam, rubbish, and salt. Incubation is performed among these birds alternately by the male and female; and the young are fed from the mouths of the old parents, who are said, for this purpose, by contracting some particular muscles, to draw up the provisions which they have swallowed. Pigeons have been occasionally used for the conveyance of letters, in cases in which intercourse between the parties was extremely difficult; the bird is to be taken from the places to which the intelligence is to be sent, and when liberated will return to its destination with great rapidity, with the interesting billet under its wing. There are few or no cases, however, which now compel recourse to so operose and doubtful an expedient.

C. palumbus, or the ring-dove. These are found in almost all parts of Europe. They depart from England, however, towards the close of the year, and are absent till the spring. They build large and ill compacted nests in the tops of trees, and avoid the habitations of men. They are one of the largest species of the pigeon, their length being rather more than seventeen inches. See Aves, Plate IV. fig. 6.

C. turtur, or the turtle-dove. These arrive in England later than any other migrating pigeon, and depart earlier.

During their short stay in this country, they are to be seen, not unfrequently, in Kent, in flocks of about fifteen or twenty, and commit no small depredations on the pea fields of that county, peas being their most favourite food. They build generally in the woods, and on the highest trees. The sounds of the male are particularly soft and impressive, and his assiduity to please the companion of his joys and cares has induced the poets of every age to exhibit him as a model of pure, constant, and delicate attachment. See Aves, Plate IV. fig. 7.

C. migratoria, or the American migratory pigeon. These birds pass the summer in the northern parts of North America, and on the approach of winter move towards the southern. They build in trees, and feed principally upon acorns, and mast of every description. They are also extremely fond of rice and corn. They pass in their periodical migrations in flocks, stated to extend in length two miles, and a quarter of a mile in width; occasionally alighting in the course of their journey, and covering the foliage of considerable woods. During what is called their flight time, the common people of the country easily knock them from their roosts, and find them a very nourishing and pleasant, as well as cheap article of food. In Louisiana, it is a common entertainment in an evening, in which ladies frequently participate, to enter the woods frequented by these birds, and burn a small quantity of sulphur under the trees on which they are lodged. Stupified by this application, they almost immediately quit their hold, and drop lifeless to the ground, whence they are picked up in quantities.

C. œnas inhabits old turrets, and rocky banks of Europe and Siberia, fig. 2.

COLUMBATES. } See Columbium.
COLUMBIC *acid.* }

COLUMBIUM, in mineralogy and chemistry. Mr. Hatchet, in examining some minerals in the British Museum, observed one which attracted his attention, from its resemblance to chromate of iron. On analysing it, he found it to be composed of a metallic acid, united with oxide of iron; and this acid, by farther experiments, was found to differ in its properties from every other. Mr. Hatchet did not succeed in reducing it to the metallic state. To the metal, however, which he supposed to be its basis, he gave the name of Columbium, as the ore affording it was the produce of America. The mineral which afforded this metallic acid is of a dark brownish grey colour; its lustre is vitreous, inclining to metallic: its fracture imperfectly lamellated: it is moderately hard and very brittle: its particles are not attracted by the magnet: its specific gravity is 5.9. From this mineral Mr. Hatchet extracted the peculiar matter which may be named columbic acid. The columbic acid is of a pure white colour, and not extremely heavy; it has scarcely any taste, nor does it appear to be soluble in boiling water, but, when placed on litmus paper, mixed with distilled water, soon renders the paper red.

From the acid solutions of columbic acid, the alkalies throw it down in the form of a white flocculent precipitate. Prussiate of potash changes the colour to an olive-green, and a precipitate of the same colour is gradually formed. Tincture of galls produces a deep orange-coloured precipitate, especially when there is not too great an excess of acid present. Zinc, immersed in the solution, gives rise to a white precipitate. The fixed alkalies combine readily, both in the humid and in the dry way, with columbic acid, forming with it salts called columbates. When fused with it, a compound is formed, which is soluble in water; and if the alkali be in the state of carbonate, the carbonic acid is disengaged during the fusion with effervescence. When a solution of potash is boiled on it, a quantity is dissolved; the solution, which has a considerable excess of alkali, affords, by gentle evaporation, a white salt in shining scales, having a disagreeable acrid flavour, not soluble very readily in cold water, but, when dissolved, the solution is permanent. Nitric acid added to it precipitates the columbic acid. Prussiate of potash and tincture of galls produced no change; but when with either of them a few drops of muriatic acid were added, precipitates, similar to those produced by these re-agents in the acid solutions, appeared an olive green with the one, and an orange-coloured precipitate with the other. Hydro-sulphuret of ammonia produced a reddish brown precipitate.

This substance is possessed of properties different from any of the known metals or metallic oxides or acids: for although in some qualities it approaches to titanium, tungsten, or to molybdena, it differs from them, and from all the others, particularly in the precipitates it affords with prussiate of potash and tincture of galls, in not combining with ammonia, and in being insoluble, and unalterable with regard to colour, by nitric acid.

COLUMELLA, in botany, a genus of the Syngenesia Superflua class and order; receptacle naked, cellular; seeds crowned with a toothed margin; calyx cylindrical, imbricate; florets of the ray undivided. One species, found at the Cape.

COLUMN, a round pillar, made to support and adorn a building, and composed of a base, a shaft, and a capital.

Columns are different in the different orders of architecture, and may be considered with regard to their matter, construction, form, disposition, and use. See Architecture.

COLUMNEA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx five-parted; corolla ringent; upper-lip three-parted; the middle part vaulted, emarginate; gibbous above at the base; anthers connected; capsule two-celled; seeds nestling. There are six species, all natives of hot countries, and most of them of the West Indies.

COLUMNIFERÆ, in botany, the name of the thirty-seventh order in Linnæus's "Fragments of a Natural Method," consisting of plants whose stamina and pistil have the appearance of a pillar in the centre of a flower: an instance of this order is the genus Bixa, which see.

COLURES, in astronomy and geography, two great circles, supposed to intersect each other at right angles in the poles of the world, and to pass through the solstitial and equinoctial points of the ecliptic. That which passes through the two equinoctial points is called the equinoctial colure, and determines the equinoxes; and the other which passes through the poles of the ecliptic is called the solstitial colure, because it determines the solstices.

COLUTEA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx five-cleft; legume inflated, gaping on the upper suture at the base. There are nine species. Most of the Coluteas are shrubs, with pinnate leaves, and stipules distinct from the petiole; peduncles sometimes two-flowered, but more frequently many-flowered in spikes, both axillary and terminating. They are easily distinguished by their membranaceous, inflated pod; natives of hot climates.

COLYMBUS, the diver, in natural history, a genus of birds of the order Anseres. Generic character: bill toothless, subulate, straight, and pointed: throat toothed; nostrils linear; legs fettered. The guillemot and the diver are included by Gmelin under one genus, while Latham considers each as furnishing a genus by itself. We shall adopt the system of the former, and notice, in what follows, the most important of these two classes, under one head.

C. troile, or foolish guillemot. These birds are, in summer, surprisingly abundant on the coasts of England, and furnish to the sportsman an invaluable supply of experience in the art of shooting flying. Whatever numbers may be destroyed, the rest only quit their stand to take a circular flight, which brings them back to the spot whence the gun alarmed them, and which the death of their companions cannot induce them finally to leave. Their flesh is eaten by the Kamschatkans, though extremely ill-flavoured, and their skins valued by those people as a highly ornamental dress. The eggs are said to be extremely delicate, and it is remarkable that no two are spotted or streaked alike.

C. glacialis, or the Northern diver, is the largest of the genus, and weighs so much as sixteen pounds, measuring three feet six inches in length. This is found in various places in the North of Europe, but scarcely ever seen so far south as England, unless in winters extremely rigorous. It is rarely seen on land, being almost perpetually on the ocean, where it dives with extreme vigour in pursuit of various fishes, and with such dexterity as rarely fails of success. It can fly with rapidity, and to a great distance. In Iceland it is often found, and, while breeding, frequents the lakes and rivers of that island. The inhabitants of the banks of the Oby prepare the skin of this bird without injuring the feathers, and render it convertible into compact, durable, and ornamental parts of dress, as caps, or even mantles, which are proofs against moisture, and afford extraordinary warmth.

C. immer, or the imber, resembles the last in habits and manners. It is fonud in the lakes of Canada, and in those of Switzerland, as well as in almost all the northern parts of Europe. It will swim under water to the distance of a hundred paces, and is caught by land or in the water with extreme difficulty. By a hooked line, however, baited with its favourite fish, it has often been drawn up from a considerable depth, and thus exhibited to many observers a singular variety from the sportsman's usual practice.

COMA, or COMA-VIGIL, a preternatural propensity to sleep, when nevertheless the patient does not sleep, or, if he does, awakes immediately without any relief. See MEDICINE.

COMA, in botany, a collection of floral leaves, which, in the crown imperial, lavender, sage, cow-wheat, and some other plants, terminate the flower-stem, and form an appearance like a tuft of hair.

COMA *Berenices*, *Berenice's hair*, in astronomy, a constellation of the Northern hemisphere, composed of stars near the Lion's tail. See ASTRONOMY.

COMARUM, in botany, a genus of the Icosandria Polygamia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Essential character: calyx tencleft; petals five, smaller than the calyx; receptacle of the seeds ovate, spongy, permanent. There is but one species; *viz.* C. palustre, marsh-cinquefoil, a native of most parts of Europe, in boggy ground.

COMB, an instrument made of horn, ivory, tortoise-shell, box, or holly-wood, &c. and useful for separating and adjusting the hair, &c.

COMB-*making*. Combs are not only made for the purpose of cleansing the hair, but for ornament: they are sometimes set with brilliant stones, pearls, and even diamonds; some again are studded with cut steel: these are of different shapes, and are used to fasten up the hair when ladies dress without caps. Combs may, of course, be had of all prices, from the value of a few pence to almost any sum. They are generally made of the horns of bullocks or of elephants, and sea-horse's teeth, and some are made of tortoise-shell and ivory, others of box or holly-wood. The horns of bullocks are thus prepared for this manufactory: the tips are sawn off; they are then held in the flame of a wood fire; this is called roasting, by which they become nearly as soft as leather. While in that state they are slit open on one side, and pressed in a machine between two iron plates; they are then plunged into a trough of water, from which they come out hard and flat; they are then sawn into lengths, according to the size wanted. To cut the teeth, each piece is fixed into a tool called a claw. The maker sits on a triangular sort of a stool to his work, and under him is placed the claw that holds the horn, ivory, &c. that is to be formed into a comb. The teeth are cut with a fine saw, or rather a pair of saws, and they are finished with a file. A coarser file, called a rasp, is used to reduce the horn, &c. to a proper thickness; and when they are completely made, they are polished with charcoal and water, and receive their last finish with powder of rotten stone. The process used for making ivory combs is nearly the same as that already described, except that the ivory is first sawed into thin slices. The best ivory comes from the island of Ceylon, and Achen, in the East Indies; as it possesses the property of never turning yellow, it is consequently much dearer than any other kind.

Tortoise-shell combs are much esteemed; and there are methods of staining horn, so as to imitate it, of which the following is one; the horn to be dyed is first to be pressed into a flat form, and then done over with a paste, made of two parts of quick-lime and one of litharge, brought into a proper consistence with soap-ley. This paste must be put over all the parts of the horn, except such as are proper to be left transparent, to give it a nearer resemblance to tortoise-shell. The horn must remain in this state till the paste be quite dry, when it is to be brushed off. It requires taste and judgment, so to dispose the paste, as to form a variety of transparent parts, of different magnitudes and figures, to look like nature. Some parts should also be semitransparent, which may be effected by mixing whiting with a part of the paste. By this means spots of a reddish brown will be produced, so as greatly to increase the beauty of the work. Horn thus dyed is manufactured into combs, and these are frequently sold for real tortoise-shell.

COMBAT, in law, or single combat, denotes a form of trial between two champions of some doubtful cause or quarrel, by the sword or batoons. This form of proceeding was anciently very frequent, particularly among the barbarous nations in their original settlements; and obtained, not only in criminal, but also in civil causes; being built on a presumption, that God would never grant the victory but to him who had the best right. It was originally permitted, in order to determine points respecting the reputation of individuals, but afterwards became much more extensive. The accuser first swore to the truth of his accusation; the accused gave him the lie: upon which each threw down a gage, or pledge of battle, and the parties were committed prisoners to the day of combat. See CHAMPION.

COMBINATION, in mathematics, is the variation or alteration of any number of quantities, letters, sounds, or the like, in all the different manners possible. It is shewn, in the memoirs of the French Academy, that two square pieces, each divided diagonally into two colours, may be combined 64 different ways, so as to form so many different kinds of chequer-work; which appears surprising enough, when one considers that two letters or figures can only be combined twice. See CHANGES.

COMBINATION, *doctrine of.* Prob. 1. Any number of quantities being given, together with the number in each combination, to find the number of combinations. One quantity admits of no combination: two, *a* and *b*, only of one combination; of three quantities, *a b c*, there are three combinations, *viz. a b, a c, b c;* of four quantities, there are six combinations, *viz, a b, a c, a d, b c, b d, c d;* of five quantities, there are ten combinations, *viz. a b, a c, b c, a d, b d, c d, a e, b e, c e, d e.* Hence it appears that the numbers of combinations proceed as 1, 3, 6, 10; that is, they are triangular numbers, whose sides differ by unity from the number of given quantities. If this then be supposed *q*, the side of the number of combinations will be $q - 1$, and so the number of combinations $\frac{q-1}{1}, \frac{q+0}{2}$. See TRIANGULAR NUMBERS.

If three quantities are to be combined, and the number in each combination be three, there will be only one combination, *a b c;* if a fourth be added, four combinations will be found, *a b c, a b d, b c d, a c d;* if a fifth be added, the combinations will be ten, *viz. a b c, a b d, b c d, a c d, a b e, b d e, b c e, a c e, a d e;* if a sixth, the combinations will be twenty, &c. The numbers, therefore, of combinations proceed as 1, 4, 10, 20, &c. that is, they are the first pyramidal triangular numbers, whose side differs by two units from the number of given quantities. Hence, if the number of given quantities be *q*, the side will be $q - 2$, and so the number of combinations $\frac{q-2}{1}, \frac{q-1}{2}, \frac{q+0}{3}$.

If four quantities are to be combined, we shall find the numbers of combinations to proceed as pyramidal, triangular numbers of the second order, 1, 5, 15, 35, &c. whose side differs from the number of quantities by the exponent minus an unit. Wherefore, if the number of quantities be *q*, the side will be $q - 3$, and the number of combinations $\frac{q-3}{1}, \frac{q-2}{2}, \frac{q-1}{3}, \frac{q+0}{4}$. See PYRAMIDAL NUMBERS.

Hence is easily deduced a general rule of determining the number of combinations in any case whatsoever. Suppose, for example, the number of quantities to be combined *q*, and the exponent of combination *n*; the number of combinations will be $\frac{q-n+1}{1}, \frac{q-n+2}{2}, \frac{q-n+3}{3}, \frac{q-n+4}{4}$, &c. till the number to be added be equal to *n*. Take $q = 6$ and $n = 4$, the number of combinations will be $\frac{6-4+1}{1} \frac{6-4+2}{2} \frac{6-4+3}{3} \frac{6-4+4}{4} = \frac{6-3}{1} \frac{6-2}{2} \frac{6-1}{3} \frac{6+0}{4} = \frac{3}{1} \frac{4}{2} \frac{5}{3} \frac{6}{4} = 15.$

If it be required to know all the possible combinations of the given quantities, beginning with the combinations of the several two's, then proceeding to three's, &c. we must add $\frac{q-1}{1} \frac{q+0}{2}, \frac{q-2}{1} \frac{q-1}{2} \frac{q+0}{3}, \frac{q-3}{1} \frac{q-2}{2} \frac{q-1}{3} \frac{q+0}{4}$, &c.

Whence the number of all the possible combinations will be $\frac{q}{1} \frac{q-1}{2} + \frac{q}{1} \frac{q-1}{2} \frac{q-2}{3} + \frac{q}{1} \frac{q-1}{2} \frac{q-2}{3} \frac{q-3}{4} + \frac{q}{1} \frac{q-1}{2} \frac{q-2}{3} \frac{q-3}{4} \frac{q-4}{5}$ which is the sum of the unciæ of the binomial raised to the power *q*, and abridged of the exponent of the power increased by unity $q + 1$. Wherefore, since these unciæ come out $1 + 1$, by being raised to the power *q*; and since $1 + 1$ is equal to 2, $2q - q - 1$ will be the number of all the possible combinations. For example, if the number of quantities be 5, the number of possible combinations will be $25-6=32-6=26$.

Prob. 2. Any number of quantities being given, to find the number of all these changes which these quantities, combined in all the manners possible, can undergo. Let there be two quantities *a* and *b*, their variations will be two; consequently, as each of them may be combined with itself, to these there must be added two variations more. Therefore the number of the whole will be $2 + 2 = 4$. If there were three quantities, and the exponent of the variation 2, the combinations will be 3, and the changes 3; to wit, *a b*, *a c*, *b c*, and *b a*, *c a*, *c b*; to which if we add the three combinations of each quantity with itself *a a*, *b b*, *c c*, we shall have the number of changes $3 + 3 + 3 = 9$.

In like manner, it is evident, if the given quantities were 4, and the exponent 2, that the number of combinations will be 6, and the number of changes likewise 6, and the number of combinations of each quantity with itself 4; and therefore the number of changes 16; if with the same exponent the given quantities were 5, the number of changes would be 25; and in general, if the number of the quantities were *n*, the number of changes would be n^2.

Suppose the quantities 3, and the exponent of variation 3, the number of changes is found $27 = 3^3$, *viz.* *a a a*, *a a b*, *a b a*, *b a a*, *a a c*, *a c a*, *c a a*, *a b b*, *b a b*, *b b a*, *a b c*, *b a c*, *b c a*, *a c b*, *c a b*, *c b a*, *a c c*, *c a c*, *c c a*, *b b b*, *b b c*, *c b b*, *b c b*, *b c c*, *c b c*, *c c b*, *c c c*. In like manner it will appear, if the quantities were 4, and the exponent 3, that the number of changes would be $64 = 4^3$; and in general, if the number of quantities was $= n$, and the exponent 3, the number of changes would be n^3.

By proceeding in this manner it will be found, if the number of quantities be *n*, and the exponent *n*, that the number of changes would be n^n. Wherefore, if all the antecedents be added, where the exponent is less, the number of all the possible changes will be found $n^n + n^{n-1} + n^{n-2} + n^{n-3} + n^{n-4}$, &c. till the number subtracted from *n* leaves 1, because the beginning is from single quantities taken once.

Since, then, the number of all possible changes is in a geometrical progression, the first or smallest term of which is *n*, the largest n^n, and the denominator n^1; it will be equal $(n^{n+1} - n) \div (n - 1)$. Suppose $n = 4$, the number of all possible variations will be $(4^5 - 4) \div (1 - 4) = \frac{1020}{3} = 340$.

Suppose again $n = 24$, the number of all the possible variations will be $(24^{25} - 24) \div (24 - 1) = 32009658644$-$40631898677795534825060 0$ divided by $23 = 1391724288887252999425128493402200$. In so many various methods may the 24 letters of the alphabet be varied and combined among themselves.

Combination, in chemistry, is the intimate union of two bodies, by chemical attraction, into one substance, so that neither of them can be recognized, nor can they be separated from each other by any mechanical force. Of this principle are the following instances. Salt will unite with water, from which it cannot be separated again but by chemical agency. Sulphur and lime may by heat be united, and form a compound, the properties of which are totally dissimilar to those of either the substances used. In both cases an affinity has been exerted between the substances, and they have combined. Combination is to be distinguished from mixture, in which dissimilar particles are blended together, without being united by attraction, in which no new qualities are acquired, in which the difference of parts is easily discovered, and these parts are capable of being separated by mechanical means. It is distinguished from aggregation, which is merely the union of particles of the same kind of matter, forming an aggregate, uniform in composition, but possessing all the properties of the particles of which it is composed.

Combination, in military science. One ought to regard combination as forming a part of military science. A general, who has an enterprize in contemplation, should, before he risks the execution of it, combine well in his mind all the ideas that can lead to its success; and he ought not always to rely on his own solution of the case. But when his ideas on the subject are pretty well fixed, he should lay them before the general officers, who are under his orders or command, for their opinion and concurrence.

Combination, in law. Combinations to do unlawful acts are punishable before the unlawful acts are executed; this is to prevent the consequences of combination and conspiracies, &c.

COMBRETUM, in botany, a genus of the Octandria Monogynia class and order. Natural order of Calycanthemæ. Onagræ, Jussieu. Essential character: calyx four or five toothed, bell-shaped, superior; corolla four or five-petalled, inserted into the calyx; stamina very long; seed one, four or five-angled, the angles membranaceous. There are four species. This genus is very imperfectly known, and being a very fine one, deserves the attention of the cultivators of exotic plants.

COMBUSTION. The temperature of bodies may be raised by various means, which are generally such as produce an agitation among the particles. The sun's light, and also the chemical or mechanical actions of bodies upon each other, if sufficiently intense or rapid, produce this effect. One of the most generally known methods of producing a high temperature consists in striking or rubbing bodies together; and there is no action more familiar to us, for this purpose, than the striking of a flint against a piece of steel. Whenever an elevated temperature is thus produced in a body communicating with the open air, it is observable that, according to the nature of the body itself, the heat is either conducted away, and nothing farther happens, or else it continues, and even increases, so as to spread by communication through every part of the body, and produce a change in its nature. Thus, if one corner or extremity of a thin piece of stone or glass be made red hot, it will soon become cold again, and no farther effect will follow; but if the corner of a piece of paper or wood be heated in like manner, it will not, in common circumstances, become cold again without alteration, but the heat will be communicated to the whole mass, and will continue until the body shall have undergone a remarkable change. This phenomenon is called combustion or burning; the bodies which are liable to it are called combustible; and after they have undergone this process they are said to have been burned.

There are scarcely any chemical changes, by which heat is produced, sufficient to exhibit the appearance of light, unless oxygen be in the act of entering into combination with a combustible body. One of the earliest observations respecting ordinary combustion must have been, that it cannot take place without common air, and that it is extinguished by shutting out the air. It is now well known, that the air acts only by means of its oxygen, which unites with and changes the combustible body.

The earlier doctrines respecting heat and fire are scarcely entitled to notice; and certainly must not occupy our pages. It will be sufficient for us to remark, that the hypothesis of an element called fire, which was supposed to escape from burning bodies and ascend to a sphere above, was modified by Beccher and Stahl, by the supposition of a general principle, assumed to exist in all combustible bodies, and denominated phlogiston; capable of passing in combination from one body to another, or of flying off with a violent agitation, in which the heat was imagined to consist. As this theory was established upon the observation of a number of striking chemical facts, it was for a long time universally received. Various modifications were, however, proposed by different chemists, as discoveries came to be made; particularly with regard to the agency and combination of air in bodies, and afterwards those of the existence of oxygen, and the laws by which heat, or the cause of temperature, is governed. These advances led to the rejection of phlogiston altogether; a change of theory, which was more rapidly effected by the patronage, exertions, and scientific labour of Lavoisier; who devoted the influence of an elevated situation, the extent of his fortune, and the powers of an uncommonly clear and comprehensive intellect, to this object. It is to be regretted that, with claims so well founded and so great, this philosopher should have sought for more; but it is certainly true, that he himself gave support to the powerful cry of that party, which has proclaimed him the author of the modern theory of combustion; whereas, if they had continued to do justice to Rey, Hooke, Mayow, Hales, Bayen, Priestley, and others, there would have been little of absolute facts left for Lavoisier to claim in the way of original discovery; though it would be difficult to find adequate terms to express the obligation under which the scientific world is placed with regard to him, for his ample and accurate repetition of experimental investigations, and the very luminous and able manner in which he has digested and stated the whole mass of facts, and applied them to theoretical results.

Combustion, as understood by modern chemists, is the rapid combination of oxygen with a body, which is attended with increase of temperature and the emission of light. The burned body is therefore an oxygenated compound. Thus we may form a notion of combustion by burning a piece of iron wire. If the diameter of the wire be very small, such, for example, as half the thickness of a hair, and it be made up into a tuft like wool, it may be lighted by a candle, and will burn, like other more readily combustible bodies, until it has received a certain portion of oxygen, after which the combustion will cease. If the same iron had been exposed to the atmosphere without additional heat, it would also have attracted oxygen, but in a longer time; and though the result might have been the same, we should not have called this slow process by the name of combustion.

Though the modern theory of combustion is simplified by rejecting phlogiston, and rendered more accurate by comprehending facts formerly unknown, yet it must not be disguised, that it is inadequate to account for the great and most striking fact, namely, the increase of temperature, otherwise than by hypothesis. Heat, or elevation of temperature, seems, in the opinions of all philosophers, to consist in the agitation of the particles of something, whether we suppose that thing to be the body itself, or a peculiar element called caloric. According to those philosophers who assert the existence of this last principle, the combination of oxygen and the combustible body does emit or give out caloric, either because there is less room for it in the new compound, of which the capacity is changed, according to Dr. Irvine's doctrine; or because a portion of caloric, which was before latent, or combined in one or both of the component parts, is, according to Black, given out in consequence of the resulting attraction of the new compound for it being less than before. They, who are disposed to see this subject treated at length, may consult the system of the ingenious Fourcroy, where they will find the modern caloric affording the same general services to chemical hypothesis, as were formerly obtained from its predecessor, phlogiston.

Notwithstanding the truly valuable and numerous discoveries of facts by Black, Irvine, Crawford, and other modern philosophers, we are far from being in possession of proof, that elevation of temperature is universally occasioned by diminution of capacity, or the extrication of latent heat. But, as we are upon the whole more habituated to consider bodies themselves, than their properties in the abstract, a preference has been given to the method of ascribing events to peculiar additional substances, rather than to motions or modifications of the bodies in which they may take place. Many eminent philosophers have, nevertheless, considered heat as a motion in the particles themselves; but it is not so easy to speculate upon the principles of motion among a system of particles, as it is to assert the combination and disengagement of a chemical element, though this assertion does not remove the difficulty, but only places it a step farther off.

If we admit that the particles of a body do not touch each other; as appears to be established from the different degrees of inertia and of weight, as well as from the expansions and contractions occasioned by change of temperature, and other causes; and if we likewise consider the particles as attracting each other,—it appears to follow by analogy, from what we know of the rest of the universe, that they must be kept asunder by motion. From this inference we shall be led to consider natural masses as distinct systems of revolving particles; comparable with those nebulæ which occupy the celestial spaces, and of which the parts are, no doubt, governed by cometary and planetary revolutions. It is much to be regretted, that the mathematical consideration of this subject by Mr. Buée, in a work announced in Nicholson's Journal, vol. iii. p. 234, quarto series, has not yet been laid before the public.

The ordinary appearances of bodies in a state of combustion may be explained, in a general way, by attending to the state of the bodies which undergo it. If the parts of an ignited body, such as that of a piece of charcoal, become oxygenated, previous to or at the very instant of their separation from the mass, there will be no appearance of light but at the surface of the burning body; but if small parts of the body be separated from the general mass, during the very process of combustion, and before it is completed, as happens mechanically when the particles of iron are torn off by the action of a dry grindstone, or chemically when the particles of fat rise in vapour from the wick of a lighted candle, a burning mass will be seen, variable in its figure, which, in the latter case, is called flame. And that this explanation accounts for the flame of burning bodies is manifested, from the little difference between the two phenomena here mentioned, and the still less difference between the results, namely flame, which are produced by projecting the dust of rosin, or a stream of hydrogen, through the flame of a candle.

According to the theory which supposes caloric to be an independent substance, combustion must be a rapid union of oxygen with a combustible body; and the heat has been supposed to be given out from the oxygen during a condensation of this last, which, it is imagined, takes place universally in this process. This, however, has not been proved.

Dr. Thomson, considering caloric and light as distinct substances, has adduced many facts and observations, to prove, that as caloric abounds in oxygen, so light is a component part of every combustible. And thence, according to his doctrine, while the base of oxygen combines with the base of the combustible, the caloric of the one and the light of the other unite in the form of fire. From this theory he shows why, in the transitions of oxygen from one combustible base to another, the act of combustion does not take place; namely, because the caloric of the oxygen has no light presented to it to combine with. The whole doctrine, though undoubtedly requiring further developement and proof, is entitled to the greatest attention of chemists. See Caloric, Capacity, Chemistry, Heat.

Combustion *of living individuals of the human species.* Citizen Lair, in 1797, communicated to the Philomathic Society at Paris, a memoir on the spontaneous combustion of human individuals, of which instances are related in the Copenhagen Acts of 1692; the Annual Register, 1763 and 1775: the Philosophical Transactions, 1744; the Observations of Le Cat, 1729 and 1749; and the Journal de Medecine for 1779 and 1783: and to these he has added some others related by persons living at Caen, and on the testimony of a surgeon of the same town, who attested the circumstances of an event of this description by a verbal process.

Difficulties would no doubt be offered for reasoning against these facts; but the writer remarks, that human testimony is not to be rejected, unless the probability that the facts must be impossible shall be greater than that arising from the concurrence of evidence; and he adds, that the narratives, though varying so widely as to time and place, do very remarkably agree in their tenor. The circumstances are, that (1) the combustion has usually detroyed the person, by reducing the body to a mass of pulverulent fatty matter, resembling ashes. 2. There were no signs of combustion in surrounding bodies, by which it could be occasioned, as these were little if at all injured; though (3) the combustion did not seem to be so perfectly spontaneous, but that some slight cause, such as the fire of a pipe, or a taper, or a candle, seems to have began it. 4. The persons were generally much addicted to the use of spiritous liquors; were very fat; in most instances women; and old. 5. The extremities, such as the legs, hands, or cranium, escaped the fire. 6. Water, instead of extinguishing the fire, gave it more activity, as happens when fat is burned. 7. The residue was oily and fetid ashes, with a greasy soot, of a very penetrating and disagreeable smell.

The theory of the author may be considered as hypothetical, until maturer observations shall throw more light on the subject. The principal fact is, that charcoal and oil, or fat, are known in some instances to take fire spontaneously, and he supposes the carbon of the alcohol to be deposited in the fat parts of the human system, and to produce this effect.

COMEDY, a dramatic poem, representing some event in common life, which is supposed to take place among private individuals. Its object is to ridicule the vices and follies of mankind.

The unities of action, time and place, the division of the acts, the introduction of episodes, the intermixture of the scenes, are common to both tragedy and comedy. But in other essentials they differ: the one inspires terror and pity; the other excites gaiety and mirth. The characters in tragedy are, kings, princes, tyrants, heroes; those in comedy are, ridiculous people of quality, cits, valets, gossips, &c. The style also of the latter has its peculiar characteristics; it should be simple, lively, familiar, and replete with sallies of wit, satire, and genuine humour.

As almost all the rules of dramatic poetry are constructed with a view to strengthen the resemblance of fiction to reality, they ought in comedy to be most minutely attended to; because, as the scenes it represents bear a nearer affinity to real life, any defect in the resemblance is more readily discovered. Hence the necessity of truth in the delineation of character, of simplicity in the texture of the intrigue, of spirit and consistency in the dialogue, and of genuine nature in the sentiments. Hence, too, that grand requisite, the art of concealing art, in managing the progressive intricacy of the plot, which constitutes the illusion of theatrical representations. The intrigue of comedy does not consist in the construction of a fable barely probable, but in a natural series of familiar events, developed in the most clear and impressive way. It may be of use, therefore, to trace the rise and progress of comedy, with its various revolutions, in order to examine the principles on which those rules are founded, and to point out their various applications.

On the waggon of Thespis, comedy was a mere tissue of ribaldry, uttered to the passing multitude by vintagers, with their faces stained with wine-lees. After the example of the Sicilian poets Epicoharmus and Phormis, Crates gave it a more regular form, and raised it to a more appropriate stage. Comedy then took for its model the tragedy invented by Æschylus, or rather both were founded on the poems of Homer. This epoch is, properly speaking, the origin of comedy among the Greeks; they divided it into the old, the middle, and the new. The Athenian comedians at first produced satires in action, that is to say, they represented characters known and named, whose follies and vices they imitated. This was the old comedy.

To repress this licence, the laws forbad the mention of names. Neither the malignity of the poets, however, nor that of the spectators, lost any thing by this interdict. The resemblance of masks, dress, and gesture, designated public characters so well, that they were recognized at sight. Thus, in the middle comedy, the poet, having no longer to dread the reproach of personality, was emboldened in his satirical attacks; at the same time he was doubly sure of applause; for, while feeding the malice of his audience by the blackness of his portraits, he afforded their vanity the gratification of guessing his originals. It was in these two pieces that Aristophanes so often triumphed, to the shame of the Athenians.

Satirical comedy presented at first view many appearances of advantage. There are vices, against which the institutions of a state provide no punishment. Self-interestedness, or incapacity in the administration of public affairs, ingratitude, infidelity, breach of promise, the tacit and artful usurpation of the merit of another—all these escape the severity of law. Satirical comedy assigned to them a punishment the more terrible, as it was inflicted in a public theatre. There the guilty were arraigned, and the people sat in judgment. It was doubtless to maintain so salutary a species of terror, that the first satirical poets were not only tolerated, but even hired by the magistracy, as censors of the republic. Even Plato was led away by this apparent advantage, when he admitted Aristophanes into his banquet: if, indeed, the Athenian satirist, and the Aristophanes of the banquet, are one and the same person, which may at least be fairly doubted.

Such was the state of comedy at Athens, when her two great tragic poets acquired the glory of rendering virtue interesting, and crime odious, by the most affecting and terrible pictures. How singular, that the same people should delight in exhibitions so opposite and contrasted! the heroes of Sophocles and Euripides were no more, but the sage calumniated by Aristophanes was still living. The Athenians could applaud with enthusiasm the great men of former days, while at the same time they could behold with satisfaction their wisest philosopher exposed to contempt and ridicule.

The government, too late, perceived that the poets had eluded, in what was called middle comedy, the law which forbad the mention of names; they enacted another, which banished from the stage all personal imitation, and restricted comedy to the general representation of manners. This was the æra of new comedy: it ceased to be a direct satire, and assumed the legitimate and classical form which it has since preserved. Menander shone in this department; a poet as elegant and natural as Aristophanes was the reverse. We cannot but deeply regret the loss of his works, when we read the eulogies which Plutarch, in common with all the ancients, has pronounced on them.

But it is easier to copy what is gross and low, than what is refined and noble; hence the first Latin poets chose Aristophanes for their model. Of this number was Plautus, who, notwithstanding, does not resemble him. Terence, who came after Plautus, imitated Menander, without equalling him; Cæsar used to call him a demi-Menander, and reproached him with his want of the *vis comica*, by which is meant those master-strokes which fathom characters, which dive into the inmost recesses of the soul, and expose its hidden vices to public derision and shame.

Plautus excels in gaiety, strength, and variety: Terence in truth, delicacy, and elegance: the one has the advantage of imagination, unrestrained by the rules of art over talents subjected to all those rules; the other has the merit of uniting sprightliness with decency, politeness with pleasantry, and exactness with ease; the one amuses by the matter, the other by the style; and we wish Plautus had the refinement of Terence, and Terence the humour of Plautus.

The modifications of comedy in its first stages, and the varieties observable in it at the present day, all originate in the predominating character of each particular people, and in their respective forms of government. Thus, in a democratical state, the administration of government, and the conduct of the leading men, being the chief objects of animadversion and censure, the Athenian people, ever discontented and restless, delighted in theatrical satires, which exposed not only the vices of individuals, but the concerns of government, the prevarications of orators, the faults of generals, and even their own facility to be duped and corrupted. Hence their applause at the political satires of Aristophanes. This licence was repressed as the government grew less popular, as may be seen in the later comedies of that author, and in what vestige remains of those of Menander. In these the state was always respected, and private intrigues were substituted for public cabals.

The Romans under the consuls, as jealous of liberty as the Athenians, but more jealous of the dignity of their government, never suffered the republic to be exposed to the shafts of poetic ridicule : hence their first comic authors ventured upon personal, but never upon political, satire.

The low popular comedy was always freely tolerated, and the comedy of Grecian manners, called Palliata, enjoyed equal indulgence ; but when the nobles of Rome were introduced on the stage, as in the pieces called Prætextæ and Togatæ, the action was more restrained, and ridicule was banished. This style, as Seneca observes, holds a middle rank between comedy and tragedy. But as luxury gradually softened the manners of Rome, comedy lost its keenness and severity; and the Romans, having imbibed the vices of the Greeks, Terence, to pourtray them, had only to copy Menander.

The same influence of public taste and political institutions has determined the character of comedy in every nation in Europe, since the revival of letters. A nation, which once affected a proud solemnity of manners, and a romantic pride of sentiment, formed the model of its drama or intrigues full of incident, and on characters replete with hyperbole. Such is the Spanish theatre, their dramatic authors display a forced exaggeration, and a freedom of imagination, which violates all rules. Yet with these faults, added to a fondness for puerile conceits, and far fetched equivoques, Lope de Vega has attained to the first rank among modern poets. He unites the happiest discrimination of character to a strength of invention, which even Corneille could admire. He took from Lope the character of his Menteur, and he declares he would have given two of his best pieces to have imagined it.

The Italian comedy is strongly indicative of the disposition of the people. Points of honour, amours, revenge for falsehood in affairs of gallantry, furnish abundance of perilous intrigues for lovers, and of endless play for the coquetries of valets and waiting women. The rage of pantomime and caricature is conspicuous in all the comedies of the Italians, and they indulge it at the expense of their better judgment. Their plots are devoid of ingenuity, sense, and wit. There is hardly one among the immense collections of their pieces, which a man of taste would bear to read to the end. Indeed, the Italians at last began to be sensible of this, and Florence set the example of substituting for these miserable farces the best comedies of Moliere translated into Italian. Other states followed the example, and in all probability the French comedy will soon become general in Italy.

A nation, formerly counted the first in politeness and refinement, when every individual made it a duty to conform his sentiments and ideas to the manners of society, when prejudices were principles, and usages laws; this nation could afford few originals, its characters were softened by deference, and its vices palliated by good-breeding. The French comedy has, however, served to improve the English stage as much as the difference of manners would allow. Moliere is certainly a just model of comic excellence : he possesses that philosophic penetration, which seizes extremes as well as their intermediate degrees, and that power of contrast, which gives force to his painting, which the delicacy of his pencil might otherwise have lost.

In a country like ours, where every individual glories in his privilege of thinking for himself, originals must always abound. Hence the English comedy excels all others in strength of character, and in the true expression of nature : it is simple, consistent, and philosophical. The genius of Shakespeare has been considered by some as most happy in comedy ; the truth is, that in every department of the drama he is supreme. Clouds and mists may at times obscure him, but he is still the sun of the poetic hemisphere, and all other luminaries before his splendour must dwindle to the magnitude of stars.

The plays of his contemporary, Jonson, though antiquated and obsolete, contain sallies of the finest satire, and strokes of genuine comic humour. Those of Fletcher and Massinger, and of other poets of that age, had the merit of contributing to the advancement of our drama, and laid the foundation of its present excellence.

After a dark period of puritanical fanaticism, the English comedy revived in the reign of Charles II.; but the stage was but too faithful a mirror of his licentious court. The comedies of Dryden are tinged with this alloy; indeed, in other respects, they add little honour to the name of that poet. Those of Otway are too obscene to be acted, or even read. The comic muse of Congreve has been equally blamed for licentiousness and for exuberance of wit. The latter reproach may perhaps justly apply to the best comic productions of the present age.

Comedy has been divided into three kinds, according to the ends which it proposes. By pourtraying vice, it renders it contemptible, as tragedy renders crime odious: this is characteristic comedy. When men are represented as the sport of fortune, it is called incidental comedy. When the domestic virtues are drawn in amiable colours, and in situations where misfortune renders them interesting, it may be termed sentimental comedy.

The first of these is the most useful to manners, and at the same time the strongest, the most difficult, and of course the rarest. It traces vice to its source; it attacks it in its principle; it presents the mirror to mankind, and makes them blush at their own image. Hence it supposes in its author a consummate knowledge of human nature, a prompt and accurate discernment, and a vigour of fancy, which seizes at once what penetration could not comprehend in detail.

Incidental comedy is perhaps the most successful and popular, as it keeps the attention continually awake by lively and unexpected changes, and as it furnishes a source of amusement and mirth, when the sallies of wit might fail in their effect by too frequent recurrence, if not relieved by such aid.

Sentimental comedy is perhaps more useful to morals than even tragedy, as it excites a deeper interest, because the examples it holds forth affect us more nearly. But as the style of comedy can neither be sustained by the grandeur of objects, nor animated by the strength of incident and situation, as it should be at the same time familiar and interesting, there are two different extremes to be avoided—of being cold, and of being romantic. Simple nature is the true middle path, and it is the highest effort of art to be at the same time artful and natural.

A style of comedy superior to these is that which unites characteristic with incidental comedy. Here the characters are involved by the foibles of the mind and the vices of the heart in the most humiliating cross purposes, which expose them to the laughter and contempt of the audience. A happier specimen of this style could not be found than in the School for Scandal.

Such are the three kinds of comedy. There are others, which we have purposely omitted to enumerate. First, that obscene comedy, which is no longer suffered on the stage but by a sort of prescription, and which cannot excite a smile without raising a blush; secondly, that drama of false sentiment, the offspring of the German school, which once threatened to destroy our taste for genuine comedy, but which has now happily passed into oblivion; and, lastly, that comedy of low fun and pantomine trick, the feeble resource of minds without genius, talent, or taste, which it is the disgrace of the British stage of the present day to bring forward, and the reproach of the British public to tolerate and encourage.

COMET. See Astronomy.

COMETARIUM, a curious machine, exhibiting an idea of the revolution of a comet about the sun. It is contrived in such a manner, as by elliptical wheels to shew the unequal motion of a comet in every part of its orbit. The comet is represented by a small brass ball, carried by a wire, in an elliptic groove, about the sun in one of its foci, and the years of its period are shewn by an index moving with an equable motion over a graduated silver circle.

COMETES, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Tricoccæ. Essential character: involucre four-leaved, three-flowered; calyx four-leaved;

capsule tricoccous. One species, *viz.* C. alterniflora, an annual, and a native of Suratte.

COMMA, among grammarians, a point or character marked thus (,), serving to denote a short stop, and to divide the members of a period.

COMMANDANT, in the army, is that person who has the command of a garrison, fort, castle, regiment, company, &c.

COMMANDER, in the navy, an officer who has the command of a ship of war under 20 guns, a sloop of war, armed ship, or bomb-vessel. He is entitled Master and Commander, and ranks with a Major of the army.

COMMANDER *in Chief*, is the chief Admiral in any port, or on any station, appointed to hold the command over all other admirals within that jurisdiction.

COMMELINA, in botany, so called in honour of John and Casper Comelins, two famous Dutch botanists, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Junci, Jussieu. Essential character: corolla six-petalled; nectaries three, cross-shaped, pedicelled. There are twelve species, natives of warm climates.

COMMENDAM, in the ecclesiastical law, the trust or administration of the revenues of a benefice, given either to a layman to hold, by way of *depositum*, for six months, in order to repairs, &c. or to an ecclesiastic, or beneficed person, to perform the pastoral duties thereof, till once the benefice is provided with a regular incumbent.

Commendams were formerly a very laudable institution: for when an elective benefice became vacant, for which the ordinary could not, for some reason, immediately provide, the care of it was recommended to some man of merit, who took upon him the direction of it till the vacancy was filled up, but enjoyed none of the profits.

At length it became a maxim among the canonists, that a clerk might hold two benefices, the one titular, and the other in commendam: yet still the commendam was to continue only till other provisions were made; and afterwards they began to be given for a determinate time.

COMMENSURABLE, among geometricians, an appellation given to such quantities as are measured by one and the same common measure.

COMMENSURABLE *numbers*, whether integers or fractions, are such as can be measured or divided by some other number, without any remainder: such are 12 and 18, as being measured by 6 or 3.

COMMERCE, the exchange of the natural or artificial productions of a country for those of another, either by barter or by representative signs of their value: the most general representative of the value of other commodities being coin or bullion, the profits of commerce are frequently estimated by the quantity of money it brings into a country; but a very beneficial foreign trade may be carried on without any balance being payable in money, or the balance may be absorbed by payments on other accounts. The commerce of Great Britain has long been in a very flourishing state, and has become of unparalleled extent, but the quantity of coin and bullion in the country has not increased in any considerable degree.

Commerce, in a general point of view, is usually distinguished into two kinds, the commerce of import and of export; but there is little reason for this distinction, for whatever a nation imports, it must have paid an equivalent for to the country of which it is purchased, and consequently the two branches are intimately dependent, and could not exist separately for any considerable period.

The value obtained in foreign markets, for the goods or manufactures which a nation exports, repays the labour of procuring or manufacturing them, with a profit to the master manufacturer and to the exporting merchant; and this value being invested in foreign produce, which on importation affords a further profit to the merchant, it is evident that the transaction, while it supports individuals, makes a real addition to the wealth of the country, by the greater value of the returns imported beyond that of the goods exported. Commerce, therefore, while it is the means of procuring a mutual interchange of conveniencies between distant countries, and of extending knowledge and civilization over every part of the globe, contributes essentially to the strength and influence of the countries by which it is encouraged.

Superficial views on subjects of political economy have inclined princes and statesmen to the opinions, that wealth consisted principally in gold and silver, and that those metals could be brought into a country which had no mines only by the balance of trade, or by exporting to a greater value than it imported; commerce has therefore experienced public encouragement, and, agreeable to the principles on which its value has been estimated, the principal regulations have consisted in restraints upon importation, and encouragements to exportation. The duties and restrictions imposed by one country, either with the view of encouraging its trade and manufactures, or for the purpose of rendering commerce a source of public revenue, have, however, only created similar returns from other states, and the commerce of Europe has become a complicated system of high duties, drawbacks, prohibitions, and bounties, attended with much unnecessary expense, and holding out continual temptations to fraud and evasion. The impolicy and injustice of many of the existing restraints has been shewn by Dr. Adam Smith and others, and the prevalence of just sentiments of the reciprocal advantages of freedom of trade will render future commercial arrangements more liberal and beneficial.

Commercial intercourse was one of the earliest effects of the progress of civilization, but it was not till the gradual improvement of navigation had lessened the dangers of long voyages, that distant nations were enabled to exchange their surplus produce, and to enjoy the conveniencies and luxuries of foreign climes. The Egyptians, at a very early period, opened a trade with the western coast of the continent of India; but the Phenicians and the Carthaginians carried commerce to a much greater extent, the trading voyages of the latter extending not only to all the coasts of Spain and Gaul, but even to Britain. The commerce of the Greeks was confined to the ports of the Mediterranean till the foundation of Alexandria, which soon acquired the greater part of the trade with India, and became for a time the first commercial city in the world. The extent of the Roman empire, and the spirit of its government, gave facility and security to commercial transactions, and rendered Rome the metropolis of the commercial world till the fourth century, when the seat of empire was removed to Constantinople, which was thus made the emporium of commerce. Here it continued to flourish, even when the devastations of the Goths and Vandals had annihilated commercial intercourse in almost every other part of Europe, and a considerable trade with India was kept up, although, after the conquest of Egypt by the Arabians, it could only be carried on by a very tedious and difficult channel of conveyance.

The inhabitants of Italy who fled to the islands of the Adriatic, and founded the city of Venice, were led by their situation to the pursuit of commerce, which they carried on with success, and in no very great length of time became almost the sole carriers of the East Indian merchandize brought to Alexandria, which their vessels distributed to all parts of Europe. The example of Venice led to the cultivation of commerce at Genoa, Florence, Pisa, and other cities of Italy, which for several centuries were the only places in Europe that carried on any considerable foreign trade. The insecurity of property, during the unsettled state of Europe which succeeded the destruction of the western empire, caused an almost general suspension of commercial intercourse till the time of Charlemagne, whose extensive empire facilitated correspondence between different parts of Europe, which had before little connection, while the establishment of Christianity in Germany contributed to the increase of cities and towns in the north of Europe, and introduced an acquaintance with the productions of more southern climates.

The encouragement given to manufactures in Flanders, and their consequent improvement, drew the merchants of other countries to the fairs and markets established at Bruges, Courtray, and many other towns, which thus became of considerable importance, while a taste for the productions of the East was spreading through almost every part of Europe, acquired in Palestine during the crusades, and contributing very materially to the encouragement of foreign trade. The productions of India were, however, obtained at great risk and expense, till the improvement of navigation, by the invention of the mariner's compass, and the subsequent discovery of a passage to India by the Cape of Good Hope. This was soon followed by the still more important discovery of the West Indies, and the continent of America, events which filled Europe with astonishment, and opened a vast field for speculative and commercial enterprize. Spain and Portugal attempted to monopolize the benefits of the discovery of America, but their injudicious policy has rendered them little more than the channels, through which the profits of this trade have been conveyed to more industrious states.

The establishment of English colonies in North America, the improvement of manufactures in Flanders, Holland, France, and England, the encouragement of navigation, the institution of public banks, and the more general practice of insurance, favoured the extension of commerce, supplied it with new materials, and rendered it more secure. It has been protected, in all the states of Europe, by numerous laws and edicts; it has been encouraged by bounties and privileges, and commercial treaties have been formed between different nations for removing impediments, and facilitating a mutually beneficial intercourse. The commerce of Europe has thus expanded in a degree of which former times could have no idea, and while it has multiplied the luxuries and refinements of society, it has contributed essentially to the advancement of naval power, and been rendered by most states a fruitful source of public revenue.

Commerce *of Great Britain*. The unmanufactured commodities exported by England, for many centuries before the woollen manufacture had made any progress, were sufficient to procure the few foreign articles then in request, and also to bring a yearly balance of cash, by which some other branches of foreign trade were carried on to a small extent, and a beginning was made to the acquirement of commercial capital. The foreign trade of this country was, however, in its infancy, almost wholly in the hands of foreigners, who settled in London, and a few other ports, for the purpose of carrying on commerce with their respective countries; many of these merchants were Jews, whose profits must have been very considerable, to induce them to submit to the impositions to which they were frequently exposed. By degrees some of the inhabitants of London, and of the ports lying opposite to France and Flanders, began to build ships of their own, and to enter into competition with the alien merchants.

In the reign of Edward III. the exports of England consisted chiefly of wool, skins, hides, leather, butter, tin, and lead, of which wool was by far the most considerable, the quantity amounting to about 30,000 sacks of 26 stone each in a year. From a record in the Exchequer it appears, that in 1354 the exports of England amounted to 294,184*l.* 17*s.* 2*d.* the imports to 38,970*l.* 3*s.* 6*d.* money of that time. This is a great balance, considering that it arose almost wholly from the exportation of wool and other raw materials; but it is not very probable that the excess of the exports was usually so great as in this particular year. It was not till the middle of this century that the English began to extend their commercial voyages to the Baltic; nor till the middle of the subsequent century that they sailed to the Mediterranean.

The improvement of the woollen manufacture greatly increased the value of the exports, as France had not then engaged in this manufacture, and Holland had not carried it to any considerable extent; so that England enjoyed almost a monopoly of that manufacture, for the supply of the north and west parts of Europe, before the year 1640, Spain and Portugal being then almost entirely supplied from this country with light draperies, as well for their home consumption, as for that of their extensive colonies, from whence, in return, we then received sugar, tobacco, drugs, and other commodities, with which we are now supplied by our own colonies. In 1672 the Parliament repealed the duties payable by aliens on the exportation of the native commodities and manufactures of England, putting them in this respect on a level with English subjects. This salutary principle was further extended in 1700, by removing the duties on every kind of woollen goods and on all kinds of corn, grain, and meal, exported. Many subsequent events, as the establishment of the credit of the Bank, the union with Scotland, the consolidation of the two East Indian Companies, and the rapid improvement of the North American colonies, contributed materially to the advancement of the commerce of Great Britain: and Mr. Erasmus Philips, in his "State of the Nation in respect to her Commerce, &c." makes "the balance of England's trade, one year with another, to have been in our favour, on an average, or medium, 2,881,357*l.* from 1702 to 1712." This appears to have been somewhat beyond the truth, but it is certain that foreign trade was then gradually increasing, and it was greatly promoted by an act passed in 1722, for extending the principle which had been adopted with respect to woollen goods, by permitting the exportation, duty free, of all merchandize, the produce of Great Britain, (except a few particular articles) and the importation, duty free, of the materials for dying, essential to several manufactures.

From this period, the encouragement given to the fisheries in different parts, the increased cultivation of the West India islands, and the immense acquisitions of territory in the East Indies, have combined, with the increasing wealth and population of Great Britain, to extend its commercial transactions in all directions, and greatly to augment their former magnitude. The great increase of the national expenditure has caused most articles of foreign produce to be burthened with a variety of heavy duties, and subjected commerce to numerous restrictions and impediments; yet, under these disadvantages, it has of late years increased in an unparalleled degree, and in the year ending 5th January, 1807, produced a net revenue to government from the duties of customs, amounting to 7,774,049*l.* 4*s.* 9*d.* This large contribution from foreign trade evinces its present magnitude; but its total amount, as well as that of its several branches, will be more particularly shewn from the Custom-house accounts of the value of the commodities exported and imported. These accounts being formed according to the rates established in the year 1696, which, in most instances, are greatly below the present value of the articles, certainly give an adequate idea of the magnitude of the commerce of Great Britain; but this very circumstance renders them in a comparative view the more indisputable evidence of its increase.

Total Official value of the Imports and Exports of Great Britain, in the year 1805.

	Imports.	Exports.
Denmark and Norway	*L*1,071,479	*L*5,172,066
Russia	2,527,078	1,646,475
Sweden	269,161	159,597
Poland	429,450	80,500
Prussia	1,790,781	5,520,072
Germany	319,444	2,180,784
Holland	726,264	418,801
Flanders	3,070	23,343
France	469,820	551
Portugal and Madeira	936,500	1,495,814
Spain and Canaries	916,165	111,380
Streights and Gibraltar	42,919	183,823
Italy	393,517	507,535
Malta	9,304	127,514
Turkey	103,590	135,410
Ireland	3,010,609	3,758,973
Isle of Man	21,697	62,431
Guernsey, Jersey, &c.	81,241	198,324
Greenland	261,086	952
Total of Europe	13,383,275	21,784,345
America and West Indies	9,115,161	12,163,917
Asia	6,072,160	1,638,600
New Holland	153	30,643
Africa	105,976	980,789
Sierra Leone	867	10,660
Total	*L*29,177,592	*L*36,608,954

The commerce of Great Britain with the countries surrounding the Baltic has always been deemed of much importance, as being the principal means of procuring the stores necessary for the maintenance of its navy. The capital employed in this branch of trade must be much greater than formerly, from the increased price of hemp, iron, masts, and timber of all kinds, pitch, tar, and the other articles of import. The returns of this country are British manufactures of various kinds, East India goods, and West India produce.

The trade with Germany experienced a great augmentation about the year 1794, when it became the channel through which Holland, France, and other parts of the Continent, obtained the goods, which, in times of peace, they had usually imported direct from Great Britain. The port of Hamburgh for a time possessed he principal share of the of trade Europe, but the unusual flow of business in this direction encouraged a spirit of adventure and speculation, which in 1799 produced great embarrassment, involving not only the merchants of Hamburgh, but also some of the most considerable houses in Bremen, Frankfort, Amsterdam, and London. The trade with Germany, however, continued of great importance, till the influence of France obliged them to break off their intercourse with this country.

The trade with Holland and Flanders, one of the most ancient branches of the commerce of this country, has not increased in proportion with the trade to other parts: it is, however, still considerable in time of peace. The total value of the exports to Holland in 1792 was 1,516,449*l.*, in 1802 they amounted to 4,957,997*l.*

France, enjoying great natural advantages, and having for a long time many colonial possessions, had not occasion to receive much merchandize from this country. The frequent hostilities between the two countries has likewise prevented the formation of permanent commercial connections, but some intercourse of this kind always subsisted even in time of war, particularly with the ports of Calais, Bourdeaux, Havre, and Rouen, till the reign of Bonaparte, who resorted to a new mode of warfare, by prohibiting all intercourse whatever with Great Britain, even through the intervention of neutral vessels.

The commerce with Spain and Portugal has not of late years been of great extent; the export to the latter country, however, consisting almost wholly of British produce and manufactures, has generally been considered a valuable branch of foreign trade, and measures have been frequently adopted for its preservation. In 1801, when Portugal was threatened with invasion, the wines of that country were allowed to be imported and warehoused, on bond being given for the payment of the duty when taken out for consumption. The removal of the government to the Brazils, and subjugation of the country by the French, must cause a great revolution in this branch of trade.

The Mediterranean trade suffered great interruption from the war which began in 1793; and in the war of 1803, it was reduced to little more than the supply of the islands of Sicily and Malta.

The exports to the coast of Africa must experience a considerable diminution from the abolition of the slave trade, till a more reputable species of traffic is cultivated with the inhabitants of that extensive continent, who will be induced to furnish a greater quantity of their native commodities, in order to procure the cheap manufactures and luxuries to which they have been accustomed.

The East India trade has always been deemed very lucrative; but from the risks of such a distant voyage, the necessity of a large capital, and other circumstances, most of the states of Europe have deemed it expedient to vest this trade in the hands of an exclusive company. From about the year 1750, the mercantile concerns of the English East India Company have become blended with the revenues derived from the territorial possessions which they have acquired in India, and which have been augmented to an immense extent, as the nett amount of these revenues, as well as the fortunes acquired by their officers and servants, are invested in merchandise, in order to be remitted to Great Britain. The imports of the Company have therefore increased very considerably, and in the year 1797, Mr. Irving, the inspector general of imports and exports, gave his opinion, that, including the private trade of individuals, carried on through the medium of the Company, and the proceeds of the territorial revenues, Great Britain derived an actual profit from the East India trade of about 2,300,000*l.* per annum. The principal articles imported from the East Indies are, from China, teas, nankeen cloths, and raw silk; from Bengal, piece goods of various kinds, raw silk, pepper, saltpetre, spices, drugs, sugar, coffee, &c. The total value of all the goods sold at the Company's sales, in the year ending 1st March, 1806, was 8,781,442*l.*

The West India trade, in the year 1787, employed about 130,000 tons of shipping; and in the year 1804, above 180,000 tons, navigated by 14,000 seamen. In 14 years, ending 1804, the value of the imports had increased nine millions sterling, and the revenue derived from them had increased above three and a half millions, including the conquered colonies; but, exclusive of these, the imports from the West Indies were about a fourth of the whole imports of Great Britain. This branch of trade is however subject to great fluctuations, of which a remarkable instance has occurred since the year 1792. The destruction of St. Domingo, the most productive sugar colony in the world, gave a new aspect to British West Indian affairs. A yearly quantity of above 110,000 hogsheads being thus suddenly taken out of the market, the prices rose to an unusual height. The confusion which took place in Guadaloupe soon after, and the operations of the war in the West Indies, diminished the supply, and raised the price of produce still further. This of course became a great inducement to increase the cultivation of the British islands, and of those recently conquered, while, about the same time, the introduction of the Bourbon cane enabled even the bad lands of the old islands to produce plentiful crops of sugar. From these causes the quantity of sugar has been constantly and rapidly increasing since 1792; the blank occasioned in that year has been filled up, and a great surplus has been added to the ordinary produce of former periods. The produce of the Spanish islands during the same period has increased rapidly. These circumstances caused a sudden decline in the price of sugar, which became unusually low in 1807, and, combined with the interruption of the export trade to the continent of Europe, reduced the West India merchants and planters to great difficulties.

The American war was regarded by many persons as involving, in a great measure, the ruin of the foreign commerce of Great Britain. Since the establishment of the independence of the American States, however, experience has proved that we derive a much greater benefit from that country than heretofore, as we now take from them no more than it is our interest to take, while, from having but little capital, and much employment at home, it must be many years before they can attempt to rival us in any considerable branch of foreign trade. The exports to America consist almost wholly of British manufactures, the official value of which in the year 1800 was 6,885,507*l.*; the imports are, tobacco, rice, corn, and other unmanufactured produce. A very considerable trade is also carried on between the United States and the British West India islands, which is considered as almost essential to the support of the latter. The trade with the remaining British possessions in North America is not of great extent; the principal branches of it are, the fur trade of Canada, Hudson's Bay, and the Newfoundland fishery.

The total amount of the exports and imports sufficiently proves, that the mercantile shipping of Great Britain must be greatly increased beyond what was employed in former periods. The total number of vessels that entered inwards, and cleared out, with their tonnage, and the number of men and boys usually employed in navigating the same, as shewn in the following statement for three years, ending the 5th January, 1807, will furnish a correct idea of the extent of shipping employed in the commerce of Great Britain.

	INWARDS.			OUTWARDS.		
	Ships.	Tons.	Men.	Ships.	Tons.	Men.
1804	14,779	2,002,686	113,723	15,224	2,051,135	124,255
1805	15,931	2,186,173	121,899	15,540	2,101,030	125,332
1806	15,911	2,095,568	120,342	15,710	2,054,472	124,189

By the act imposing a duty on all sea assurances, as well as by the act for establishing the convoy duty, the extent and value of the foreign trade of this country has been more clearly ascertained than heretofore, and it appears that the capital employed in commerce cannot be less than 80,000,000*l.* The annual profit derived from it has been variously estimated, but, according to the best authority, it appeared, in the year 1797, to be about 10,500,000*l.* per annum.

COMMERSONIA, in botany, so called in memory of M. Commerson, the French traveller, a genus of the Pentandria Pentagynia. Essential character: calyx one-leafed, bearing the corolla; petals five; nectary five-parted; capsule five-celled, echinate. One species, a native of Otaheite and the other Society Isles.

COMMISSARY, in the ecclesiastical law, an officer of the Bishop, who exercises spiritual jurisdiction in places of a diocese so far from the episcopal see, that the chancellor cannot call the people to the bishop's principal consistory court, without giving them too much inconveniency.

COMMISSARY *general of the musters*, an officer appointed to muster the army, as often as the general thinks proper, in order to know the strength of each regiment and company, to receive and inspect the muster rolls, and to keep an exact state of the strength of the army.

Commissary *general of stores*, an officer in the artillery, who has the charge of all the stores, for which he is accountable to the office of ordnance.

Commissary *general of provisions*, an officer who has the inspection of the bread and provisions of the army.

COMMISSION, in common law, the warrant or letters patent which all persons exercising jurisdiction have, to empower them to hear or determine any cause or suit: as the commission of the judges, &c. Most of the great officers, judicial and ministerial, of the realm are made also by commission; by means of commission, oaths, cognizance of fines, answers in chancery, &c. are taken; witnesses examined, offices found, &c.

Commission *of bankruptcy*, is the commission that issues from the Lord Chancellor, on a person's becoming a bankrupt within any of the statutes, directed to certain commissioners appointed to examine into it, and to secure the bankrupt's lands and effects, for the satisfaction of his creditors.

Commissioners, *Lords, of the Admiralty*, are five or seven persons appointed by the crown, for executing the office of Lord High Admiral, to whose jurisdiction all maritime affairs are entrusted. See Admiralty court.

Commissioners *of the Navy*, officers appointed to superintend the affairs of the marine, under the direction of the Lords of the Admiralty. Their duty is more immediately concerned in the building and repairing ships; they have also the appointment of certain officers.

COMMITMENT, in law, the sending of a person charged with some crime to prison, by warrant or order. A commitment may be made by the King and council, by the judges of the law, the justices of peace, or other magistrates, who have authority by the laws and statutes of the realm so to do. Every commitment should be made by warrant, under the hand and seal of the party committing, and the cause of commitment is to be expressed in the warrant. The terms of it must also require the criminal to be kept in custody till discharged according to due course of law, &c. Wheresoever a constable or person may justify the arresting another for a felony, or treason, he may justify the sending him or bringing him to the common gaol. But it is most advisable, for any private person, who arrests another for felony, to cause him to be brought as soon as possible before some justice of peace, that he may be committed or bailed by him. The privy-council, or any two of them, or a Secretary of State, may lawfully commit persons for treason, and for other offences against the state. All felons shall be committed to the common gaol, and not elsewhere. 5 Hen. IV. c. 10. But vagrants and other criminals, offenders, and persons charged with small offences, may, for such offences, or for want of sureties, be committed either to the common gaol or house of correction, as the justices in their judgment shall think proper. 6 G. c. 19. All persons who are apprehended for offences not bailable, and those who neglect to offer bail for offences which are bailable, must be committed; and wheresoever a justice of peace is empowered to bind a person over, or to cause him to do a certain thing, he may commit him, if in his presence he shall refuse to be so bound, or do such a thing. A commitment must be in writing, either in the name of the King, and only tested by the person who makes it; or it may be made by such person in his own name, expressing his office or authority, and must be directed to the gaoler or keeper of the prison. The commitment should contain the name and surname of the party committed, if known; if not known, it may be sufficient to describe the person by his age, &c. and to add, that he refuses to tell his name. It ought to contain the cause, as for treason or felony, or suspicion thereof; and also the special nature of the felony, briefly, as for felony, for the death of such an one, or for burglary, in breaking the house of of such an one. All commitments, grounded on acts of parliament, ought to be conformable to the method prescribed by them. And where a statute appoints imprisonment, but does not limit the time, in such case the prisoner must remain at the discretion of the court. If the goaler shall refuse to receive a felon, or take any thing for receiving him, he shall be punished for the same by the justices of gaol delivery. But no person can justify the detaining a prisoner in custody, out of the common gaol, unless there be some particular reason for so doing; as if the party should be so dangerously ill, that it would apparently hazard his life to send him to gaol, or that there be evident danger of a rescue from rebels, or the like. The sheriff or gaoler shall certify the commitment to the next gaol delivery.

Commitment *discharged.* A person legally committed, for a crime, certainly appearing to have been done by some person or other, cannot be lawfully discharged but by the king, till he be acquitted upon his trial, or have an *ignoramus* found by the grand jury, or none shall prosecute him, on a proclamation for that purpose by the justices of gaol delivery.

COMMITTEE *of Parliament,* a certain number of members appointed by the House for the examination of a bill, making report of an inquiry, process of the house, &c. When a parliament is called, and the speaker and members have taken the oaths, there are committees appointed to sit on certain days, *viz.* the committee of privileges and elections, of religion, of trade, &c. which are standing committees. Sometimes the whole House resolves itself into a committee, on which occasion each person has a right to speak and reply as often as he pleases, which is not the case when a house is not in a committee.

COMMODORE, in maritime affairs, an officer of the British navy, commissioned by the Lords of the Admiralty, or by an admiral, to command a squadron of men of war in chief; during which time he bears the rank of brigadier-general in the army, and is distinguished from the inferior ships of his squadron by a broad red flag, or pendant, tapering towards the outer end, and sometimes forked. The title Commodore is given by courtesy to the senior captain, where three or more ships of war are cruizing in company. The word is also used to denote the convoy ship in a fleet of merchantmen, who carries a light in his top, to conduct the rest, and keep them together.

COMMON, is a right of privilege which one or more persons claim to take or use, in some part or portion of that, which another man's lands, waters, woods, &c. naturally produce, without having an absolute property in such lands, woods, waters, &c.

Common *law,* that body of rules received as law in England, before any statute was enacted in parliament to alter the same.

The common law is grounded upon the general customs of the realm, including the law of nature, the law of God, and the principles and maxims of law; it is also founded on reason, as said to be the perfection of reason, acquired by long study, observation, and experience, and refined by the learned in all ages. It may likewise be said to be the common birthright that the subject has for the safeguard and defence not only of his goods, lands, and revenues, but of his wife, children, life, fame, &c. Our common law, it is said, after the heptarchy, was collected together into a body by divers of our ancient kings, who commanded that it should be observed through the kingdom; and it was therefore called common law, because it was common to the whole nation, and before only affected certain parts thereof, being anciently called the sole right, that is the right of the people.

The common law of England is, properly, the common customs of this kingdom; which, by length of time, have obtained the force of laws. The goodness of a custom depends upon its having been used time out of mind; or, in the solemnity of our legal phrase, time whereof the memory of man runneth not to the contrary. This gives it its weight and authority; and of this nature are the maxims and customs which compose the common law, or *lex non scripta,* of this kingdom. This unwritten, or common law, is properly distinguished into three kinds: 1. General customs, which are the universal rule of the whole kingdom, and form the common law in its stricter and more useful signification. 2. Particular customs, which, for the most part, affect only the inhabitants of particular districts. 3. Certain particular laws, which by custom are adopted and used by some particular courts of pretty general and extensive jurisdiction.

Common *place book,* among the learned, denotes a register of what things occur worthy to be noted in the course of a man's study, so disposed as that, among a number of subjects, any one may be easily found. Several persons have their several methods of ordering them; but that which is best recommended is Mr. Locke's method, which he has published in a letter to Mr. Toisnard, determined thereto by the great conveniency and advantage he had found from it in twenty years experience. The substance of this method is as follows:

The first page of the book, or, for more room, the two first pages fronting each other, are to serve for a kind of index to the whole, and contain references to every place or matter therein; in the commodious contrivance of this, so as it may admit of a sufficient variety of materials, without confusion, all the secret of the method consists. The manner of it, as laid down by Mr. Locke, will be conceived from the following specimen, wherein what is to be done in the book for all the letters of the alphabet is here shewn in the first four.

A	*a*	
	e	
	i	
	o	
	u	
B	*a*	
	e	2. 3.
	i	
	o	
	u	
C	*a*	
	e	
	i	
	o	
	u	
D	*a*	
	e	
	i	
	o	
	u	

The index of the common place book being thus formed, it is ready for the taking down any thing therein.

In order to this, consider to what head the thing you would enter is most naturally referred, and under which one would be led to look for such a thing; in this head or word regard is to be had to the initial letter, and the first vowel that follows it; which are the characteristic letters whereon all the use of the index depends.

Suppose, *e. g.* I would enter down a passage that refers to the head beauty; B, I consider, is the initial letter, and *e* the first vowel; then looking upon the index for the partition B, and therein the line *e* (which is the place for all words whose initial is B, and the first vowel *e*; as beauty, beneficence, bread, bleeding, blemishes, &c.) and finding no numbers already wrote to direct me to any page of the book where words of that characteristic have been entered, I turn forward to the first blank page I find, which, in a fresh book, as this is supposed to be, will be page 2, and here write what I have occasion for on the head beauty; beginning the head in the margin, and indenting all the other subservient lines, that the head may stand out and shew itself; this done, I enter the page where it is wrote, *viz.* 2, in the space B *e*: from which time the class B *e* becomes wholly in possession of the second and third pages, which are consigned to letters of this characteristic.

Note. If the head be a monosyllable beginning with a vowel, the vowel is at the same time both the initial letter and the characteristic vowel; thus the word Art is to be wrote in A *a*. Mr. Locke omits three letters of the alphabet in his index, *viz.* K, Y, and W, which are supplied by C, I, and U, equivalent to them: and as for Q, since it is always followed by an *u*, he puts it in the first place of Z: and so has no Z *u*, which is a characteristic that very rarely occurs. By thus making Q the last of the index, its regularity is preserved, without diminishing its extent. Others choose to retain the class Z *u*, and assign a place for Q *u* below the index.

If any imagine these hundred classes are not sufficient to comprehend all kinds of subjects without confusion, he may follow the same method, and yet augment the number to 500, by taking in one more characteristic to them.

But the inventor assures us, that in all his collections, for a long series of years, he never found any deficiency in the index as above laid down.

COMMON *Pleas* is one of the King's courts now held constantly in Westminster Hall, but in former times was moveable. All civil causes, as well real as personal, are, or were formerly, tried in this court, according to the strict law of the land. In personal and mixed actions it has a concurrent jurisdiction with the King's Bench, but has no cognizance of pleas of the crown. The actions belonging to the Court of Common Pleas come thither by original, as arrests and outlawries; or by privilege or attachment for or against privileged persons; or out of inferior courts, not of record, by pone, recordari, accedas ad curiam, writ of false judgment, &c. The chief judge of this court is called Lord Chief Justice of the Common Pleas, who is assisted by three other judges: the other officers of the court are, the custos brevium, who is the chief clerk; three prothonotaries and their secondaries; the clerk of the warrants, clerk of the essoins, fourteen filazers, four exigentors, a clerk of the juries, the chirographer, the clerk of the King's silver, clerk of the treasury, clerk of the seal, clerk of the outlawries, clerk of the inrolment of nes and recoveries, and clerk of the errors.

COMMON *prayer* is the liturgy in the Church of England. Clergymen are to use the public form of prayers prescribed by the Book of Common Prayer; and refusing to do so, or using any other public prayers, are punishable by 1 Eliz. c. ii.

COMMON, in grammar, denotes the gender of nouns, which are equally applicable to both sexes; thus parens, a parent, is of the common gender.

COMMON, in geometry, is applied to an angle, line, or the like, which belongs equally to two figures.

COMMON *divisor*, a quantity or number which exactly divides two or more other quantities or numbers, without leaving any remainder.

COMMON *measure*, is such a number as exactly measures two or more numbers without a remainder.

COMMON, *greatest*, *measure*, of two or more numbers, is the greatest number that can measure them: as 4 is the greatest common measure of 8 and 12.

COMMONS, in a general sense, consist of all such men of property in the kingdom, as have not seats in the House of Lords, every one of whom has a voice in parliament, either personally, or by his representatives. In a free state, says judge Blackstone, every man, who is supposed a free agent, ought to be in some measure his own governor, and therefore a branch, at least, of the legislative power should reside in the whole body of the people. In so large a state as ours, it is therefore wisely contrived, that the people should do that by their representatives, which it is impracticable to perform in person; representatives chosen by a number of minute and separate districts, wherein all the voters are, or easily may be, distinguished.

COMMONS, in parliament, are the lower house, consisting of knights elected by the counties, and of citizens and burgesses by the cities and borough towns. In these elections, anciently, all the people had votes; but in the 8th and 10th of King Henry VI. for avoiding tumults, laws were enacted, that none should vote for knights but such as were freeholders, did reside in the county, and had forty shillings yearly revenue, equivalent to near 20*l.* a year of our present money: the persons elected for counties to be *milites notabiles*, at least esquires, or gentlemen fit for knight-hood; native Englishmen, at least naturalized; and twenty-one years of age; no judge, sheriff, or ecclesiastical person, to sit in the House for county, city, or borough.

The House of Commons, in Fortescue's time, who wrote during the reign of Henry VI. consisted of upwards of 300 members: In Sir Edward Coke's time their number amounted to 493. At the time of the union with Scotland, in 1707, there were 513 members for England and Wales, to which 45 representatives for Scotland were added: so that the whole number of members amounted to 558. In consequence of the union with Ireland in 1801, 100 members were added for that country; and the whole House of Commons now consists of 658 members.

COMMONS, *Doctors*. See COLLEGE *of Civilians*.

COMMUNIBUS *locis*, a Latin term, frequently used by philosophical writers, implying some medium or common relation between several places. Thus Dr. Keil supposes the ocean to be one quarter of a mile deep, *communibus locis*, that is, at a medium, or taking one place with another.

COMMUNIBUS *annis* has the same meaning with regard to time, that *communibus locis* has with regard to places.

COMMUNICATION *of motion*, the act whereby a body at rest is put into motion by a moving body; or it is the acceleration of motion in a body already moving. See MECHANICS.

COMMUTATION, in law, the change of a penalty or punishment from a greater to a less; as when death is commuted for banishment, &c.

COMOCLADIA, in botany, a genus of the Triandria Monogynia class and order. Natural order of Terebintaceæ, Jussieu. Essential character: calyx three-parted; corolla three-parted; drupe oblong, with a two-lobed nucleus. There are three species, natives of the West-Indies.

COMPANY, in commerce, an association formed for carrying on some branch of trade which requires a greater capital than private traders can usually command, or which is liable to engagements to which individual responsibility is deemed inadequate. In the infancy of commerce, almost every branch of foreign trade was carried on by a particular company, which generally possessed exclusive privileges; and such institutions were then necessary and beneficial; but in modern times, when individuals have accumulated larger capitals, and the improvement of navigation facilitated commercial intercourse with all parts of the world, and the general practice of insurance reduced the risk of foreign voyages to a regular addition to the cost of commodities, there are very few branches of foreign trade, which cannot be more advantageously carried on by individuals, or private co-partnerships, than by public companies.

When companies do not trade upon a common stock, but are obliged to admit any person properly qualified upon paying a certain fine, and agreeing to submit to the regulations of the company, each member trading upon his own stock, and at his own risk, they are called regulated companies. When they trade upon a joint stock, each member sharing in the common profit or loss in proportion to his share in this stock, they are called joint stock companies. The regulated companies for foreign trade, which at present subsist in Great Britain, are, the African Company, the Turkey, or Levant Company, the Russia Company, and the Eastland Company; they have, however, little more than a nominal existence, as any person may freely trade to these parts, without being a member of any company, on paying a very small additional duty. The principal joint stock companies for foreign trade are, the East India Company, and the Hudson's Bay Company; the South Sea Company has long given up its commercial undertakings, and the Sierra Leone Company has not yet acquired much importance. There is, however, a multitude of joint-stock companies established, some with exclusive privileges, but in general without any such advantage, for carrying on the banking business, for the different kinds of insurance, for granting and purchasing annuities, for making docks, navigable canals, tunnels, roads, or rail-ways, and for working mines.

The utility of joint-stock companies for many of these purposes, and the success which some of them have experienced, has frequently produced a disposition for the multiplication of such establishments, and an opinion that they might be extended to almost every branch of trade and manufactures. The rage for forming public companies was, in 1720, carried to a degree of infatuation, which led thousands to subscribe to projects the most useless or impracticable, and gave rise to such a spirit of speculation and stock-jobbing as rendered necessary the interference of parliament. In consequence of the act then passed, 6 Geo. I. c. 18, upwards of two hundred projected companies ended in the loss and disappointment of their respective subscribers. The recollection of this circumstance prevented for many years any similar attempts, till the frequency of subscriptions for making canals shewed the facility of raising large sums in this manner for any public undertakings, and led to the formation of joint stock companies for other purposes. In the course of the year 1807 proposals were circulated for establishing six new insurance companies; seven subscription breweries: four public distilleries; five genuine wine companies; two vinegar manufactories; a corn, flour, and provision company; a united public dairy; a new medical laboratory for the sale of genuine medicines; three coal companies; a clothing company; a linen company; a united woollen company; a paper company; two or three copper companies; a national light and heat company; two new banks; two commission sale companies; and a company for purchasing canal shares, and lending money for completing canals. On the Attorney General proceeding against one or two of these intended companies, most of the others were abandoned.

Company, *East India*, was established by a charter from Queen Elizabeth, dated 31st December, 1600, which, though not confirmed by act of parliament, was then considered as conferring an absolute exclusive privilege. Under this authority, the members of the company traded, for about twelve years, on their separate capitals, which, in 1613, they united into a joint-stock. In the reign of James I. the company obtained a new charter, and enlarged their capital to 1,500,000*l.*; their profits at this time were not very great; and in the year 1655, Cromwell dissolved the Company and laid open the trade, but the mischief which followed obliged him to re-establish it about three years after. New charters were granted to the Company in 1661, 1669, and 1676, confirming all their former privileges; but as these privileges were derived merely from royal charters, without the sanction of parliament, their exclusive right began to be questioned, and individuals frequently endeavoured to participate in a commerce which had become very advantageous. These private adventurers increasing in number, the Company, in 1683, found means to obtain another charter, by which all former charters were confirmed, and they were empowered to seize the ships and merchandize of individual traders, to maintain military forces, and to establish a court of judicature. They were soon after involved in war with the Mogul, and other embarrassments, which were attempted to be rectified by the oft tried expedient of a new charter; and being thus armed with new powers, they endeavoured to exclude effectually all individuals from interfering in the trade. In 1693, the charter of the Company became void, from default in payment of the tax imposed on their stock, but it was renewed, upon condition of being determinable upon three years notice.

The Company having sustained great losses during the war with France, and fallen into disrepute, a proposal was made in 1698, by Mr. Samuel Shepherd, and a number of other merchants, to advance for the public service 2,000,000*l.* at 8 per cent. interest, provided the sole exclusive trade to India was settled on them; the proposal was accepted, and a new company established by authority of parliament, and incorporated by charter, under the title of the English Company trading to the East Indies. The contentions and emulation between the old and new Companies was so great, that it became necessary, even for the sake of public tranquillity, to unite them: this was partly effected in 1702, and in 1708 the two Companies were, by act of parliament, perfectly consolidated, under their present title of the United Company of Merchants of England trading to the East Indies. On the extension of the term of their exclusive trade to three years notice after Lady Day 1726, they lent to government the further sum of 1,200,000*l.* without receiving any additional interest, and as it was necessary to raise this sum by the sale of new stock, the capital of the company thus became 3,200,000*l.*

In 1712 the term of the company's exclusive trade was extended to three years notice after Lady Day 1733; which by a subsequent agreement was prolonged to 1766; and again, to three years notice after Lady Day 1780, with a provision, that if their exclusive privileges should be then determined, by the re-payment of all sums which they had lent to government, with all arrears of interest, the Company should still remain a corporation for ever, and enjoy the East India trade in common with all other subjects.

The interference of the Company, about the year 1750, in the contentions between some of the native princes, led to the acquirement of considerable territories, and laid the foundation of the extensive political authority which the Company now possess, and which comprehends dominions of greater extent than three times the area of the united kingdoms of Great Britain and Ireland.

On an average of 16 years preceding 1757, at which time the Company derived little assistance from territorial revenues, the annual sales of their imports amounted to about 2,055,000*l.*; and for the same period their exported goods and stores amounted annually, at their prime cost, to 238,000*l.*; the bullion exported to 690,000*l.*; and they paid in discharge of bills of exchange 190,000*l.* During the succeeding ten years the sales of imports became increased to 2,150,000*l.* annually on the average, the quantity of bullion exported was reduced to about 120,000*l.* per annum, but the exports in goods and stores, and the money raised by bills of exchange were increased in a greater ratio compared with the returns from abroad. From 1767 to 1777 the export of goods was 490,000*l.*; in bullion about 110,000*l.*; the sums raised by bills 458,000*l.* per annum; and by the aid afforded from the revenues, the investments were increased so as to produce about 3,300,000*l.* per annum; the affairs of the Company, during this period were however far from being in a flourishing situation; they were under the necessity of reducing their dividend, and of applying to parliament for assistance; but these difficulties being removed, the dividend, in 1778, was raised again to 8 per cent.

In the seven years ending with 1784, the average sales of the imports of the Company, notwithstanding the expensive war in which they were engaged, fell off in the proportion only of about 200,000*l.* annually; the export in bullion was for that period very trifling, but the goods and stores exported were increased to about half a million. The termination of the war left the Company's affairs both at home and abroad in great derangement, and the discussions which followed produced a general conviction, that some new arrangement was necessary for the future government of their extensive territorial acquisitions. The principal measure adopted was the establishment of a board of control, composed of a certain number of commissioners appointed by the king, and removeable at his pleasure. This board was authorised to check, superintend and control, the civil and military government and revenues of the Company, and to inspect the dispatches transmitted by the Directors to the different presidencies. The appointment of the Governor-general, President, or Counsellors in the differentprecidencieswas made subject to the approbation and recall of his Majesty; and a tribunal was created for the trial of Indian delinquents. Some further regulations were adopted in 1786, the chief of which were, bestowing on the Governor-general of India the high prerogative, of deciding in opposition to the sense of the majority of the council; and uniting the offices of Commander in Chief and Governor-general in the same person. The Company were empowered to increase their capital, by creating 800,000*l.* new stock, for which they obtained 1,240,000*l.* at the rate of 155 per cent.; and in 1789 they were authorised to add a million to their capital, which was effected at the rate of 174 per cent. and preference was given to such persons as were stockholders at the time of subscription. Their annual dividend at this time was 8 per cent. and continued at this rate till 1793, when, in pursuance of an agreement with government for the renewal of their charter, another million was added to their capital, which thus became 6,000,000*l.* and the dividend was raised to 10½ per cent.

By the agreement in 1793, the term of their exclusive trade was continued, under various regulations, for 20 years from the 1st of March, 1794, with the former proviso, that if, after the expiration of that term, their right to the sole trade shall cease, in consequence of three years previous notice being given by parliament, and the repayment of such sums as may be then due from the public, they shall continue a corporation notwithstanding, with power to carry on a free trade in common with other persons.

The Company is under the management of twenty-four directors, elected by the proprietors of the Company's stock, who hold 1000*l.* or upwards. Such proprietors are likewise entitled to vote, on all occasions, in the quarterly and special general courts of the Company.

Company, *South Sea.* The scheme for satisfying the national deficiencies by the establishment of this Company was arranged and brought forward in 1711, by Mr. Harley, then chancellor of the Exchequer, and the opinion of its efficacy for retrieving the languishing state of public credit was so great, that upon his being created Earl of Oxford, this service was particularly mentioned in the patent as one of the chief reasons for advancing him to that honour. It certainly afforded considerable relief to government, by consolidating a variety of debts and arrears of interest, and making a general provision for them, which the expectation of gain from the commercial undertakings of the Company induced the proprietors readily to accept. These debts and deficiencies formed the first capital of the Company, which amounted to 9,177,967*l.* 15*s.* 4*d.* including half a million raised towards the current services of the year. In 1715 their capital was increased to 10,000,000*l.* and in 1719 to 11,746,844*l* 8*s.* 10*d.*; but as all the sums thus subscribed into South Sea stock consisted of public debts, which were thus transferred from the individual proprietors of them to the company, it became necessary for the company to borrow money on bonds, to enable them to undertake their ostensible object of trade to South America.

In 1720, the Company engaged in one of the most memorable projects ever attempted in Great Britain. It was founded upon an agreement with government, authorizing the Company to take in, either by subscription or purchase, all the public debts, at such prices as they could agree upon with the respective proprietors; and they were empowered to raise the money which would be necessary for making these purchases, either by calls upon their members, by annuities, bonds, or bills, or by opening subscriptions for new stock. It is difficult to conceive how the Company could expect to derive such permanent advantages from this transaction, as would support any considerable increase of their dividend; yet the expectation of great profits was so general, as to excite the most extensive, though the most extravagant, infatuation that was ever known in money transactions in this country. South Sea Stock was soon sold at double the sum that had been paid in upon it, and in the course of a short time reached the enormous price of 1000 per cent. The rapidity of its fall, however, exceeded that by which it rose; for, before the end of the year, the difference of price was more than 800 per cent. in the course of only three weeks, by which thousands of persons suffered very severe losses, and many were entirely ruined.

The only branches of trade in which the Company ever engaged were, in supplying the Spanish colonies in America with negroes, and the Greenland whale-fishery. In both these undertakings the Company were considerable losers; in consequence of which, in 1748, they gave up the contract with Spain, and from that period have not carried on any branch of commerce whatever, their whole business being confined to transferring and paying the dividends on the public funds, known by the title of South Sea Stock, Old and New South Sea Annuities, and South Sea Annuities of 1751.

The company is under the management of three governors and twenty-one directors. The whole expense of managing the concern in the year ending the 5th of January, 1807, was 10,727*l.* of which 3,692*l.* was paid to the sub and deputy governors and directors, and 4,735*l.* to 36 officers and clerks employed by them. The sum annually paid by the public to the South Sea Company is 14,713*l.* 10*s.* 6*d.* and about 70*l.* for fees and allowances to the cashier.

COMPANY, *Hudson's Bay*, was established in 1670, by charter, granted by Charles II. to his cousin Prince Rupert, and seventeen other persons of distinction, who were incorporated for carrying on an exclusive trade to all parts of Hudson's Bay, and invested with great powers and privileges. The establishment excited the jealousy of the French, who in 1686 seized on all their forts or factories, except that at Port Nelson: they were, however, retaken in 1693; but they have been annoyed by the same power at several subsequent periods: and in 1782 a French squadron, under La Perouse, destroyed the settlements, forts, merchandise, &c. of the company, to the supposed value of about 500,000*l.* sterling, but without retaining possession of the place.

The Company's charter not being confirmed by parliament, they have no right in law to an exclusive trade; but the nature of the trade is such, that private adventurers cannot engage in it in competition with them. The Company is under the direction of a governor, deputy governor, and a committee of seven members: their capital stock is said not to exceed 110,000*l.* which is in the hands of a very small number of proprietors.

COMPANY, *Sierra Leone*, was instituted in the year 1791, with a capital of about 230,000*l.* The general object of the subscribers was the introduction of civilization into Africa, for effecting which end they proposed to establish a secure factory at Sierra Leone, with the view to a new trade in produce, chiefly with the interior of the country; but the reception into the settlement of near 1200 blacks from Nova Scotia, in March, 1792, produced much embarrassment, which was increased in 1793 by the war, which interrupted their trade, and subjected them to depredations. In 1794 the colony was attacked and taken by the French, who destroyed every description of property belonging to the Company, by which they sustained a loss of about 52,000*l.* In 1798, however, the colony had so far recovered as to contain about 1200 inhabitants: the heads of families were about 300; of whom about one half were supported by their farms, many were mechanics, about 15 were retail shopkeepers, 20 or 25 followed the busines of fishing, 10 or 15 traded in small vessels of their own, 4 were employed as schoolmasters, 12 or 15 as seamen, and about 20 as labourers under the Company: from 3 to 400 native labourers worked in the settlement for hire, chiefly on the farms, which were increasing rapidly.

Further difficulties and losses have been experienced, from an insurrection of the Nova Scotians in 1800, and an attack of some of the neighbouring tribes in 1801, but the colony is now possessed of more effectual means of defence, and a great impediment to its progress has been done away by the abolition of the slave trade.

COMPANY, *Dutch East India*. This once celebrated establishment was formed by the union of a number of separate companies in 1602: it carried on for many years a very flourishing trade, which has since declined very rapidly, particularly from about the year 1770, and in 1799 it was entirely suspended. The Dutch have likewise had West India Companies, a Levant Company, Companies for the Baltic sea, the whale fishery, &c.

COMPANY, *French East India*, was established in 1664, but never became of much importance. In 1769 the trade was laid open. A new Company was established in 1785, but was abolished in 1790. The other commercial Companies of France were, principally, a West India Company, a St. Domingo Company, the Senegal Company, the Mississippi Company, the Company of the West, and the Bastion Company.

COMPANY, *Danith East India*, and also the Swedish East Company, still possess a share in the commerce of the East, although it is not very considerable.

COMPANY, in military affairs, a small body of foot commanded by a captain, who has under him a lieutenant and ensign.

The number of centinels, or private soldiers, in a company, may be from 50 to 80; and a battalion conssists of thirteen such companies, one of which is always grenadiers, and posted on the right: next them stand the eldest company, and on the left the second company; the youngest one being always posted in the center.

Companies not incorporated into regiments are called irregulars, or independent companies.

COMPANY *of ships*, a fleet of merchanmen, who make a charter party among themselves, the principal conditions whereof usually are, that certain vessels shall be acknowledged admiral, vice-admiral, and rear-admiral; that such and such signals shall be observed; that those which bear no guns shall pay so much per cent. of their cargo; and in case they be attacked, that what damages are sustained shall be reimbursed by the company in general. In the Mediterranean such companies are called Conserves.

COMPARATIVE *anatomy*, is the science which examines the structure of the body in animals. It includes, in its most extensive sense, a view of the corporeal organization of all classes of the animal kingdom.

This science, which is very aptly denominated comparative anatomy, affords the most essential aid in elucidating the structure of the human body, and in explaining the doctrines of physiology.

The want of any organ in certain classes of animals, or its existence under different modifications of form, structure, &c. cannot fail to suggest most interesting conclusions concerning the office of the same part to the human subject. Thus our physiological reasonings, which must necessarily be partial and incomplete, when deduced from the structure of a single animal or class, are extended and corrected by this general comparative survey, and may therefore be relied on with the greater confidence. We are indebted to such investigations for the discovery of the circulation and of the lymphatic system; for the elucidation of the functions of digestion and generation; indeed, there is no branch of anatomy or physiology, which has not received most material benefit from the same source. Hence Haller has very justly observed, that "physiology has been more illustrated by comparative anatomy, than by the dissection of the human body."

The study of comparative anatomy is moreover of the greatest importance in its connection with veterinary science, and with that highly interesting pursuit, natural history. It would be an affront to our readers to enlarge upon its utility in the former point of view; but we may be allowed to observe on the latter subject, that anatomical structure forms the only sure basis of a natural classification of the animal kingdom; and that any arrangement, not founded on this groundwork, will lead us into the most gross and palpable errors.

Lastly, this study opens to the mind a great source of interest and satisfaction, in exhibiting such numerous and undeniable proofs of the exertion of contrivance and design in the animal structure; in displaying those modifications of particular parts and organs, by which they are adapted to the peculiar circumstances of the animal, and become subservient to its wants, its necessities, or its enjoyments.

The importance of the subject, from the above-mentioned circumstances, is now so fully recognised, that it begins with justice to be considered as an essential part of a regular medical education. Public lectures have been delivered on it for some years in Germany and France; and lately the example has been followed in this metropolis.

Hitherto there has been rather a deficiency of good works on this science, and particularly of elementary books. Blasius has given a collection of the writings of several authors on the anatomy of particular animals, in one volume 4to., entitled "Anatomia animalium figuris variis illustrata," Amstel. 1681; which may still be consulted with advantage, particularly on account of the plates. Cuvier's "Leçons d'Anatomie comparée," in five large 8vo. volumes, form a very valuable and useful repository of facts in comparative anatomy; but the subject is treated at such length, and with so many uninteresting details, that the book is by no means adapted for the use of students. The only compendious and scientific view of the subject, which we can recommend to beginners, is the short system published by Blumenbach of Gottingen, and translated from the German by Mr. Lawrence, who has accompanied it with numerous additional notes.

The necessity of confining this article within a given number of pages renders it impossible for us to give a general view of the subject: we shall, therefore, select such parts as are either particularly interesting in themselves, or such as become important from elucidating the structure or functions of the human body.

It is necessary for us to make a few remarks on the classification of the animal kingdom, as the terms employed in the following article differ occasionally from those of the Linnæan system, which has been hitherto chiefly used in this country; and, independently of this circumstance, such of our readers, as have not particularly attended to the study of natural history, may derive assistance and information from a short sketch and explanation of the arrangement of animals according to their anatomical structure, with an enumeration of the chief genera in each order.

That the Linnæan system is exposed to numerous and well grounded objections, and that in many instances it disregards anatomical structure, which should form the basis of a natural classification, will be readily allowed by the most sanguine admirers of its illustrious author. Yet it must be remembered, that the general adoption of this method renders it desirable to deviate from it in as few instances as possible; since the introduction of new orders and names must necessarily create difficulty and confusion in the study of the science. The French zoologists, whose successful labours in the advancement of natural history must be acknowledged with every due tribute of respect, have carried the rage of innovation too far, in the universal rejection of the Linnæan method, and the unnecessary multiplication of new orders and genera. The defects or errors of any system could not cause so much perplexity and inconvenience, as the want of a generally received standard, and the unlimited licence, in which every individual indulges, of fabricating new classifications and arrangements. To judge by some recent works, we should be led to suppose, that the merit of a systematic arrangement of animals does not consist in the simplicity or intelligibility of the system; but is in proportion to the number of newly-created terms.

Animals may be distributed into two grand divisions: those which have a vertebral column, and red blood: and those which have no vertebræ, and are white blooded.

In the former division there is always an interior skeleton; the chief support of which is the column of vertebræ, a spinal marrow contained in the vertebral canal; never more than four members, of which one or both pairs are wanting in some instances. The brain is contained in a cranium: there is a great sympathetic nerve; five senses; two moveable eyes; and three semicircular canals in the ear. The circulation is performed by one muscular ventricle at least. There are lymphatic as well as blood vessels. The jaws being placed horizontally, the mouth is opened by their moving from above downwards, or from before backwards. There is a continuous alimentary canal, extending from the mouth to the anus, which is always placed behind the pelvis; peritoneum; liver, spleen, and pancreas; two kidneys, and renal capsules; and two testicles.

The vertebral animals are subdivided into warm and cold-blooded.

Warm blooded vertebral animals have two ventricles in the heart, and a double circulation; and breathe by means of lungs. The cranium is completely filled by the brain. The eyes are closed by eyelids. The tympanum of the ear is hollowed out of the cranium, and the labyrinth is excavated in the bone. Besides the semicircular canals, the ear has a cochlea. The nostrils communicate with the fauces, and allow the passage of air into the lungs. The trunk is constantly furnished with ribs.

In cold blooded vertebral animals, the brain never entirely fills the cranium. The eyes seldom possess moveable eye lids. When the tympanum exists, it is on a level with the surface of the head. There is no cochlea. The different parts of the ear are connected but loosely to the cranium.

The division of warm blooded animals contains two classes; Mammalia and Birds.

The mammalia are viviparous, and suckle their young, from which circumstance the name is derived. They have an uterus with two cornua: and the male has a penis.

There are two occipital condyles, connecting the head to the atlas: never less than six, nor more than nine cervical vertebræ: a very complicated brain; four ossicula auditus, and a spiral cochlea. The skin covered with hair. A muscular diaphragm separates the chest and abdomen. There is an epiglottis. The lower jaw only moves. The fluid in the lacteals is white, and passes through several conglobate glands. There is an omentum.

Blumenbach establishes the following orders in this class:

COMPARATIVE ANATOMY.

I. *Bimanum.* Two handed.

Genus 1. Homo.

II. *Quadrumana,* four handed animals; having a separate thumb, capable of being opposed to the other fingers, both in their upper and lower extremities. Teeth like those of man, except that the cuspidati are generally longer.

1. Simiæ, apes, monkeys, baboons.
2. Lemur, macauco.

III. *Bradypoda,* slow-moving animals.

1. Bradypus, sloth.
2. Myrmecophaga, ant-eater.
3. Manis, scaly-lizard, or pangolin.
4. Dasypus or Tatu, armadillo.

This order forms two in the arrangement of Cuvier. 1st. Tardigrada; which includes the sloths. There are no incisores in either jaw; there is a complicated stomach, but no rumination. 2dly. Edentata, toothless animals. Some of these have no teeth; others want the incisores and cuspidati. The tongue is long, slender, and projectile, for seizing the insects on which the animals feed; body covered with hard substances. The armadillo, manis, ant-eater, and ornithorhyncus, or duck-billed animal, belong to this order.

IV. *Cheiroptera,* having the fingers elongated for the expansion of a membrane which acts as a wing.

Vespertilio, bat.

V. *Glires.* Rodentia of Cuvier—gnawing animals. Have two long and very large incisor teeth in each jaw, by which they cut and gnaw hard bodies, chiefly vegetables; there is a large interval behind these teeth, unoccupied by cuspidati; long intestines, and generally a large cœcum. The hind legs, being longer than the front extremities, give to these animals a leaping mode of progression. The disproportion is sometimes so great, that the front legs are not used in walking. A bone in the penis.

1. Sciurus, squirrel.
2. Glis, dormouse (Myoxus, Linn.)
3. Mus, mouse and rat.
4. Marmota, marmot.
5. Cavia, guinea-pig.
6. Lepus, hare and rabbit.
7. Jaculus, jerboa.
8. Castor, beaver.
9. Hystrix, porcupine.

VI. *Feræ,* predaceous and carnivorous animals. Very strong and large pointed canine teeth: molares forming pointed prominences; short and simple alimentary canal, and consequently slender belly.

1. Erinaceus, hedge-hog.
2. Sorex, shrew.
3. Talpa, mole.
4. Meles, badger.
5. Ursus, bear.
6. Didelphis, opossum, kanguroo.
7. Viverra, weasels, ferret, polecat, civit.
8. Mustela, skunk, stoat, &c.
9. Canis, dog, wolf, jackal, fox, hyena.
10. Felis, cat, lion, tiger, leopard, lynx, panther, &c.
11. Lutra, otter.
12. Phoca, seal or sea-calf.

The five first genera of this order form the plantigrada of Cuvier; animals which rest the whole of the foot on the ground. They are less carnivorous than the others; have a longer intestinal canal, and no cæcum.

The sixth genus forms the Pedimana of the same zoologist; as they possess a separate thumb on the hind extremities only. They have a pouch in the abdomen, containing the mammæ, and holding the young in their early state. One species, the kanguroo, (didelphis gigantea) must however be excepted. That is placed among the rodentia, and does not possess the separate thumb.

The order carnivora of Cuvier will include from the seventh to the eleventh genus, both inclusive. These have a bone in the penis. The seal belongs to this amphibia.

In the three following orders the toes are so incased in horny coverings, that they can only serve to support the body in standing or progression. As these animals all feed on vegetables, the intestines are very long, and the belly consequently large.

VII. *Solidungula* (solipeda, Cuvier,) a single toe on each foot, with an undivided hoof; a small and simple stomach, but large intestines, and particularly an enormous cæcum; incisores in both jaws; mammæ in the groin, as in the pecora.

1. Equus, horse and ass.

VIII. *Pecora* or *Bisulca* (ruminantia of Cuvier,) a divided hoof. No incisores in the upper jaw, where their place is supplied by a callous prominence; stomach consisting of four cavities; rumination of the food; long intestines. Their fat becomes hard and brittle when cold. The mammæ are placed between the posterior extremities. The penis of the male has no bone.

1. Camelus, camel, dromedary, lama.
2. Capra, sheep, goat.
3. Antilope, antelope, chamois.
4. Bos, ox, buffalo.
5. Giraffa, giraffe or camelopard.
6. Cervus, elk, deer-kind.
7. Moschus, musk.

IX. *Belluæ*, animals of an unshapely form, and a tough and thick hide; whence they have been called, by Cuvier, pachydermata (from παχυς thick, and δερμα skin.) They have more than two toes: incisores in both jaws, and in some cases enormous tusks; mammæ extend under the belly, where they are numerous.

1. Sus, pig kind, pecari, babiroussa.
2. Tapir.
3. Elephas.
4. Rhinoceros.
5. Hippopotamus.
6. Trichecus, morse or walrus, manati or sea-cow.

The last genus of this order, together with the foca (seals) constitutes the Amphibia of Cuvier. These animals have short members adapted for swimming.

X. *Cetacea*, whales, living entirely in the sea, and formed like fishes; breathe by an opening at the top of the head, called the blowing hole; through which they throw out the water, which enters their mouth with the food; smooth skin covering a thick layer of oily fat; no external ear; a complicated stomach; multilobular kidneys; larynx of a pyramidal shape, opening towards the blowing hole; testes within the abdomen; mammæ at the sides of the vulva; bones of the anterior extremity concealed and united by the skin, so as to form a kind of fin; no posterior extremities; teeth which retain their prey, but do not masticate, and instead of which there are sometimes layers of a horny substance called whalebone.

1. Monodon, narwhal, sea-unicorn.
2. Balæna, proper whale.
3. Physeter.
4. Delphinus, dolphin, porpoise.

Cuvier distributes the class mammalia into three grand divisions:

1. Those which have claws or nails (mammiféres a ongles:) including the following orders: bimana, quadrumana, cheiroptera, plantigrada, carnivora, pedimana, rodentia, edentata, tardigrada.

2. Those which have hoofs (mammif. a ongles) including the pachydermata, ruminantia, and solipeda.

3. Those which have extremities adapted for swimming (mammif. a pieds en nageoire.) Amphibia and cetacea.

Birds are oviparous; have a single ovary and oviduct; a single occipital condyle; very numerous cervical vertebræ; a very large sternum; and anterior extremities adapted for flying, the posterior only being used for walking.

They have three eyelids; no external ear; a bone in the tongue; a cochlea conical, but not spiral; a single ossiculum auditus; body covered with feathers. The lungs are attached to the surface of the chest, and penetrated by the air, which goes all over the body; no diaphragm; there is a larynx at each end of the trachea; no epiglottis; the jaws are covered with a horny substance, and are both moveable; there are no lips, gums, nor teeth; the chyle is transparent; no mesenteric glands, nor omentum; no bladder of urine, the ureters terminating in a bag, through which the eggs and fæces come, *viz.* the cloaca; the pancreas and liver have both several ducts entering the intestine; spleen in the centre of the mesentery.

This class cannot be distributed into orders so clearly distinguished by anatomical characters as the preceding one. Blumenbach divides them into two leading divisions.

(A) TERRESTRIAL BIRDS.

Order I. *Accipitres.* Birds of prey, with strong hooked bills, and large curved talons, a membranous stomach, and short cæca.

1. Vultur, vultures.
2. Falco, falcon, eagle, hawk, kite.
3. Strix, owl.
4. Lanius, shrike, or butcher bird.

II. *Levirostres*, light-billed birds, having a large hollow bill.

1. Psittacus, parrot kind.
2. Ramphastos, toucan.
3. Buceros, rhinoceros bird.

III. *Picæ*, this and the two following orders are not clearly characterised.

1. Picus, woodpecker.
2. Jynx, wryneck.
3. Sitta, nuthatch.
4. Alcedo, king's-fisher.
5. Trochilus, humming bird, &c. &c.

IV. *Coraces.*

1. Corvus, crow, raven, jackdaw, magpie, jay, &c.
2. Coracias, roller.
3. Paradisea, birds of paradise.
4. Cuculus, cuckoo, &c. &c.

V. *Passeres,* small singing-birds.

1. Alauda, lark.
2. Sturnus, starling.
3. Turdus, thrush, black-bird.
4. Emberiza, bunting.
5. Fringilla, finches, canary-bird, linnet, sparrow.
6. Motacilla, nightingale, redbreast, wren.
7. Hirundo, swallows, martins, &c.
8. Caprimulgus, goatsucker, &c.

VI. *Gallinæ*, gallinaceous birds, mostly domesticated. They possess a large crop, strong muscular gizzards, short legs.

1. Columba, pigeons.
2. Tetrao, grous, quail, partridge.
3. Numida, guinea-fowl.
4. Meleagris, turkey.
5. Pavo, peacock.
6. Otis, bustard.

VII. *Struthiones*, struthinous birds. The largest of the class: possess extremely small wings, and are therefore incapable of flight; but run very swiftly.

1. Struthio, ostrich.
2. Casuarius, cassowary or emu.

(B) AQUATIC BIRDS.

Order I. *Grallæ*, waders frequenting marshes and streams; long naked legs; long neck; cylindrical bill, of different lengths.

1. Ardea, crane, stork, heron, bittern.
2. Scolopax, woodcock, snipe, curlew.
3. Tringa, lapwing, huffs, and reeves.
4. Charadrius, plover.
5. Fulica, coot.
6. Rallus, rail.
7. Phœnicopterus, flamingo.
8. Tantalus, ibis, &c.

II. *Anseres*, swimming birds; webfooted; bill broad and flat, covered by a somewhat soft substance, on which large nerves are distributed.

1. Colymbus, diver.
2. Larus, gull.
3. Procellaria, petrel.
4. Diomedea, albatros.
5. Pelecanus, pelican, cormorant.
6. Anas, swan, duck, goose.
7. Mergus, goosander.
8. Alca, auk, puffin.
9. Aptenodytes, penguin.

The two classes of cold-blooded vertebral animals are, the Amphibia, and Fishes.

The former, differing considerably from each other, have very few common characters; for in different instances they walk, fly, swim, and crawl. There is no external ear, nor cochlea; the brain is always very small; the lungs are in the same cavity with the other viscera, and have very large air-cells; no epiglottis, omentum, nor mesenteric glands; two ovaries and oviducts; cloaca, through which the fæces and urine are expelled, and in which the organs of generation terminate; neither hair, feathers, nor mammæ; skin either naked, or covered with scales; both jaws are moveable; there is an urinary bladder.

Order I. *Reptilia*, having four feet, (*quadrupeda ovipara.*)

1. Testudo, tortoise, turtle.
2. Rana, frog, toad.
3. Lacerta, lizards, crocodile, cha-

meleon, newt, salamander, iguana, &c.

II. *Serpentia.* No external members; body of an elongated form, and viscera of a similar shape; they are oviparous; but the egg is sometimes hatched in the oviduct; both jaws moveable.

1. Crotalus, rattlesnake.
2. Boa. Immense serpents of India and Africa.
3. Coluber, viper.
4. Anguis, blind worm.
5. Amphisbæna.
6. Cæcilia.

Fishes. Breathe by means of branchiæ or gills, and have no trachea, nor larynx; organs of motion consisting of fins; nose unconnected with the organs of respiration; ear entirely enclosed in the head, the tympanum, &c. being absent; both jaws moveable; the place of the pancreas supplied by the pyloric cæca; an urinary bladder; two ovaries; heart consisting of a single auricle and ventricle. They may be distributed into two leading divisions: the cartilaginous, whose skeleton consists of cartilage; the bony, where it is formed of a more firm substance.

(A) CARTILAGINOUS FISHES.

Order I. *Chondropterygii;* having no gill-cover; an uterus, with two oviducts.

1. Petromyzon, lamprey.
2. Gastrobranchus.
3. Raia, skate, torpedo, stingray.
4. Squalus, shark, saw-fish.
5. Lophius, sea-devil, frog-fish.
6. Balistes, file-fish.
7. Chimæra.

II. *Branchiostegii;* having a gill-cover.

1. Accipenser, sturgeon, beluga.
2. Ostracion, trunk-fish.
3. Tetrodon.
4. Diodon, porcupine-fish.
5. Cyclopterus, lumpsucker.
6. Centriscus.
7. Syngnathus, pipe-fish.
8. Pegasus.

(B) BONY FISHES, DIVIDED ACCORDING TO THE SITUATION OF THEIR FINS.

Order I. *Apodes;* no ventral fins.

1. Muræna, eel-kind.
2. Gymnotus, electrical eel.
3. Anarrhichas, sea-wolf.
4. Xiphias, sword-fish.
5. Ammodites, launce.
6. Ophidium.
7. Stromateus.
8. Trichiurus.

II. *Thoracici;* ventral fins directly under the thoracic.

1. Echeneis, sucking-fish.
2. Coryphæna, dorado.
3. Zeus, dory.
4. Pleuronectes, flounder, plaice, dab, holibut, sole, turbot.
5. Chætodon.
6. Sparus.
7. Perca, perch.
8. Scomber, mackarel, bonito, tunny.
9. Mullus, mullet, &c. &c.

III. *Abdominales;* ventral fins behind the thoracic; chiefly inhabit fresh water.

1. Cobitis, loach.
2. Silurus.
3. Salmo, salmon, trout, smelt.
4. Esox, pike.
5. Clupea, herring, sprat, shad.
6. Cyprinus, carp, tench, gold-fish, minow, &c. &c.

IV. *Jugulares;* ventral fins in front of the thoracic.

1. Gadus, haddock, cod, whiting, ling.
2. Uranoscopus, star-gazer.
3. Blennius, blenny.
4. Callionymus, dragonet.
5. Trachinus, weaver.

The animals, which have no vertebral column, do not possess so many common characters as the vertebral classes; their hard parts, when they have any, are generally placed on the surface of the body; the centre of the nervous system, instead of being inclosed in a bony case, lies in the same cavity with the viscera; the œsophagus is generally surrounded by a nervous chord coming from the brain; their respiration is not carried on by lungs, and they have no voice; their jaws move in various directions; they have no urinary secretion.

The invertebral animals were distributed by Linnæus into two classes; insects and worms (vermes.) The anatomical structure of these animals was very imperfectly known, when the Swedish naturalist first promulgated his arrangement. But the labours of subsequent zoologists, and particularly those of Cuvier, have succeeded in establishing such striking and important differences in their formation, that a subdivision of the Linnæan classes became indispensably necessary. The insects of Linnæus are divided into crustacea and insecta : and the vermes of the same author form three classes : *viz.* Mollusca, Vermes, and Zoophyta.

The Mollusca derive their name from the soft fleshy nature of their body. This class includes those pulpy animals, which may either be destitute of an external covering, when they are called mollusca nuda, as the slug ; or may be inclosed in one or more shells, as the snail, oyster, &c. when they are termed testacea.

The animals of this class have no articulated members : they have blood-vessels, and a true circulation ; they respire by means of gills ; they have a distinct brain, giving origin to nerves ; and a spinal marrow.

1. Sepia, cuttlefish.
2. Argonauta.
3. Nautilus.
4. Limax, slug.
5. Aplysia.
6. Doris.
7. Clio.
8. Patella, limpet.
9. Helix, snail.
10. Haliotis, Venus's ear.
11. Murex, caltrop, or rockshell.
12. Strombus, screw.
13. Buccinum, whelk.
14. Ascidia.
15. Thalia.
16. Ostrea, oyster.
17. Solen, razorshell.
18. Cardium, cockle.
19. Mytilus, muscle, &c. &c.

Cuvier classes the numerous genera of this order under the three following divisions : 1. Cephalopoda, (from κεφαλη the head, and πȣς the foot) which have their organs of motion placed round the head ; 2. Gasteropoda, (from γαςηρ, the belly, and πȣς,) such as crawl on the belly ; and 3. Acephala, (from α, privative, and κεφαλη,) which have no head. The three first genera belong to the first division ; the ten succeeding ones come under the second ; and the remainder exemplify the last order.

According as the shell of the testaceous mollusca consists of a single convoluted tube, or of two or more separate pieces, they are called cochleæ bivalves, multivalves, &c.

Crustacea possess a hard external covering, and numerous articulated members ; a long nervous chord, beset with ganglia ; compound eyes ; antennæ and palpi like those of insects ; a heart and circulating vessels, and gills ; teeth in the cavity of the stomach.

1. Cancer, crab, lobster, crayfish, shrimp.
2. Monoculus.

Insects have articulated members and antennæ. Those which fly are subject to what is called a metamorphosis ; they pass through certain intermediate states of existence before they assume the last or perfect form. From the egg proceeds the larva, or caterpillar : this changes to the chrysalis, nympha, or aurelia, from which the perfect insect is produced ; nervous system consisting of a chord beset with ganglia ; no heart nor blood-vessels ; respiration carried on by means of tracheæ.

Order I. *Coleoptera ;* having a hollow, horny case, under which the wings are folded.

1. Scarabæus, beetles.
2. Lucanus, stag-beetle.
3. Dermestes.
4. Coccinella, lady-bird.
5. Curculio, weevil.
6. Lampyris, glow-worm.
7. Meloe, Spanish-fly.
8. Staphylinus.
9. Forficula, earwig.

II. *Hemiptera ;* four wings, either stretched straight out, or resting across each other.

1. Blatta, cockroach.
2. Gryllus, locust, grasshopper.
3. Fulgora, lantern-fly.
4. Cimex, bug, &c.

III. *Lepidoptera ;* soft hairy body, and four expanded wings.

1. Papilio, butterfly.
2. Sphinx, } moths.
3. Phalæna, }

IV. *Neuroptera;* four reticulated wings.

1. Libellula, dragon-fly.
2. Ephemera, &c.

V. *Hymenoptera;* generally possessing a sting.

1. Vespa, wasp, hornet.
2. Aspis, bee.
3. Formica, ant.
4. Termes, white ant.
5. Ichneumon, &c.

VI. *Diptera;* two wings.

1. Œstrus, gad-fly.
2. Musca, common flies.
3. Culex, gnat, mosquito.
4. Hippobosca, horse-leech, &c.

VII. *Aptera;* no wings.

1. Podura, springtail.
2. Pediculus, louse.
3. Pulex, flea, chigger.
4. Acarus, tick, mite.
5. Aranea, spider.
6. Scorpio, scorpion, &c.

The vermes may be divided into two orders; the intestinal, which inhabit the bodies of other animals; and the external.

The former are not of such a complicated organization as the latter; so that they are sometimes arranged among the zoophytes. The external worms have a nervous chord possessing ganglia, an elongated body composed of rings, and having no distinct head; there are no members; circulating vessels, but no heart; no nerves have been discovered in the intestinal worms.

Order I. *Intestini.*

1. Gordius, guinea-worm.
2. Ascaris, thread-worm, round-worm.
3. Tricocephalus.
4. Fasciola, fluke.
5. Tænia, tape-worm.
6. Hydatis, hydatid.

II. *Externi.*

1. Aphrodite, sea-mouse.
2. Sipunculus.
3. Hirudo, leech.
4. Nereis.
5. Nais.
6. Planaria.
7. Lumbricus, earth-worm, &c.

The Zoophytes have neither brain nor nerves; no heart, nor, perhaps, blood-vessels; no articulated members.

Order. I. *Echinodermata;* covered by a hard and tough coriaceous skin.

1. Echinus, sea hedge-hog.
2. Asterias, star fish, &c.

II. *Soft* or *Gelatinous Zoophytes.*

1. Medusa, sea-blubber, sea nettles.
2. Actinia, sea-anemone.
3. Hydra, fresh water polype.

III. *Infusória,* the animalcules of infusions.

1. Vorticella, wheel-animal.
2. Brachionus.
3. Vibrio, eel of vinegar.
4. Volvox.
5. Monas.

IV. Inhabitants of corals, corallines, sponges, &c.

COMPARATIVE OSTEOLOGY.

It has been asserted, that the bones in some instances have not their ordinary white colour. Thus the amedabad finch, (fringilla amandava,) and the golden pheasant, have been said to possess yellow bones; but this is not true. In the garpike (esox belone) the bones are green; and in some varieties of the common fowl in the East Indies they are black; but this colour is said by Mr. Hunter to reside in the periosteum.

The opinion of Aristotle, that the bones of the lion had no marrow, is totally unfounded.

The bones of the cranium are much more completely ossified at the time of birth, in the mammalia, than in man. In the former the fontanells are hardly discernible. When we compare the pelvis, and the whole mechanism of parturition in the woman, with those of the female quadruped, the cause of this difference appears; we then discover, why the yielding and over lapping of the large bone of the cranium, which is chiefly effected by the fontanells, is only required to facilitate the birth of the human fœtus.

The skeleton remains constantly cartilaginous in some animals; such as the skate, shark, sturgeon, and all those fishes, which, from this circumstance, have been denominated cartilaginous. The bones of birds are almost universally hollow; but their cavities, which never contain marrow, are filled with air. This organization unites the advantages of strength and lightness.

Crustaceous animals, (crab, lobster, &c.) have a skeleton which surrounds and contains their soft parts, and which serves at the same time the purposes of a skin. When it has attained its perfect consistence, it grows no more: but as the soft parts still increase, the shell separates, and is detached, being succeeded by a larger one. This new covering is partly formed before the other separates: it is at first soft, sensible, and vascular; but it speedily acquires a hard consistence by the increased deposition of calcareous matter.

Some of the mollusca have hard parts in the interior of their body. The common cuttlefish (sepia officinalis) has a white, firm, and calcareous mass, of an oval form, and slightly convex on its two surfaces, commonly known by the name the cuttlefish-bone, contained in the substance of its body. It has no connection with any soft part, whence it appears completely as a foreign body: no vessel nor nerve can be perceived to enter it; nor does it receive the attachment of any tendon. In the calmar (sepia loligo) this body resembles horn in its appearance; it is transparent, hard, and brittle. Its form resembles that of a leaf, except that it is larger; and sometimes that of a sword blade. These parts must grow like shells, by the simple addition of successive layers.

In the vertebral animals, the bony parts of the body are composed of a gelatinous substance, united to phosphate of lime. But in the lower orders of animals, the hard parts are composed chiefly or entirely of carbonate of lime. This is the case with the shells of all the testacea.

SKELETON OF MAMMALIA.

The form of the different mammalia, particularly the four footed ones, varies considerably; and their skeletons must be marked by corresponding differences. Yet these varieties may be included, at least for the greatest part, under the following peculiarities; which serve to distinguish their skeletons from those of birds.

The skeletons of mammalia possess:	Those of birds are distinguished by:
1. A skull with genuine sutures, at least with very few exceptions; as perhaps the elephant, and the duck-billed animal, (ornithorhyncus.)	1. A skull which has not real sutures, at least in the adult.
2. Jaws furnished with teeth. Except the anteaters, the manis, the balæna (whale.)	2. A bill without teeth.
3. An upper jaw, which does not move.	3. An upper jaw, which does move. There are some exceptions, *viz.* the rhinoceros bird.
4. An os intermaxillare.	4. No os intermaxillare.
5. Two occipital condyles.	5. A single occipital condyle.
6. Seven cervical vertebræ. Except the three-toed sloth, and some cetacea.	6. More than seven cervical vertebræ.
7. Moveable dorsal vertebræ.	7. Motionless dorsal vertebræ.
8. A pelvis closed in front. Except the anteaters; which have it open: and the cetacea, which have none.	8. A pelvis open anteriorly. Except the ostrich.
9. True clavicles in a few genera only.	9. Clavicles constantly; and almost as universally the forklike bone.

The structure of the cranium presents a very remarkable singularity in the elephant. Its two tables are separated from each other, to a considerable extent, by numerous bony processes; between which are formed a vast number of cells, communicating with the throat by means of the eustachian tube, and filled with air, instead of the bloody or medullary substance which occupies the diplöe of animals. The use of this structure in increasing the surface for attachment of those large muscles, which belong to the lower jaw, proboscis and neck, and in augmenting the mechanical power of these muscles, by removing their attachments to a greater distance from the centre of motion, has been very ingeniously explained by Camper. (Œuvres, tom. 2.) These advantages are attained by the cellular structure which we have just described, without augmenting the weight of the head, and this precaution is particularly necessary in the present instance, as the head is on other accounts more heavy and massy in this than in any other animal. The air cells of birds, in general, and particularly those which pervade the cranium in the ostrich, eagle, and owl, present examples of a similar formation, attended with the same uses; *viz.* those of increasing the bulk and strength of the bone, and diminishing its weight.

A comparison of the human cranium with that of animals will lead us to some interesting conclusions. Daubenton fixed on the situation of the foramen magnum occipitale as a point of comparison. He draws two lines, which intersect each other in the profile of the scull: one passes from the posterior margin of the great foramen, (which, in almost all mammalia, is also the superior one,) through the lower edge of the orbit; the other takes the direction of the opening itself, beginning at its posterior edge, and touching the articular surface of the condyles. He determines, according to the angle formed by the junction of these two lines, the similarity or diversity of the form of crania.

This angle is, however, but an imperfect criterion; for its variations are included between 80° and 90° in almost all quadrupeds, which differ very essentially in other points. And small variations occur in the individuals of one and the same genus.

The variations in the situations of the occipital foramen are important, when viewed in connection with the ordinary position of the animal's body. In man, who is designed to hold his body erect, this opening is nearly equi-distant from the anterior and posterior extremities of the skull. The head therefore is supported in a state of equilibrium on the vertebral column. The angle, formed by the two lines mentioned by Daubenton, is only of three degrees.

Quadrupeds, which go on all-fours, have the occipital foramen and condyles situated farther back, in proportion as the face is elongated. That opening, instead of being nearly parallel to the horizon, forms a considerable angle with it: which, measured according to Daubenton, is of 90 degrees in the horse. The weight of the head in these animals is not therefore sustained by the spine, but by a ligament of immense strength, which is either entirely deficient, or so weak as to have its existence disputed, in the human subject. This ligamentum muchæ, or cervical ligament, arises from the spines of the dorsal and cervical vertebræ, (which are remarkably long for that purpose,) and is fixed to the middle and posterior part of the occipital bone. It is of great size and strength in all quadrupeds, but most particularly in the elephant; where the vast weight of the head, so much increased by the enormous size of the tusks, sufficiently accounts for its increased magnitude. It is bony in the mole, probably on account of the use which the animal makes of its head, in disengaging and throwing up the earth.

Animals of the genus Simia and Lemur hold a middle rank between man, who is constantly erect, and quadrupeds, whose body is supported by four extremities. Their structure is by no means calculated, like that of man, for the constant maintenance of the erect posture; but they can support it with greater facility, and for a longer time, than other animals. Hence, in the orang-outang, the occipital foramen is only twice as far from the jaws as from the back of the head; so that Daubenton's angle is only of 37°. It is somewhat larger in the other species of Simiæ, and measure 47° in the lemur.

The general form of the cranium is most materially influenced by the direction, and the various degrees of prominence, of the facial bones.

To determine this with greater precision, Camper instituted the facial line; the application of which is most minutely explained in his posthumous work, "On the natural Differences of the Features, &c." Like Daubenton, he draws on the profile of the cranium two straight lines, which intersect each other; but in different directions from those of the French anatomist. An horizontal line passes through the external auditory passage and the bottom of the cavity of the nose: this is intersected by a more perpendicular one, proceeding from the convexity of the forehead to the most prominent point of the upper jaw, or of the intermaxillary bone. The latter is the proper facial line; and the angle which it forms with the horizontal line determines, according to Camper, the differences of the crania of animals, as well as the national physiognomy of the various races of mankind.

The two organs which occupy most of the face are, those of smelling and tasting, (including those of mastication, &c.) In proportion as these parts are more developed, the size of the face, compared to that of the cranium, is augmented. On the contrary, when the brain is large, the volume of the cranium is increased in proportion to that of the face. A large cranium and small face indicate therefore a large brain, with inconsiderable organs of smelling, tasting, masticating, &c.; while a small cranium, with a large face, shew that these proportions are reversed.

The nature and character of each animal must depend considerably on the relative energy of its different functions. The brain is the common centre of the nervous system. All our perceptions are conveyed to this part, as a sensorium commune: and this is the organ by which the mind combines and compares these perceptions, and draws inferences from them; by which, in short, it reflects and thinks. We shall find that animals partake in a greater degree of this latter faculty, or at least approach more nearly to it, in proportion as the mass of medullary substance, forming their brain, exceeds that which constitutes the rest of the nervous system; or, in other words, in proportion as the organ of the mind exceeds those of the senses. Since then the relative proportions of the cranium and face indicate also those of the brain and the two principal external organs, we shall not be surprised to find that they point out to us, in great measure, the general character of animals, the degree of instinct and docility which they possess. Man combines by far the largest cranium with the smallest face; and animals deviate from these relations, in proportion as they increase in stupidity and ferocity.

One of the most simple methods (though sometimes indeed insufficient) of expressing the relative proportions of these parts, is by means of the facial line, which has been already described. This angle is most open, or approaches most nearly to a right angle, in the human subject; it becomes constantly more acute, as we descend in the scale from man; and in several birds, reptiles, and fishes, it is lost altogether, as the cranium and face are completely on a level. The idea of stupidity is associated, even by the vulgar, with the elongation of the snout; hence the crane and snipe have become proverbial. On the contrary, when the facial line is elevated by any cause which does not increase the capacity of the cranium, as in the elephant and owl, by the cells which separate the two tables, the animal acquires a particular air of intelligence, and gains the credit of qualities which he does not in reality possess.

Hence the latter animal has been selected as the emblem of the goddess of wisdom. The invaluable remains of Grecian art shew that the ancients were well acquainted with these circumstances; they were aware, that an elevated facial line formed one of the grand characters of beauty, and indicated a noble and generous nature. Hence they have extended the facial angle to 90 degrees in the representation of men, on whom they wished to bestow an august character. And in the representation of their gods and heroes, they have even carried it beyond a right angle, and made it 100°.

It must, however, be allowed, that the facial angle is of chief importance in its application to the cranium of the human subject, and of the quadrumana: as various circumstances affect the conclusions which would result from employing it in other classes of mammalia. Thus, in the carnivorous, and some of the ruminating animals; in the pig, and particularly in the elephant, the great size of the frontal sinuses produces an undue elevation of the facial line. In many of the rodentia, as the hare, &c. the nose occupies so large a space, that the cranium is thrown quite back, and presents no point on a front view, from which this line can be drawn.

The following are the angles formed by drawing a line along the floor of the nostrils, and intersecting it by another, which touches the anterior margin of the upper alveoli, and the convexity of the cranium, (whether the latter point be concealed by the face or no;)

European infant	90°
——— adult	85
Adult negro	70

Orang-outang	67°
Long-tailed monkies	65
Baboons	40 to 30
Pole-cat	31
Pug-dog	35
Mastiff; the line passing along the outer surface of the skull	41
Ditto; inner ditto	30
Leopard; inner surface	28
Hare	30
Ram	30
Horse	23
Porpoise	25

In the third and fourth tables of Cuvier's "Tableau Elementaire del'Histoire Naturelle," the crania of several mammalia are represented in profile, so as to afford a sufficient general notion of the varieties in the facial angle. A similar comparative view, in one plate, is given by White, in his account of the "Regular Gradation," &c. from the work of Camper.

A vertical section of the head, in the longitudinal direction, shews us more completely the relative proportions of the cranium and face. In the European, the area of the section of the cranium is four times as large as that of the face; the lower jaw not being included. The proportion of the face is somewhat larger in the negro: and it increases again in the orang-outang. The area of the cranium is about double that of the face in the monkeys; in the baboons, and in some of the carnivorous mammalia, the two parts are nearly equal. The face exceeds the cranium in most of the other classes. Among the rodentia, the hare and marmot have it one third larger; in the porcupine and the ruminantia, the area of the face is about double that of the cranium; nearly triple in the hippopotamus; and almost four times as large in the horse. In reptiles and fishes, the cranium forms a very inconsiderable portion of the section of the head, although it is considerably larger than the brain which it contains.

The outline of the face, when viewed in such a section as we have just mentioned, forms in the human subject a triangle, the longest side of which is the line of junction between the cranium and face. This extends obliquely, backwards and downwards, from the root of the nose towards the foramen occipitale. The front of the face, or the anterior line of the triangle, is the shortest of the three. The face is so much elongated, even in the simiæ, that the line of junction of the cranium and face is the shortest side of the triangle, and the anterior one the longest. These proportions become still more considerable in other mammalia.

The upper jaw-bones of other mammalia do not, as in man, touch each other under the nose, and contain all the upper teeth; but they are separated by a peculiar, single, or double intermaxillary bone, which is in a manner locked between the former, and holds the incisor teeth of such animals as are provided with these teeth. It exists also in the pecora, which have no incisor teeth in the upper jaw; as well as in such genera as have no incisor teeth at all; *viz.* the duck-billed animal and the armadillo. It is even found in those mammalia which are wholly destitute of teeth; as the ant-eater and the proper whales. It is joined to the neighbouring bones by sutures, which run exteriorly by the side of the nose and snout, and which pass towards the palate, close to the foramina incisiva. Its form and magnitude vary surprisingly in several orders and genera of mammalia. It is small in many feræ; as also in the walrus. In the glires it is remarkably large, on account of the immense size of their incisor teeth.

In human crania, at least those of the fœtus and young children, there is a small transverse slit near the foramen incisivum, of which Fallopius gave the following accurate account in the year 1561: "I find this division to be rather a slit than a suture, since it does not separate one bone from the other, nor does it appear exteriorly, nor join two bones, which is the office of sutures." "Obs. Anat."

"Hence I was much surprised to find Vicq D'Azyr, in 1780, discover in this point an unexpected resemblance between the cranium of the human subject and of quadrupeds." Mem. de l'Acad. des Sc. 1780.

In the celebrated dispute of the sixteenth century, whether Galen's osteology was derived from the skeleton of man or the ape, Ingrassias argued for the latter side of the question, from Galen's having ascribed an intermaxillary bone to the human subject. And the same author, in his classical "Commentarii in Galeni Librum de Ossibus," Panorm, 1603, fol. particularly points out the parts, "where Galen, led astray by the dissection of apes, deviates from the true construction of the human body."

In mammalia which have horns, these parts grow on particular processes of certain bones of the cranium. In the one-horned rhinoceros, they adhere to a rough and slightly elevated surface of the vast nasal bone. The front horn of the two-horned species has a similar attachment; the posterior rests on the os frontis, as those of the horned pecora do. Two kinds of structure are observed in the latter; there are either proper horns, as in the genera of the ox, goat, and antelope; or bony productions, as in the genus cervus, which includes animals of the deer kind: these are also called horns in English, or sometimes antlers; in French, bois de cerf. In the former, the external table of the frontal bones is elongated into a process, which contains a continuation of the frontal sinuses, except in the antelope. Its external vascular surface secretes the horn, which covers this process like a sheath. In the stag kind (in the male only in most genera) the frontal bone forms a short flattened prominence, from which the proper antler immediately shoots forth. It is renewed every year, and is covered, during the time of its growth, with a hairy and very vascular skin.

Castration, or any essential injury of the organs of generation, impedes the growth, alters the form, or interrupts the renewal of the horns.

The word horn, which is frequently applied in English to the antlers of the deer kind, as well as to the real horns of other genera, would lead to a very erroneous notion on this subject. The antler is a real bone; it is formed in the same manner, and consists of the same elements as other bones; its structure is also the same.

It adheres to the frontal bone by its basis; and the substance of the two parts being consolidated together, no distinction can be traced, when the antler is completely organized. But the skin of the forehead terminates at its basis, which is marked by an irregular projecting bony circle; and there is neither skin nor periosteum on the rest of it. The time of its remaining on the head is one year: as the period of its fall approaches, a reddish mark of separation is observed between the process of the frontal bone and the antler. This becomes more and more distinctly marked, until the connection is entirely destroyed.

The skin of the forehead extends over the process of the frontal bone when the antler has fallen: at the period of its regeneration, a tubercle arises from this process, and takes the form of the future antler, being still covered by a prolongation of the skin. The structure of the part at this time is soft and cartilaginous; it is immediately invested by a true periosteum, containing large and numerous vessels, which penetrate the cartilage in every direction, and by the gradual deposition of ossific matter convert it into a perfect bone.

The vessels pass through openings in the projecting bony circle at the base of the antler: the formation of this part, proceeding in the same ratio with that of the rest, these openings are contracted, and the vessels are thereby pressed until a complete obstruction ensues. The skin and periosteum then perish, become dry, and fall off; the surface of the antler remaining uncovered. At the stated period it falls off, to be again produced, always increasing in size.

The skeleton of quadrupeds deviates more from that of man, in the form of the lower jaw bone, than in any other part. This difference consists chiefly in the want of a prominent chin; that peculiar characteristic of the human countenance, which exists in every race of mankind, and is found in no other instance whatever. Man has also the shortest lower jaw in comparison with the cranium; the elephant, perhaps, approaching the nearest to him in this character. The same bone is further distinguished by the peculiar form and direction of its condyle. The articulation of these processes varies according to the structure of the masticating organs. They are both situated in the same straight horizontal line in the feræ; their form is cylindrical; and they are completely locked in an elongated glenoid cavity, whose margins are so extended before and behind the condyle, that all rotatory motions are rendered impossible, and hinge like movements only allowed. This structure is most strikingly exemplified in the badger, where the cylindrical condyles are so closely embraced by the margins of the articular cavity, that the lower jaw (at least in the adult animal) is still retained in its situation, after the soft parts have been entirely removed by maceration. In many herbivorous animals (in the most extensive sense of the term) these condyles are really rounded eminences; *viz.* in the elephant and beaver. Their surface is flattened in the pecora, which have also the lower jaw narrower than the upper, so that the two sets of teeth do not meet together when the mouth is shut, but are brought into contact by the free lateral motion which takes place in rumination.

As the motions of the lower jaw must be materially influenced by the form of its condyles, and by the manner in which those processes are connected to the articular cavity of the temporal bone, we shall find, as might have been expected, a close relation between these circumstances and the kind of food by which an animal is nourished. Thus, the lower jaw of the carnivora can only move upwards and downwards, and is completely incapable of that horizontal motion which constitutes genuine mastication. Hence these animals cut and tear their food in a rude and coarse manner, and swallow it in large portions, which are afterwards reduced by the solvent properties of the gastric juice. Such mammalia, on the contrary, as live on vegetables, have, in addition to this motion, a power of moving the lower jaw backwards and forwards, and to either side, so as to produce a grinding effect, which is necessary for bruising and triturating grass, and for pulverising and comminuting grains. In all these, therefore, the form of the condyle, and of its articular cavity, allows of free motion in almost every direction. The teeth may be compared, in the former case, to scissars; in the latter, to the stones of a mill.

THE TEETH.

The jaws of the mammalia, with a very few exceptions, contain teeth. The proper whales (balæna,) the pangolin (manis,) and the American ant-eaters, are the only genera entirely destitute of these organs.

Animals of the genus balæna (the proper whales) have, instead of teeth, the peculiar substance called whalebone, covering the palatine surface of the upper jaw: this resembles in its composition hair, horn, and such matters.

The lower surface of the upper jaw forms two inclined planes, which may be compared to the roof of a house reversed; but the two surfaces are concave. Both these are covered with plates of the whalebone, placed across the jaws, and descending vertically into the mouth. They are parallel to each other, and exist to the number of two or three hundred on each of the surfaces. They are connected to the bone by the intervention of a white ligamentous substance, from which they grow; but their opposite edge, which is turned towards the cavity of the mouth, has its texture loosened into a kind of fringe, composed of long and slender fibres of the horny substance, which therefore covers the whole surface of the jaw. This structure probably serves the animal in retaining and confining the mollusca, which constitute its food.

The teeth of the ornithorhynchus paradoxus and hystrix deviate very considerably from those of other mammalia. In the former animal there is one on each side of the two jaws: it is oblong, flattened on its surface, and consists of a horny substance adhering to the gum. There are likewise two horny processes on the back of the tongue: these point forwards, and are supposed by Mr. Home to prevent the food from passing into the fauces before it has been sufficiently masticated. In the ornithorhynchus hystrix there are six transverse rows of pointed horny processes at the back of the palate, and about twenty similar horny teeth on the corresponding part of the tongue.

The teeth of the human subject seem to be designed for the single purpose of mastication, and hence an erroneous conclusion might be drawn, that they serve the same office in other animals. Many exceptions must, however, be made to this general rule. Some mammalia, which have teeth for the office of mastication, have others, which can only be considered as weapons of offence and defence; *viz.* the tusks of the elephant, hippopotamus, walrus, and manati. The large and long canine teeth of the carnivora, as the lion, tiger, dog, cat, &c. not only serve as natural weapons to the animal, but enable it to seize and hold its prey, and assist in the rude laceration which the food undergoes previous to deglutition. The seal, the porpoise, and other cetacea, as the cachalot, have all the teeth of one and the same form, and that obviously not calculated for mastication. They can only assist in securing the prey which forms the animal's food.

As the number and arrangement of the teeth was made by Linnæus the basis of his classification of animals, it may be worth while to mention, that this anatomist gives the name of primores to the front, or incisor teeth; and of laniarii to the canine or cuspidati. The term of tusks is applied to such teeth as extend out of the cavity of the mouth.

Certain classes of the teeth are entirely wanting in some orders, classes, and genera of quadrupeds; and in other instances, the different descriptions of teeth, particularly the canine and molares, are separated by considerable intervals. There is no animal in which these parts are of such equal height and such uniform arrangement as in man.

All the three kinds of teeth are found in the quadrumana, the carnivora, the pachydermata (excepting the two-horned rhinoceros and elephant,) the horse, and those ruminating animals which have no horns.

Cuvier states, that the teeth of an animal, whose bones are found in a fossil state, resemble those of man, in being arranged in a continued and unbroken series.

In the simiæ, carnivora, and all such as have canines longer than the other teeth, there is at least one vacancy in each jaw, for lodging the cuspidatus of the opposite jaw. There is a vacancy behind each canine in the bear.

The horned ruminating animals not only want entirely the upper incisors, but they are also destitute of cuspidati, except the stag, which has rudiments of these teeth; and the musk (moschus moschifer) where they are very long, and curved in the upper jaw.

Between the incisors and grinders of the horse, a very large vacancy is left, in the middle of which a small canine tooth, termed the tusk, is found in the male animal; but very rarely in the female.

The elephant has grinders and two tusks in the upper jaw; but the former only in the lower. The immense tusks belong properly to the male animal, as they are so small in the female, generally speaking, as not to pass the margin of the lip. (Corse, in Phil. Trans. 1799, part 2. p. 208.)

The sloths have grinding and canine teeth, without incisors. The dolphin and porpoise have small conical teeth, all of one size and shape, arranged in a continued line throughout the alveolar margin of both jaws. The cachalot (physeter macrocephalus) has these in the lower jaw only. The teeth of the seal are all of one form, *viz.* that of the canine kind; conical and pointed.

The narwhal has no other teeth than the two long tusks implanted in its os intermaxillare; of which one is so frequently wanting.

The structure of the incisor teeth, in the rodentia, deserves attention on several accounts. They are covered by enamel only on their anterior or convex surface, and the same circumstance holds good with respect to the tusks of the hippopotamus. Hence, as the bone wears down much faster than this harder covering, the end of the tooth always constitutes a sharp cutting edge, which renders it very deserving of the name of an incisor tooth.

This partial covering of enamel refutes, as Blake has observed ("Essays on the Structure, &c. of the Teeth," p. 212,) the opinion, that the enamel is formed by the process of crystallization.

The incisor teeth of these animals are used in cutting and gnawing the harder vegetable substances, for which their above-mentioned sharp edge renders them particularly well adapted. Hence Cuvier has arranged these animals in a particular order, by the name of rodentia, or the gnawers. As this employment subjects the teeth to immense friction and mechanical attrition, they wear away very rapidly, and would soon be consumed, if they did not possess a power of growth, by which the loss is recompensed.

These teeth, which are very deeply imbedded in the jaw, are hollow internally, just like a human tooth which is not yet completely formed. Their cavity is filled with a vascular pulp, similar to that on which the bone of a tooth is formed; this makes a constant addition of new substance on the interior of the tooth, which advances to supply the part worn down. The covering of enamel extends over that part of the tooth which is contained in the jaw, as we might naturally expect: for this must be protruded at some future period, to supply the loss of the anterior portion. Although these teeth are very deeply implanted in the maxillary bones, they can hardly be said to possess a fang or root; for the form of the part is the same throughout; the covering of enamel is likewise continued; and that part, which at one period is contained in the jaw, and would form the fang, is afterwards protruded, to constitute the body of the tooth.

The constant growth of these teeth therefore proceeds in the same manner, and is effected on the same principles, as the original formation of any tooth; and can by no means furnish an argument for the existence of vessels in the substance of the part.

We cannot help being struck with the great size of these teeth, compared with the others of the same animal, or even with the bulk of the animal. Their length in the lower jaw nearly equals that of the jaw itself, although a small proportion only of this length appears through the gum. They represent the segment of a circle, and are contained in a canal of the bone, which descends under the sockets of the grinders, and then mounts up, in some instances, to the root of the coronoid process: hence, although their anterior cutting edge is in the front of the mouth, the posterior extremity is behind all the grinding teeth. No animal exhibits this structure better than the rat. The beaver also affords a good specimen of it on a larger scale. It has been drawn in this animal by Blake, ("Essay on the structure, &c. of the teeth.") The tooth does not extend so far in the upper jaw; it is there implanted in the intermaxillary bone, and terminates over the first grinder.

The observations which have been made respecting the constant growth of the incisor teeth of the glires will apply also to the tusks of the elephant. These are hollow internally, through the greater part of their length, and the cavity contains a vascular pulp, which makes constant additions of successive layers, as the tusk is worn down. One of the elephants at Exeter Change is said to have nearly bled to death from a fracture of the tusk, and consequent laceration of the vessels of the pulp. The tusks of the hippopotamus, and probably all other teeth of this description, grow in the same manner. Farther and more accurate observation may hereafter shew, that the same mode of growth obtains also in other classes of teeth, when they are exposed to great friction. Something similar may certainly be observed in the grinders of the horse. The tooth is not finished when it cuts the gum: the lower part of its body is completed, while the upper part is worn away in mastication; and the proper fang is not added till long after. Hence we can never get one of these teeth in a perfect state, for if the part out of the gum is complete, the rest of the body is imperfect; and there are no fangs: on the contrary, when the fangs are formed, much of the body has been worn away in mastication. Blake also asserts, that this structure is found in the grinders of the beaver, (p. 99.)

The narwhal is particularly distinguished by its long and spiral tusk. The animal is found so constantly with only one tusk, that it has been called, in common language, the sea-unicon; and Linnæus has even given it a similar appellation, that of monodon. Yet there can be no doubt that it possesses originally two of these; one in either jaw bone: and that which is wanting must have been lost by some accidental circumstance, as we can easily suppose, ("Shaw's Zoology," vol. ii. p. 473.) These tusks often equal in length that of the animal's body: which may be 18 feet or more: yet they are always slender.

In many baboons, and most particularly in the larger predaceous mammalia, the canine teeth are of a terrific size; in the latter animals, the whole profile of the anterior part of the cranium forms a continuous line with these teeth; which is very visible in the tiger. The canine tusks of the babiroussa, which are very long, and recurved so as nearly to describe a complete circle, present the most curious structure. Their utility to the animal appears quite obscure, when their length, direction, and smallness, are considered.

The distribution of the enamel and bony substance varies in the teeth of different animals, and even in the different orders of teeth in the same animal.

All the teeth of the carnivora, and the incisors of the ruminating animals, have the crown only covered with enamel, as in the human subject. The immense fossil grinders of the animal incognitum, or mammoth, have a similar distribution of this substance.

The grinders of graminivorous quadrupeds, and the incisors also of the horse, have processes of enamel descending into the substance of the tooth. These organs have also in the last-mentioned animals a third component part, differing in appearance from both the others, but resembling the bone more than the enamel. Blake has distinguished this by the name of crusta petrosa; and Cuvier calls it cement.

The physiological explanation of this difference in structure is a very easy and clear one. The food of the carnivora requires very little comminution before it enters the stomach: hence the form of their grinding teeth is by no means calculated for grinding: and as the articulation of the jaw admits no lateral motion, the molares, of which the lower are overlapped by the upper, can only act like the incisors of other animals. The food of graminivorous quadrupeds is subject to a long process of mastication, before it is exposed to the action of the stomach. The teeth of the animals suffer great attrition during this time, and would be worn down very rapidly, but for the enamel which is intermixed with their substance. As this part is harder than the other constituents of the teeth, it resists the attrition longer, and presents the appearance of prominent ridges on the worn surface, by which the grinding of the food is much facilitated.

The distinction of the three substances is seen better in the tooth of the elephant than in any animal. The best method of displaying it is by making a longitudinal vertical section, and by polishing the cut surface. The crusta petrosa will then be distinguished by a greater yellowness and opacity in its colour, and by an uniformity in its appearance, as no laminæ or fibres can be distinguished.

The pulp of a grinding tooth of a graminivorous quadruped is divided into certain conical processes, which are united at their bases. These vary from two to six in the horse and cow. On these the bone of the tooth is formed, as on the single pulp of the human subject, but it is here divided into as many separate shells as there are processes of the pulp: all of them however enclosed in a common capsule. The ossification commences, as in all teeth, on the points of the pulp, and extends towards the basis: when it has arrived there, the shells unite together; and they also join at their outer margins. Between the processes of the pulp other productions descend from the capsule in a contrary direction; and deposit on the surface of the shells enamel, distinguishable by its crystalline appearance, and hence denominated by Blake cortex striatus. When these membranous productions have formed their portions of enamel, they secrete the crusta petrosa within the cavities left between these productions of enamel. The outer surface of the bone of the tooth is covered by enamel, which may be compared to that which invests the crown of the human tooth, except that it is deposited in an irregular waving line, in order to render the surface better calculated for grinding; and the inequalities of this surface of enamel are filled up by crusta petrosa. The exterior enamel, and crusta petrosa, (which may be so named, by way of distinguishing them from the processes within the tooth,) are formed by the surface of the capsule.

If then we make a transverse section of a grinding tooth of the horse or cow, the exterior surface will be found to consist of an irregular layer of crusta petrosa: this is succeeded by a waving line of enamel, within which is the proper bone of the tooth. But the substance of the latter is penetrated by two productions of enamel, in the interior of each of which is crusta petrosa.

The crusta petrosa, which fills these internal productions of enamel, is sometimes not completely deposited before the tooth cuts the gum: hence cavities are left in the centre of the tooth, which become filled with a dark substance, composed of the animal food, and other foreign matters. This seldom happens to any considerable extent in the grinders of the horse. In the cow and sheep these cavities are constantly filled with the dark adventitious matter, the crusta petrosa being confined to the exterior surface of the tooth, and not existing even there so plentifully as in the horse.

The lower grinders of the horse differ very much in their formation from those of the upper jaw. Ossification commences in these by four or five points, which increase into as many small shells; yet they unite without any processes of the capsule passing down between, to form internal productions of the enamel. That substance is, however, deposited in a very convoluted manner on the bone of the tooth, so that the same end is attained, as if productions of the cortex striatus had existed in the centre of the part. The crusta petrosa fills up the irregularities of this waving line of enamel. An horizontal section of such a tooth presents the three substances arranged within each other: the crusta petrosa is external; then comes the enamel, which includes nothing but the proper bone of the tooth.

The incisors of the horse have a production of enamel in their centre; but the cavity which this forms, containing no crusta petrosa, is merely filled by the particles of food, &c. As these processes of enamel descend only to a certain extent in the tooth, they disappear at last, from the constant wear of the part in mastication. This is improperly called the filling up of the teeth; and hence a criterion arises of the horse's age.

The grinding teeth of the elephant contain the most complete intermixture of the three substances, and have a greater proportion of crusta petrosa than those of any other animal. The pulp forms a number of broad flat processes, lying parallel to each other, and placed transversely between the inner and outer laminæ of the alveoli. The bone of the tooth is formed on these in separate shells, commencing at their loose extremities, and extending towards the basis, where they are connected together. The capsule sends an equal number of membranous productions; which first cover the bony shells with enamel, and then invest them with crusta petrosa; which latter substance unites and consolidates the different portions. The bony shells vary in number from four to twenty-three, according to the size of the tooth, and the age of the animal; they have been described under the term of denticuli, and have been represented as separate teeth in the first instance. It must, however, be remembered, that they are formed on processes of one single pulp.

When the crusta petrosa is completely deposited, the different denticuli are consolidated together. The bony shells are united at their base to the neighbouring ones; the investments of enamel are joined in like manner; and the intervals are filled with the third substance, which really deserves the name bestowed on it by Cuvier, of cement. The pulp is then elongated, for the purpose of forming the roots or fangs of the tooth. From the peculiar mode of dentition of this animal, which will be explained in a subsequent note, the front portion of the tooth has cut the gum, and is employed in mastication, before the back part is completely formed, even before some of the posterior denticuli have been consolidated. The back of the tooth does not appear in the mouth until the anterior part has been worn down even to the fang.

A horizontal section of the elephant's tooth presents a series of narrow bands of bone of the tooth, surrounded by corresponding portions of enamel. Between these are portions of crusta petrosa; and the whole circumference of the section is composed of a thick layer of the same substance.

A vertical section in the longitudinal direction exhibits the processes of bone upon the different denticuli, running up from the fangs: a vertical layer of enamel is placed before, and another behind each of these. If the tooth is not yet worn by mastication, the two layers of enamel are continuous at the part where the bone terminates in a point; and the front layer of one denticulus is continuous with the black layer of the succeeding one at the root of the tooth; so that the enamel, ascending on the anterior, and descending on the posterior, surface of each denticulus forms a continued line through the whole tooth. Crusta petrosa intervenes between the ascending and decending portions of the enamel.

As the surface of the tooth is worn down in mastication, the processes of enamel, resisting by their superior hardness, form prominent ridges on the grinding surface, which must adapt it excellently for bruising and comminuting any hard substance.

The grinding bases, when worn sufficiently to expose the enamel, present a very different appearance in the Asiatic and African elephants. The processes of enamel in the former species represent flattened ovals, placed accross the tooth. In the latter they form a series of lozenges, which touch each other in the middle of the tooth.

It does not appear that crusta petrosa is an essential part in the grinders of graminivorous animals. For those of the rhinoceros do not possess it, although the enamel descends into their substance, and forms a cavity which is filled with the food, &c.

Home and Blake likewise state that it does not exist in the hippopotamus, where threre are internal productions of enamel: but Mr. Macartney, the learned and ingenious lecturer on comparative anatomy at St Bartholomew's Hospital, has found it in small quantity on the exterior surface of the tooth near its root.

The want of satisfactory observations prevents us from saying much on the change of the teeth, particularly in wild animals. Some erroneous opinions of former times, as, for instance, that the domesticated pig changes its teeth, and that the wild animal does not, hardly require an express contradiction in the present day. There is no animal of the class Mammalia, where the first appearance and subsequent removal of the deciduous teeth take place at so late a period of life as in man.

The permanent teeth are generally formed in cavities near the roots of the temporary ones; and they succeed to the vacancies left by the discharge of the latter. A different mode of succession obtains, however, in some instances. The adult molares of the human subject are formed in the back of the two jaws, from which situation they advance successively towards the front, in proportion as the maxillary bones are lengthened in that direction. A similar, but much more remarkable, species of succession is observed in the grinders of the elephant, where it was ascertained by the labours of Mr. Corse, who has explained and illustrated the subject in a series of beautiful engravings. See "Observations on the different species of Asiatic Elephants, and their Mode of Dentition," Phil. Trans. 1792, Part II.

We never see more than one grinder, and part of another, through the gum in this animal. The anterior one is gradually worn away by mastication: its fangs and alveoli are then absorbed; the posterior tooth coming forwards to supply its place. As this goes through the same stages as the preceding grinder, a third tooth, which was contained in the back of the jaw, appears through the gum, and advances, in proportion as the destruction and absorption of the other proceed. The same process is repeated at least eight times; and each new grinder is larger than that which came before it. The first or milk grinder is composed of four transverse plates or denticuli, and cuts the gum soon after birth. The 2d, which has eight or nine plates, has completely appeared at the age of two years. The 3d, formed of twelve or thirteen, at six years. From the 4th to the 8th grinder, the number of plates varies from fifteen to twenty-three, which is the largest hitherto ascertained. The exact age at which each of these is completed has not yet been made out. But it appears, that every new one takes at least a year more for its formation than its pedecessor.

From the gradual manner in which the tooth advances, it is manifest, that a small portion of it only can penetrate the gum at once. A grinder, consisting of twelve or fourteen plates, has two or three of these through the gum, whilst the others are embedded in the jaw. The formation of the tooth is complete, therefore, first at its anterior part, which is employed in mastication, while the back part is very incomplete; as the succeeding laminæ advance through the gum, their formation is successively perfected. But the posterior layers of the tooth are not employed in mastication, until the anterior ones have been worn down to the very fang, which begins to be absorbed. One of these grinders can never, therefore, be procured in a perfect state: for if its anterior part has not been at all worn, the back is not completely formed, and the fangs in particular are wanting; while the structure of the back of the tooth is not completed, until the anterior portion has disappeared.

A similar kind of succession, but to a less extent, has been ascertained by Mr. Home, in the teeth of the sus Æthiopicus. "Observations on the Structure of the Teeth of Graminivorous Quadrupeds; particularly those of the Elephant and sus Æthiopicus," Phil. Trans. 1799, Part II.

The researches of the same gentleman have also proved it to exist in the wild boar to a certain degree; and have rendered it probable that it occurred likewise in the animal incognitum (mammoth). "Observations on the Structure and Mode of Growth of the Wild Boar and Animal Incognitum." Phil. Trans. 1801, Part II.

It is remarkable, that the number of cervical vertebræ in the mammalia should be constantly seven, although the animals of this class differ so much in the length of the neck. A single exception occurs in the three-toed sloth, which has nine.

The lumbar vertebræ vary much in number; the elephant has three, the camel seven, the horse six, and the ass five. Mules have generally six. The os coccygis is prolonged so as to form the tail of quadrupeds.

The cavity of the pelvis is so narrow in the mole, that it cannot hold the parts of generation, and the neighbouring viscera, which lie, therefore, externally to the ossa pubis.

In the kangaroo, and in other marsupial animals, the anterior margin of the ossa pubis is furnished with a peculiar pair of small bones for supporting the abdominal pouch of the female.

Cetaceous animals, having no hind feet, have consequently no pelvis: but there is a pair of small bones in the lower part of the belly, which may be compared to the ossa pubis.

In a very few mammalia, as some bats and armadillos, there is a pair of ribs less than in man; but in most of the class these bones are more numerous. The horse has 18, the elephant 19, and the two-toed sloth 23 pairs. The sternum is generally cylindrical and jointed.

BONES OF THE UPPER EXTREMITY.

We may assert as a general observation, that the four component parts of the upper extremities, *viz.* the shoulder, arm, fore-arm, and hand, can be clearly shewn to exist in the anterior extremities of all mammalia, however dissimilar they may appear to each other on a superficial inspection, and however widely they may seem to deviate from the human structure.

Whenever an animal of one class resembles those of a different order in the form and use of any part, we may be assured that this resemblance is only in externals, and that it does not affect the number and arrangement of the bones. Thus the bat has a kind of wings; but an attentive examination will prove, that these are really hands, with the phalanges of the fingers elongated. The dolphin, porpoise, and other cetacea, seem to possess fins consisting of a single piece. But we find under the integuments of the fin-like members, all the bones of an anterior extremity, flattened in their form, and hardly susceptible of any motion on each other. We can recognise very clearly the scapula, humerus, bones of the fore-arm, and a hand consisting of five fingers; the same parts, in short, which form the anterior extremity of other mammalia. See Tyson's "Anatomy of a Porpoise," fig. 10 and 11: also Blasii "Anatomia Animalium," tab. 51, fig. 3, 4.

The fore-feet of the sea-otter, seal, walrus, and manati, form the connecting link between the anterior extremities of other mammalia, and the pectoral fins of the whale kind. The bones are so covered and connected by integuments, as to constitute a part adapted for the purposes of swimming: but they are much more developed than in the latter animals, and have free motion on each other.

The cold-blooded quadrupeds bear great analogy in the four component parts, and in the general structure of their anterior extremities, to the warm-blooded ones. See Caldesi's "Observations on the Turtle," tab. 3, fig. 1, 4, 5.

The bones of the wings of birds have a considerable and unexpected resemblance to those of the fore-feet of the mammalia. And the fin-like anterior member of the penguin contains, within the integuments, the same bones as the wings of other birds.

The clavicle supports the anterior extremity, and maintains the shoulder at its proper distance from the front of the trunk. It exists, therefore, in all such animals as make much use of these members, whether for the purpose of climbing, digging, swimming, or flying. It has, indeed, been supposed to be confined to Linnæus's order Primates (in which he includes man, the quadrumanous animals, and bats.) It will be found in the squirrel and beaver, who use their front extremities for the purpose of holding objects, rather than for that of supporting the body: in the mole, who employs them for digging, &c. &c. Many other animals have in its place an analogous small bone, merely connected to the muscles, and called, by Vicq d'Azyr, os claviculare, to distinguish it from the more perfect clavicle. This is the case with most of the feræ, and some glires. It does not exist, on the contrary, in such as use their fore-feet merely for the purpose of progression, since these limbs must be brought more forwards on the chest, that they may support that part, by being placed perpendicularly under it. In the genera, which hold an intermediate rank between these, which do not enjoy such an extensive utility of the fore-feet as the first division of animals, and are not so limited in their employment as the second, the clavicular bones, or imperfect clavicles, exist.

In ruminating animals, and in the horse, the metacarpus consists of a single bone, called the cannon bone, which is very long when compared with that of man. The humerus becomes shorter, in proportion as the metacarpus is elongated; so that in animals which have a cannon bone, the os humeri hardly extends beyond the trunk. Hence the mistakes which are made in common language, by calling the carpus of the horse his fore-knee, &c.

The radius forms the chief bone of the fore-arm in the mammalia, generally speaking; the ulna is a small slender bone, terminating short of the wrist in a point, and often consolidated with the radius, as in the horse and ruminating animals. A few genera, which have great and free use of their anterior extremity, have the power of pronation and supination. But this power diminishes, as the fore-feet are used more for the purpose of supporting the body in standing, and in progression. In this case, indeed, the extremity may be said to be constantly in the prone position, as the back of the carpus and toes is turned forwards.

The lower end of the ulna is larger than that of the radius in the elephant; but this circumstance occurs in no other instance.

The radius and ulna exist in the seal, manati, and whales, but in a flattened form.

Several genera of mammalia possess a hand; but it is much less complete, and consequently less useful than that of the human subject, which well deserves the name bestowed on it by Aristotle, of the organ of all organs. The great superiority of that most perfect instrument, the human hand, arises from the size and strength of the thumb, which can be brought into a state of opposition to the fingers, and is hence of the greatest use in grasping spherical bodies, in taking up any object in the hand, in giving us a firm hold on whatever we seize; in short, in a thousand offices, which occur every moment of our lives, and which either could not be accomplished at all, if the thumb were absent, or would require the concurrence of both hands, instead of being done by one only. Hence it has been justly described by Albinus as a second hand, "manus parva majori adjutrix," de sceleto, p. 465.

All the simiæ possess hands; but, even in those which many be most justly stiled anthropomorphous, the thumb is small, short, and weak; and the other fingers elongated and slender. In others, as some of the cercopitheci, there is no thumb, or at least it is concealed under the integuments; but these animals have a kind of fore-paw, which is of some use in seizing and carrying their food to the mouth, in climbing, &c. like that of the squirrel. The genus lemur has also a separate thumb. Other animals, which have fingers sufficiently long and moveable for seizing and grasping objects, are obliged, by the want of a separate thumb, to hold them by means of the two fore-paws; as the squirrel, rat, opossum, &c. Those which are, moreover, obliged to rest their body on the fore-feet, as the dog and cat, can only hold objects by fixing them between the paw and the ground. Lastly, such as have the fingers united by the integuments, or enclosed in hoofs, lose all power of prehension.

The metacarpus is elongated in those animals, where the toe only touches the ground in standing or walking; and constitutes the part which is commonly called the fore-leg; as the carpus is termed the knee.

The number of metacarpal bones is the same with that of the fingers or fore-toes, except in the ruminating animals. Even in these there are two distinct metacarpal bones, lying close together before birth: the opposed surfaces first become thinner, then are perforated by several openings, and at last disappear; so that the adult animal has a single cannon bone, possessing a common medullary cavity, internally, and marked on the outside with a slight groove at the place of the original separation. There is therefore but one metacarpal bone in the adult for the two toes. The structure of the metatarsus is the same.

The single finger or fore-toe of the horse is composed of the usual three phalanges; the first, which is articulated to the cannon, is called the pastern: the 2d is the coronet; and the 3d the os basis, or coffin bone, on which the hoof rests. There are also two sesamoid bones at the back of the pastern joint; and an additional part, called the shuttle-bone, connected to the coffin.

In those animals which have five toes, as the carnivora, &c. that which lies on the radial side of the extremity, and is therefore analogous to the thumb, is parallel with the others; and the animal, consequently, has not the power of grasping any object. The last phalanx in these supports the nail of the animal; and sends a process into its cavity. These parts are so connected, that the nail is naturally turned upwards, and not towards the ground: so that its point is not injured in the motions of the animal. The phalanx must be bent, in order to point the nail forwards or downwards.

The order of rodentia have generally five toes; that which corresponds to the thumb being the shortest.

The elephant has five complete toes; but they are almost concealed by the thick skin.

The pig has four toes; two larger ones, which touch the ground; and two smaller behind these, which do not reach so far. There is also a bone, which seems to be the rudiment of a thumb.

The phalanges of the cetacea are flattened, not moveable, and joined together in the fin.

BONES OF THE LOWER EXTREMITY.

The length of the femur depends on that of the metatarsus; and it bears an inverse ratio to the length of that part.

Hence it is very short in the horse, cow, &c. where the same mistakes are commonly committed in naming the parts as in the anterior extremity.

The proportions of the thigh and leg vary in different animals. The latter part exceeds the former in the human subject; and the same remark may be made respecting the arm and fore-arm. These parts are nearly of the same length in the orang-outang. Some persons have affirmed that the negro forms a connecting link between the European and the orang-outang in these respects. (White, on the regular Gradation in Man and Animals, &c.) In some other simiæ the leg and fore-arm exceed the thigh and arm. In other animals, although there are some varieties, the leg is generally longer than the thigh.

The fibula is consolidated to the tibia at its lower end in the mole and rat. It only exists as a small styloid bone in the horse, and becomes anchylosed to the tibia in an old animal.

The structure of the metatarsus in the ruminating animals, and the horse, is the same with that of the metacarpus.

The tarsus of the horse is composed of six bones; and is the part known in common language by the name of the hock.

Animals of the genus simia and lemur, instead of having a great toe placed parallel with the others, are furnished with a real thumb: *i. e.* a part capable of being opposed to the other toes. Hence these animals can neither be called biped nor quadruped, but are really quadrumanous or fourhanded. They are not destined to go either on two or four extremities, but to live in trees, since their four prehensile members enable them to climb with the greatest facility. So that Cuvier has denominated them "les grimpeurs pars excellence." Leçons d'Anat. Comp. vol. i. p. 493.) The prehensile tail of several species is a further assistance in this way of life. The opossum, and others of the genus didelphis, have a similar structure with the quadrumana; and it answers the same purpose. Here, however, there is a separate thumb on the posterior extremity only, whence Cuvier calls them pedimanes.

Man is the only animal in which the whole surface of the foot rests on the ground; and this circumstance arises from the erect stature, which belongs exclusively to him. In the quadrumana, in the bear, hedge-hog, and shrew, (which are called by Cuvier plantigrades,) the os calcis does not touch the ground.

The heel of a species of bear belonging to this country, *viz.* the badger (ursus meles) is covered with a long fur, which proves that this part cannot rest on the ground; although the structure both of the bones and muscles of the lower extremity of this animal approaches considerably to that of man. The same fact is stated of the bear itself, properly so called by the Parisian dissectors.

In other animals the body is supported upon the phalanges of the toes, as in the dog and cat; in the horse and ruminating animals, no part touches the ground but the last phalanx. Here the elongation of the metatarsus removes the os calcis to such a distance from the toe, that it is placed midway between the trunk and hoof.

SKELETON OF BIRDS.

The skull, which in the adult has no sutures, is articulated to the spine by a single rounded condyle. This structure gives the head a great freedom of motion, particularly in the horizontal direction. It enables the bird to place its bill between the wings when asleep; a situation in which none of the mammalia can place the snout.

The lower jaw is articulated to the cranium by means of a square bone on each side, called os quadratum. The superior mandible, which is completely immoveable in mammalia, has, with a few exceptions, more or less motion in birds. It either constitutes a particular bone, distinct from the rest of the cranium, to which it is articulated, as in the psittaci (birds of the parrot kind;) or it is connected into one piece with the cranium, by means of yielding and elastic bony plates; as is the case with birds in general. It is quite immoveable in a very few instances, as the tetrao urogallus (cock of the woods) and the rhinoceros bird.

The jaws are entirely destitute of teeth. The bill may be considered, in some degree, as supplying the place of teeth; yet as none of these animals masticate their food, but swallow it whole, the bill can only be compared to the incisors of such animals as use them for seizing and procuring their food.

It consists of a horny fibrous matter, similar to that of the nail, or of proper horns; and is moulded to the shape of the bones which constitute the two mandibles, being formed by a soft vascular substance, covering these bones. Its form and structure are as intimately connected with the habits and general character of the animal, as those of the teeth are in the mammalia. Hence an enumeration of its different figures and consistence belongs properly to the department of natural history, where it forms the foundation of classical distinctions.

The accipitres, or rapacious birds, have it very hard, hooked at the end, and furnished with a process on either side; calculated, therefore, in all respects, for seizing and lacerating their prey. Those of the parrot kind have it also hard, for bruising the firmer vegetable fruits; and the wood-pecker, nuthatch, &c. for penetrating the bark of trees.

Those birds, which take a softer kind of food, and which require a sense of feeling in the part, for distinguishing their food in mud, water, &c. have it approaching to the softness of skin. Such are, the duck, snipe, woodcock, &c.

In several classes, particularly the accipitres and gallinæ, the base of the bill is covered with a soft skin, called the cire, of unknown use.

The cervical vertebræ of birds are very numerous, and have a very free motion on each other. This great mobility of the neck enables the animal to touch every point of its body with the bill; and thus supplies the want of the prehensile faculty of the anterior extremity. The sternum is prolonged below into a vertical process (crista) for the attachment of the strong pectoral muscles, which are the chief agents in the act of flying. In the male wild swan (anas cygnas) and in some species of the genus ardea, as the crane, this part forms a peculiar cavity for the reception of a considerable portion of the trachea. The crista is entirely wanting in the ostrich and cassowary; where the sternum presents, on its anterior or under surface, an uniform convexity, and this peculiarity of structure is accounted for by observing that these birds have not the power of flying.

The wings are connected to the trunk by means of three remarkable bones. The clavicles, which are always strong, constitute straight cylindrical bones, articulated to the sides of the front of the sternum, and extending straight forwards. Their anterior extremities are connected to the sternum, by means of a bone peculiar to birds, *viz.* the fork-like bone, or, as it is more commonly termed, the merrythought. (Furcula, in French, la lunette or fourchette.) The scapula, which is flattened in form, but elongated, extends backwards from the front of the clavicle, parallel to the spine. The point of the fork-like bone is joined to the most prominent part of the keel of the sternum; and the extremities of its two branches are tied to the humeral ends of the clavicles, and the front of the scapulæ, just where these bones join each other, and are articulated with the humerus. Hence it serves to keep the wings apart in the rapid motions of flying.

As a general observation, it may be stated, that the fork is strong and elastic, and its branches wide, arched, and carried forwards upon the body, in proportion as the bird possesses strength and rapidity of flight; and accordingly the struthious birds (ostrich and cassowary,) which are incapable of this mode of progression, have the fork very imperfectly formed. The two branches are very short, and never united in the African ostrich, but are anchylosed with the scapula and clavicle. The cassowary has merely two little processes from the side of the clavicle, which are the rudiments of the branches of the fork. In the New Holland ostrich there are two very small thin bones, which are attached to the anterior edge of the dorsal end of the clavicles by ligaments; they are directed upwards towards the neck, where they are fastened to each other by means of a ligament, and have no connection whatever with the sternum.

The bones of the wing may be compared, on the whole, to those of the upper extremity in man; and consist of an os humeri; two bones of the fore-arm; two of the carpus; two, which are generally consolidated together, of the metacarpus; one bone of the thumb, and two fingers.

The stork, and some others of the grallæ, which sleep standing on one foot, possess a curious mechanism for preserving the leg in a state of extension, without any, or at least with little, muscular effort. There arises from the fore-part of the head of the metatarsal bone a round eminence, which passes up between the projections of the pulley, on the anterior part of the end of the tibia. This eminence affords a sufficient degree of resistance to the flexion of the leg, to counteract the effect of the oscillations of the body, and would prove an insurmountable obstruction to the motion of the joint, if there were not a socket, within the upper part of the pulley of the tibia, to receive it when the leg is in the bent position. The lower edge of the socket is prominent and sharp, and presents a sort of barrier to the admission of the eminence, that requires a voluntary muscular exertion of the bird to overcome, which being accomplished, it slips in with some force, like the end of a dislocated bone.

SKELETON OF THE AMPHIBIA.

Turtles and tortoises have no teeth: but their jaws are covered with a horny substance, somewhat resembling the horse's hoof in the mode of its connection with the bone. The cavity containing the brain is extremely small in comparison with the size of the skull. This circumstance is still more remarkable in the crocodile, where, in an individual measuring 13 or 14 feet, this cavity will hardly admit the thumb. The vast muscles of the jaw fill up the sides of the cranium.

The body of the turtle and tortoise is provided with two broad and flattened bony shells, to which the trunk of their skeleton is consolidated.

Frogs and toads have no teeth. In no other animal are the jaws of such immense size, in comparison with the extremely small cavity of the cranium, as in the crocodile. The anterior part of the upper jaw consists of a large intermaxillary bone; and the lateral portions of the lower maxilla are formed of several pieces joined together. The lower jaw is articulated in a peculiar manner in these animals: it has an articular cavity, in which a condyle of the upper jaw is received.

The condyle resembles, in some measure, the pulley at the inferior extremity of the humerus (the trochlea, or rotula of Albinus:) this, at least, is the case in the skull of the alligator.

The old error, of supposing that the upper jaw of the crocodile is moveable, and the lower on the contrary, incapable of motion, which has been adopted even by such anatomists as Vesalius and Columbus, has perhaps arisen from this peculiar mode of articulation. An examination of the cranium shows, that if the lower jaw remains unmoved, the whole remainder of the skull may be carried backwards and forwards by means of this joint. And such a motion is proportionally easier in the present instance than in any other animal, both on account of the very great relative size of the lower jaw, as well as from its anomalous mode of articulation. There is, however, no motion of the upper jaw bone, only upon the bones of the cranium, similar to that which occurs in most birds, serpents, and fishes.

The most surprising singularity in the skeleton of the crocodile consists in an abdominal sternum, which is quite different from the thoracic sternum, and extends from the ensiform cartilage to the pubis, apparently for the purpose of supporting the abdominal viscera.

The serpents have an upper jaw, unconnected with the rest of the skull, and more or less moveable of itself.

We find in their teeth the important and clearly defined difference, which distinguishes the poisonous species of serpents from the much more numerous innoxious tribes.

The latter have, in the upper jaw, four maxilliary bones, beset with small teeth, which form two rows, separated by a considerable interval from each other. One of these is placed along the front edge of the jaw; the other is found more internally, and is situated longitudinally on either side of the palate.

The external row is wanting to the poisonous species; which have in their stead, much larger tubular fangs, connected with the poison bladder, and constituting, in reality, bony, excretory ducts, which convey the venom into the wound inflicted by the bite of the animal.

It appears, in general, that the number of vertebræ, in red-blooded animals, is in an inverse proportion with the size and strength of their external organs of motion. Serpents, therefore, which entirely want these organs, have the most numerous vertebræ; sometimes more than 300.

It may be observed, in confirmation of this remark, that the number of vertebræ is very great in fishes of an elongated form, *viz.* in the eel, which has above one hundred. The porpoise, which has no organs of motion which deserve mentioning, has between sixty and seventy.

Birds, which have such vast power of locomotion by means of their wings, have very few vertebræ, if we consider the anchylosed ones as forming a single piece. And the frog, with its immense hind extremities, has a very short spine, consisting of still fewer pieces.

We should naturally conclude, from observing the great diversity in the general form of fishes, that the structure of their skeleton must be equally various. They agree together, however, on the whole, in having a spine, which extends from the cranium to the tail-fin; and in having the other fins, particularly those of the thorax and abdomen, articulated with peculiar bones, destined to that purpose. They have in general many more bones unconnected with the rest of the skeleton, than the animals of the preceding classes.

The cranium in several cartilaginous fishes, (in the skate for instance) has a very simple structure, consisting chiefly of one large piece. In the bony fishes, on the contrary, its component parts are very numerous; amounting to eighty in the head of the perch. Most of the latter have a more or less moveable under jaw.

Great variety in the structure of the teeth is observed in this class. Some genera, as the sturgeon, are toothless. Their jaws, which are distinct from the cranium, form a moveable part, capable of being thrust forwards from the mouth, and again retracted.

Those fishes which possess teeth differ very much in the form, number, and position of these organs. Some species of sparus (as the S. probato-cephalus) have front teeth almost like those of man; they are provided with fangs, which are contained in alveoli. In many genera of fishes, the teeth are formed by processes of the jaw-bones covered with a crust of enamel. In most of the sharks, the mouth is furnished with very numerous teeth, for the supply of such as may be lost. The white shark has more than two hundred, lying on each other in rows, almost like the leaves of an artichoke. Those only which form the front row have a perpendicular direction, and are completely uncovered. Those of the subsequent rows are, on the contrary, smaller, have their points turned backwards, and are covered with a kind of gum. These come through the covering substance, and pass forward when any teeth of the front row are lost. It will be understood from this description that the teeth in question cannot have any fangs.

The saw-fish only (squalus pristis) has teeth implanted in the bone on both sides of the sword-shapen organ, with which its head is armed.

In some fishes the palate, in others the bone of the tongue (as in the frog fish,) in others (as in several of the ray-kind,) the aperture of the mouth forms a continuous surface of tooth.

MOUTH, ŒSOPHAGUS, AND STOMACH.

We have already shown the most important circumstances relating to the mouth. Many species of the genus simia, as well as the hamster, (marmota cricetus) and some similar species of the marmot, are provided with cheek pouches, in which the former, who live on trees, place small quantities of food as a reserve: the latter employ these bags to convey their winter provision to their burrows.

The peculiar glandular and moveable bag, (bursa faucium,) which is placed behind the palate, has hitherto been only observed in the camels of the old world: and it probably serves to lubricate the throats of these animals, in their abode in the dry sandy deserts which they inhabit.

The œsophagus of quadrupeds is distinguished from that of the human subject by possessing two rows of muscular fibres, which pursue a spiral course, and decussate each other. In those carnivorous animals which swallow voraciously, as the wolf, it is very large; on the contrary, in many of the larger herbivora, and particularly in such as ruminate, its coats are proportionably stronger.

No mammalia possess an uvula, except man and the simia.

In some herbivora the stomach has an uniform appearance externally; but it is divided into two portions internally, either by a remarkable difference in the two halves of its internal coat, as in the horse, or by a valvular elongation of this membrane, as in several animals of the mouse-kind. This is also the case in the hare and rabbit, where also the food in the two halves of the stomach differs very much in appearance, particularly if the animal has been fed about two hours before death.

In these animals the left half of the stomach is covered with cuticle, while the other portion has the usual villous and secreting surface. The left portion of the cavity may be regarded as a reservoir, from which the food is transmitted to the true digestive organ; and the different states in which the food is found in the two parts of the cavity justify this supposition. Hence these stomachs form a connecting link between those of ruminating animals on one side, and those which have the whole surface villous on the other.

On the whole internal surface of the horse's stomach there are found, in vast abundance, particularly in spring, the larvæ of two species of œstrus; *viz.* the œstrus equi (which Linnæus called œstrus bovis,) and the œ. hæmorrhoidalis, the true history of which has been elucidated, for the first time in modern days, by that excellent veterinary surgeon Mr. Bracy Clark, in the "Transactions of the Linnæan Society," vol. 3.

These animals, which are called botts, attach themselves to every part of the stomach, but are in general most numerous about the pylorus; and are sometimes, but much less frequently, found in the intestines. They hang most commonly in clusters, being fixed by the small end to the inner membrane of the stomach, where they adhere by means of two small hooks or tentacula. When removed from the stomach, they will attach themselves to any loose membrane, and even to the skin of the hand: for this purpose they draw back their hooks almost entirely within the skin, till the two points of these hooks close to each other; they then present them to the membrane, and keeping them parallel till it is pierced through, they expand them in a lateral direction; and afterwards, by bringing the points downwards, or towards themselves, they include a sufficient piece of the membrane with each hook, and thus remain firmly fixed, for any length of time, without any further exertion of the animal. They attain their full growth about the latter end of May, and are coming from the horse from this time to the latter end of June. On dropping to the ground, they soon change to the crysalis, and in six or seven weeks the fly appears. This bott is larger and whiter than that of the œstrus hæmorrhoidalis, which has a reddish cast; but in its structure, and situation in the animal, resembles the former. It is found, however, to hang about the rectum, previously to quitting it, which the large horse-bott never does.

Veterinary practitioners do not seem to have decided, hitherto, whether these animals are prejudicial to the horse; nor even whether they may not be actually beneficial. Their almost universal existence at a certain season, even in animals perfectly healthy, shows that they produce no marked ill effect; yet the holes which they leave, where they were attached to the stomach, could hardly be made without causing some injurious irritation.

For the mode in which these botts gain admission into the stomach, as also for a most interesting general account of their history and structure, see Œstrus, which was furnished by Mr. Clark, and from which the preceding account is borrowed.

The food of carnivorous animals approaching in its constituent elements more nearly to those of the animal than that of the herbivorous tribes, is more easily reduced into the state which is required for the nourishment of the body in the former than in the latter case. Hence arises a leading distinction between the stomachs of these classes. In the latter animals, the œsophagus opens considerably to the right of the great extremity, so as to leave a large cul de sac on the left side of the stomach; and the small intestine commences near the cardia, leaving a similar blind bag on the right. The food must be detained for a long time in such a stomach, as the passage from the œsophagus to the pylorus is indirect, and highly unfavourable to speedy transmission. Animals of the mouse kind, and the rodentia, show this structure very well; it is very remarkable in the mus quercinus, (Cuvier, "Leçons," &c. tom. 5. pl. 36. fig. 11.) In the carnivora, the stomach, which is of a cylindrical form, has no cul de sacs; the œsophagus opens at its anterior extremity, and the intestine commences from the posterior; so that every thing favours a quick passage of the food. Animals of the weasel kind, which are very truly carnivorous, exhibit this structure the most completely. The seal also exemplifies it, and the lion. (Cuvier, pl. 36. fig. 7.)

The most complicated and artificial arrangement, both with respect to structure and mechanism, is found in the well-known four stomachs of the ruminating animals with divided hoofs: of this we shall take, as examples, the cow and sheep.

The first stomach or paunch, (rumen, penula, magnus ventor, ingluvies, is by far the largest in the adult animal; not so however in the recently born calf or lamb. It is divided externally into two saccular appendices at its extremity, and it is slightly separated into four parts on the inside. Its internal coat is beset with innumerable flattened papillæ.

This is followed by the second stomach, honeycomb bag, bonnet, or king's hood, (reticulum, ollula,) which may be regarded as a globular appendage of the paunch; but it is distinguished from the latter part by the elegant arrangement of its internal coat, which forms polygonal and acute-angled cells, or superficial cavities.

The third stomach, which is the smallest, is called the manyplus, which is a corruption of manyplies (echinus, conclave, centipellio, omasum): it is distinguished from the two former, both by its form, which has been compared to that of a hedge-hog when rolled up, and by its internal structure. Its cavity is much contracted by numerous and broad duplicatures of the internal coat, which lie lengthwise, vary in breadth in a regular alternate order, and amount to about 40 in the sheep, and 100 in the cow.

The fourth, or the red, (abomasum, faliscus, ventriculus intestinalis) is next in size to the paunch, of an elongated, pyriform shape, with an internal villous coat like that of the human stomach, with large longitudinal rugæ.

The three first stomachs are connected with each other, and with a groove-like continuation of the œsophagus, in a very remarkable way. The latter tube enters just where the paunch, the second and third stomachs, approach each other; it is then continued with the groove, which ends in the third stomach. This groove is therefore open to the first stomachs, which lie to its right and left. But the thick prominent lips which form the margin of the groove admit of being drawn together so as to form a complete canal; which then constitutes a direct continuation of the œsophagus into the third stomach.

The functions of this very singular part will vary, according as we consider it in the state of a groove, or of a closed canal. In the first case, the grass, &c. is passed, after a very slight degree of mastication, into the paunch, as into a reservoir. Thence it goes in small portions into the second stomach, from which, after a further maceration, it is propelled, by a kind of antiperistaltic motion, into the œsophagus, and thus returns into the mouth. It is here ruminated, and again swallowed, when the groove is shut, and the morsel of food, after this second mastication, is thereby conducted directly into the third stomach. During the short time which it probably stays in this situation between the folds of the internal coat, it is still further prepared for digestion, which process is completed in the fourth or true digestive stomach.

The phenomena of rumination suppose a power of voluntary motion in the part. And indeed the influence of the will in the whole function is incontestible. It is not confined to any particular time, since the animal can delay it according to circumstances, when the paunch is quite full. It has been expressly stated of some men, who have had the power of ruminating, (instances of which are not very rare) that it was quite voluntary with them. Blumenbach knew two men, who ruminated their vegetable food: both assured him that they had a real enjoyment in doing this, which has also been observed of others; and one of them had the power of doing it, or leaving it alone, according to circumstances.

The final purpose of rumination, as applicable to all the animals in which it takes place, and the chief utility of this wonderfully complicated function in the animal economy, are still completely unknown. What has been already suggested on these points is completely unsatisfactory. The old dream of Aristotle and Galen, that rumination supplies the place of incisor teeth, the materials of which are applied, in these animals, to the formation of horns, scarcely deserves mention. Perault and others supposed, that it contributed to the security of these animals, which generally eat much and are timid, by showing the necessity of their remaining long employed in chewing in an open pasture. But the Indian buffalo ruminates, although it does not fly even from a lion, but rather attacks, and often vanquishes that animal: and the wild goat dwells in Alpine countries, which are inaccessible to beasts of prey.

The peculiar structure of the stomach in the camel and lama, which enables these animals to take at one time a sufficient quantity of water to last them for two, three, or more days, and thereby renders them adapted to inhabit the dry and sandy deserts, which constitute their natural abode, is highly worthy of attention. The fluid which they drink is deposited in numerous cells, formed in the substance of their first and second stomachs, by strong bands of muscular fibres crossing each other at right angles. It should seem that the animal has the power of closing these cells by the contraction of those fibres which form the mouths of the cavities, or of expelling the contained fluid by putting the other portions of fibres in action.

This cellular structure is found in two parts of the first stomach; and it occupies the whole of the second. It was found in a dead camel, that these cavities would hold two gallons of fluid; but they were probably more capacious during life, as the animal in question always drank six or seven gallons of water every other day, and took more in the intermediate time. Mr. Bruce states, in his travels, that he procured four gallons from one which he slaughtered in Upper Egypt. "Shaw's Abridgment of Bruce's Travels." Ed. 3. p. 371.

As all the food which the animal takes passes into the first stomach, the water of the cells in that part becomes turbid; but it remains perfectly pure in the second, where it resides in the greatest quantity; which circumstance accounts for travellers being able to drink it on an emergency. The muscular bands, which form the groove described in the account of the ruminating stomach, are particularly strong; and by drawing the third stomach to the œsophagus, convey the ruminated food through the second, without polluting the water in its cells. Hence the food that has been macerated in the paunch must be sent back to the mouth directly from that cavity, without passing into the second stomach, as it does in the cow. See "Observations on the camel's stomach respecting the water which it contains," &c. by E. Home, esq. Philos. Trans. 1806.

The structure of these parts in the lama, according to the account which Cuvier has given of them, from the examination of a fetus, does not seem to differ essentially from that of the camel.

There is a peculiar glandular body at the upper orifice of the beaver's stomach, about the size of a florin, full of cavities that secrete mucus. It resembles, on the whole, the bulbus glandulosus of birds, and assists in the digestion and animalization of the dry food which this curious animal takes, consisting chiefly of the bark and chips of trees, &c.

According to Cuvier, there is a gland as large as the head of a man, situated between the coats of the stomach in the manati (trichechus manatus borealis). It is placed near the œsophagus, and discharges, on pressure, a fluid like that of the pancreas, by numerous small openings.

Mr. Home is of opinion that the glandular structure exists in the stomach of the sea-otter near the pylorus. Philos. Trans. 1796. pl. 2. And Mr. Macartney has discovered an arrangement of glandular bodies in the dormouse, round the œsophagus, just before its termination, similar in situation and appearance to the gastric glands of birds.

The stomach of the pangolin (manis pentadactyla) is almost as thick and muscular as that of the gallinaceous fowls, and contains, like that of granivorous birds, small stones and gravel, which are probably swallowed for the same purpose as in those birds.

ŒSOPHAGUS AND STOMACH OF BIRDS.

The œsophagus is of immense size in many carnivorous birds; considerably larger indeed than the intestinal canal. The capaciousness of this tube enables it to hold for a time the entire fish and large bones which these birds swallow, and which cannot be contained in the stomach; and to facilitate the discharge, by vomiting the indigestible remains of the food, which form balls of hair, feathers, and bony matter.

The œsophagus expands just before the sternum into the crop, (ingluvies, prolobus, le jabot,) which is furnished with numerous mucous or salivary glands, disposed in many cases in regular rows. In such birds as nourish their young from the crop the glands swell remarkably at that time, and secrete a greater quantity of fluid. This part is found in land-birds only, but not in all of these; it exists in all the gallinæ, and in some birds of prey.

There is another glandular and secretory organ, much more common than the crop, belonging, indeed, most probably to the whole class. This is the bulbus glandulosus, (echinus, infundibulum, proventriculus, corpus tubulosum,) which is situated before the entrance of the œsophagus into the proper stomach, and whose form and structure vary considerably in the different genera and species. In the ostrich, for example, its magnitude and form give it the appearance a second stomach. In some other birds, as the psittaci, ardeæ, (crane, stork, &c.) its appearance is different from that of the proper stomach, but its size is larger; while, on the contrary, in gallinaceous fowls it is much smaller.

This bulbus glandulosus consists of a vast congeries of glands. The œsophagus, of which it is a dilatation, has a vast number of glandular bodies interposed between its tunics, and entirely surrounding the tube, so as to constitute the "Zone of gastric glands" of Mr. Macartney. These bodies have a hollow internally, and they open into the cavity of the bulbus by numerous very plain apertures. The fluid secreted by them passes into the gizzard, and mixes with the food.

A deviation from the natural structure, which is completely unparalleled, occurs in the stomach of the cuckoo. The gizzard of the bird is covered, internally, with an abundance of short, bristle, and spiral hairs, lying close together.

The structure of the stomach differs most widely in the different orders and genera of this class. It appears merely as a thin membranous bag, in several of those which feed on flesh and insects, when compared with the thick muscular globes of the granivorous genera. But there are in both many intermediate links between these extremes, and at the same time considerable analogies in the structures, which are apparently the most opposite. This is particularly observeable in the course of the muscular fibres, and in the callous structure and appearance of the internal coat; in which points, many of what are called membranous stomachs have a great resemblance to those of the gallinæ.

Both parts, but particularly the muscular, are very strong in the gizzard (ventriculus bulbosus) of granivorous birds. We find here, instead of a muscular coat, four immensely thick and powerful muscles, *viz.* a large hemispherical pair at the sides (laterales,) and two smaller ones (intermedii) at the two ends of the cavity. All the four are distinguished, by the unparalleled firmness of their texture, and by the peculiar colour, from all the other muscles of the body.

The internal callous coat must be considered as a true epidermis; since, like that part, it becomes gradually thicker from pressure and rubbing. It forms folds and depressions towards the cavity of the stomach; and these irregularities are adapted to each other on the opposed surface. The cavity of this curious stomach is comparatively small; its lower orifice is placed very near the upper. Every part of the organ is, indeed, calculated for producing very powerful trituration; and this is still further promoted by the well-known instinctive practice of granivorous birds, of swallowing small hard stones with their food.

The end and use of swallowing these stones have been very differently explained. Cæsalpinus considered it rather as a medicine than as a common assistance to digestion; Boerhaave, as an absorbent for the acid of the stomach; Redi, as a substitute for teeth; according to Whytt, it is a mechanical irritation, adapted to the callous and insensible nature of the coats of the stomach; Spallanzani rejected all supposition of design or object, and thought that the stones were swallowed from mere stupidity. There seems not much sagacity to be discovered in this opinion, when we consider that these stones are so essential to the due digestion of the corn, that birds grow lean without them, although they may be most copiously supplied with food. This paradoxical opinion has, however, been already refuted by J. Hunter and G. Fordyce. Blumenbach thinks that the stones kill the grain, and deprive it of its vitality, which otherwise resists the action of the digestive powers. Thus it has been found that if the oats and barley given to horses be previously heated, the animal only requires half the quantity, and thrives equally well.

Reptiles and birds have their nostrils terminated by two longitudinal slits on the palate; they have no velum palati, nor epiglottis.

The œsophagus of the serpent kind is of immense magnitude; for these reptiles swallow animals larger than themselves, which are retained for a considerable time in the tube, and descend into the stomach by degrees, where they are slowly subjected to the action of the gastric juice. The whole process sometimes occupies many days, or even weeks. There is hardly any distinction between œsophagus and stomach.

From the peculiar formation of the nose of fishes, and from their respiring by means of gills, their fauces have no connection with any nasal cavity, or glottis.

The œsophagus is of great width in fishes; and is distinguished with difficulty in many cases from the stomach. These animals swallow their food whole, without subjecting it to any mastication; and if the stomach will not hold the whole, a part remains in the œsophagus, until that which has descended lower is digested. The alimentary canal is generally very short; sometimes extending straight from the mouth to the anus with very little dilatation, as in the lamprey (petromyzon marinus.)

The crustacea, and some insects, are furnished with organs of mastication of similar structure. Their mouth is formed of two or more pairs of jaws placed laterally. These move from without inwards, and vice versa; whereas those of red-blooded animals move from above downwards, and back again. The parts which are termed the lips of insects are two bodies, of which one is placed above or in front of the jaws, and the other below or behind them. The palpi or feelers are articulated to the jaws. All insects which have jaws, possess the power of masticating hard animal and vegetable substances; for these parts are of a firm horny texture, and in many cases are very large, when compared with the size of the animal.

The locust (grylli,) the dragon-fly (libellula,) the beetles, and particularly the lucanus cervus, or stag-beetle, and the staphylinus maxillosus, are examples in which the jaws are very large and manifest, and often possess denticulated edges. All the genera of the following order have jaws; *viz.* the coleoptera, orthoptera, neuroptera, and hymenoptera. The insects of the remaining orders derive their nourishment chiefly from liquids; which they get either from animal or vegetable substances by means of a spiral and tubular tongue, or soft proboscis, as in the lepidoptera; with a broad opening, admitting of extension and retraction (the hemiptera;) or a horny pointed tube, containing sharp bristly bodies internally (the diptera and aptera.)

The stomach of the bee is a transparent membranous bag, in which the nectar of the flowers is elaborated and converted into honey. The animal vomits it up from this reservoir, and deposits it in the hive.

The stomach of the crab and lobster is a very singular organ. It is formed on a bony apparatus, in short, a species of skeleton, and does not therefore collapse when empty. To certain parts of this bony structure, round the pylorus, the teeth are affixed. Their substance is extremely hard, and their margin is serrated or denticulated; as they surround the tube, near the pylorus, nothing can pass that opening without being perfectly comminuted. These bones and teeth are moved by peculiar muscles.

In those mollusca, which possess jaws, these parts are fixed in the flesh of the animal, as there is no head to which they can be articulated. They are two in number in the cuttle-fish, are composed of a horny substance, and resemble exactly the bill of a parrot. They are placed in the centre of the lower part of the body, and are surrounded by the tentacula, which enable the animal to attach itself to any object. By means of these parts, the shell-fish, which are taken for food, are completely triturated. The common snail and slug have a single jaw, semilunar in its form, and denticulated. The tritonia has two jaws, which act like the blades of a pair of scissars. The other mollusca possess no organs of this kind, but have, in some instances, a sort of proboscis; as the buccinum, murex, voluta, doris, scyllæa, &c.

In the worms, properly so called, there are sometimes hard parts, forming a kind of jaws or teeth; thus in the nereis, the mouth possesses several calcareous pieces. The ophrodite (sea-mouse) has a proboscis, furnished with four teeth, which it can extend and retract at pleasure. Within the mouth of the leech are three semicircular projecting bodies, with a sharp denticulated edge: by this apparatus the animal inflicts its wound of the well known peculiar form in the skin.

The teeth of the echinus (sea-hedgehog) are of a very singular arrangement; a round opening is left in the shell for the entrance of the food; a bony structure, on which five teeth are placed, fills up this aperture; and as these parts are moved by numerous muscles, they form a very complete organ of mastication.

The stomach of the vermes is, in general, a membranous bag, but in some cases its structure is more complicated. The helix stagnalis and the onchidia have gizzards. The aplysia has three strong muscular stomachs, provided with pyramidal bony processes. The latter structures, together with those of the lobster and crab, present a new analogy, as Cuvier has observed, between the membranes of the intestines and the integuments of the body. This is particularly strengthened by the annual shedding of the lobster's teeth, when its crustaceous covering falls off.

The bulla lignaria has a very powerful stomach, containing three hard calcareous shells, by which the animal is enabled to bruise and masticate the other testacea on which it feeds.

ON THE INTESTINAL CANAL.

The intestinal canal (which is the most common part in the whole animal kingdom after the stomach) is distinguished in the mammalia by two peculiarities, which depend on the mode of nutrition. It is comparatively shorter in carnivorous animals, and there is also in these less difference, to external appearance, between the small and the large intestine than in the herbivora. Yet these rules are not without their exceptions; for the seal has very long, and the sloth very short, intestines; the badger, which is not a proper carnivorous animal, and several true herbivora, as for instance, the rell-mouse, (glis esculentus,) have no distinction between the large and small intestine, &c.

In considering the proportionate lengths of the intestinal canal, and the relation which these bear to the kind of food on which the animal subsists, many circumstances must be taken into the account, besides the mere measure of the intestine. Valvular projections of the internal membrane; dilatations of peculiar parts of the canal; and a large general diameter, compensate for shortness of the intestine; and vice versa. The structure of the stomach must also be considered, as whether it is formed of more than one cavity; whether the œsophagus and intestine communicate with it in such a manner as to favour a speedy transmission of the food, or whether there are cul de sacs which retain the aliment for a long time in the cavity. The formation of the jaws and teeth, and the more or less perfect trituration and comminution which the food experiences in the mouth, must likewise be viewed in connection with the length and structure of the alimentary canal.

The whole length of the canal is greater in the mammalia than in the other classes. It diminishes successively, as we trace it in birds, reptiles, and fishes, being shorter than the body in some of the latter animals, which is never the case in the three first classes.

In omnivorous animals, the length of the canal holds a middle rank between those which feed on the flesh and such as take vegetable food; thus, in the rat, its proportion to the body is as 8 to 1; in the pig 13 to 1; in a man 6 or 7 to 1. The diminution in length in the latter case is compensated by other circumstances, *viz.* the numerous valvulæ conniventes, and the preparation which the food undergoes by the art of cookery.

In carnivorous animals, every circumstance concurs to accelerate the passage of the alimentary matter. It receives no mastication; it is retained for a very short time in the stomach; the intestine has no folds or valves; it is small in diameter: and the whole canal, when compared to the body, is extremely short, being 3 or 5 to 1. In general there is no cæcum.

The ruminating animals present the opposite structure. The food undergoes a double mastication, and passes through the various cavities of a complicated stomach. The intestines are very long; 27 times the length of the body in the ram. Hence the large intestines are not dilated or cellular, nor is there a cæcum. The solipeda have not such a length of canal, nor is their stomach complicated; but the large intestines are enormous, and dilated into sacculi; and the cæcum is of a vast size, equal, indeed, to the stomach. The rodentia, which live on vegetables, have a very large cæcum, and a canal 12 or 16 times as long as the body. In the rat, which can take animal as well as vegetable food, the canal is shorter than in the other rodentia.

There are some exceptions to the rule which we have just mentioned, respecting the length of the canal in carnivorous and herbivorous animals. The seal, which takes animal food, has very long intestines; the sea-otter resembles it in this respect, and differs therein most remarkably from the common otter, which resembles other carnivorous animals in the shortness of its intestinal tube. The length of canal in the former is twelve times that of the animal, and only three times and a quarter in the latter. (Home, in the Philos. Trans. 1799, part 2.) Whales have likewise a longer canal than other carnivorous mammalia; their stomach is complicated, and the intestine has longitudinal folds. It seems, therefore, that a considerable length of intestinal canal is found in all mammalia which live much in the water, although they are carnivorous.

The plantigrade animals, which have carnivorous teeth, but feed equally well on vegetables, have a long canal; but it is very narrow, and possesses no cæcum, nor distinction of large intestine.

A species of bat (vespertilio noctula) seems to have the shortest intestinal canal of any mammalia; it is only twice the length of the animal's body. On the contrary, the rousette (vesp. vampyrus, Linn. v. caninus, Blum.) which lives entirely on vegetables, has it seven times as long.

In a few instances, as the beaver and sloth, the rectum and urethra have a common termination, which may be compared to the cloaca of birds. This resemblance is the most striking in the ornithorhynchus.

A remarkable difference is observed in the length of the canal between the wild and domesticated breeds of the same species. In the wild boar the intestines are to the body as nine to one; in the tame animal these proportions are as thirteen to one. In the domestic cat, five to one; in the wild cat, three to one; in the bull, twenty-two to one; in the buffalo, twelve to one. They are, on the contrary, longer in the wild than in the tame rabbit; the proportions in the former being eleven, and in the latter nine to one.

The proportion of the intestinal canal to the length of the body, in birds, is as two, three, four, or five to one. It is not always longest and largest in the granivorous species, as many piscivorous birds have it equally long.

It is hardly twice the length of the body in many reptiles; and not so much in the frog, although it is nine times as long as the space between the mouth and the anus in the tadpole.

The alimentary canal of some fishes is continued straight from the mouth to the anus, and does not, therefore, equal the length of the body. The lamprey, skate, and shark, are thus circumstanced.

Most birds have two cæca, which are longer in the gallinæ than in the carnivorous tribes. The rectum ends in a part called the cloaca, which is a large membranous bag, containing also the termination of the ureters, that of the oviduct, the vasa deferentia, and of a membranous bag of unknown use, called bursa fabricii. This also holds the penis, where there is one.

ALIMENTARY CANAL OF THE LOWER ORDERS.

The simple globular hydatid, which is frequently found in the different viscera both of man and quadrupeds, has been supposed by some to be an animal consisting entirely of a stomach. Doubts, however, have been lately raised, whether or no this be really an animal. Even if it were allowed that these bags are animals, it does not follow that their cavity is a stomach; and the attachment of the young to the sides would rather justify us in considering it as the organ of generation.

The hydatid, which is more frequently found in animals which possess a head and mouth like the tænia, enabling it to attach itself to parts, and which can be seen to move when placed in warm water, is generally allowed to possess an independent vitality. But whether the bag of water, which forms its body, be a stomach, is certainly doubtful.

The most simple form of an alimentary cavity exists in the common fresh water polype (hydra). It appears to be excavated in the substance of the body, and has a single opening situated in the centre of the space surrounded by the tentacula. The nutritive matter soaks immediately into the body, and imparts its colour to the animal.

The large masses of gelatine, called medusæ, which resemble in form mushrooms, and are found floating in the sea, have a somewhat similar structure. A stomach is hollowed out in the pedicle; and vessels, commencing from its cavity, convey the nutritious food over the body. Sometimes the stomach has a simple opening; in other cases there are branching tentacula, on which canals commence by open orifices; these unite together to form larger tubes, and the successive union of these vessels forms at last four trunks, which open into the stomach, and convey the food into that cavity. This very singular structure constitutes a remarkable analogy to the roots of trees; and Cuvier has formed a new genus, under an appellation derived from this comparison, *viz.* the rhizostoma, from ῥιζη a root, and ϛομα, a mouth.

The star-fish (asterias) has a membranous cavity in the centre of its body, communicating externally by a single opening; two canals extend from this into each of the branches, or, as they are sometimes called, the fingers of the animal, where they subdivide and form numerous blind processes.

The tape-worm (tænia) has a small canal running on each side of its body; the two tubes are joined together by transverse productions at each joint.

The ascaris lumbricoides (round-worm) has a simple canal running from one extremity of the body to the other.

The leech (hirudo sanguisuga, or medicinalis) has a short œsophagus and a very large stomach, divided by numerous membranous septa, which are perforated in the centre. It has been generally supposed that this animal has no anus; but Cuvier says that it possesses a very small one. Leçons d'Anat. Comp. tom. iv. p. 141.) Dumeril, on the contrary, denies its existence. (Zoologie Analytique, p. 298.)

The common earth-worm (lumbricus terrestris) has a long canal, divided by several partitions.

The aphrodite aculeata has an intestine running according to the length of the body, and sending off on each side several blind processes, which enlarge at their termination.

In the proper mollusca, besides the stomach, which has been already noticed, there is an intestine, seldom of considerable length, making some turns in its course; it passes in all the acephalous mollusca through the heart.

The intestinal canal of insects varies very much in the different genera and species. It may be stated, on the whole, that a long and complicated intestinal tube denotes that the insect feeds on vegetables; while the contrary characters indicate animal food.

Great difference is found, in some instances, between the larva and the perfect insect. The voracious larvæ of beetles (scarabæi) and butterflies, have intestines ten times as large as the winged insects which are produced from them.

In the dragon-fly (libellula,) which is very carnivorous, the intestine is not longer than the body. There is a small but muscular stomach.

The orthoptera (which class contains the locusts, &c. well known for their destructive powers) have a long and complicated alimentary apparatus. They have first a membranous stomach. This is succeeded by another cavity covered internally with scales or teeth, and possessing a very thick muscular coat; in short, a true gizzard. Round the end of this the cæcal processes are attached. There is, lastly, an intestinal canal, differing in length and diameter.

The alimentary canal runs straight along the body in the crustacea, and is uniform in its dimensions, excepting the stomach.

ON THE LIVER, SPLEEN, AND OMENTUM.

The spleen and omentum seem to be less constantly found in the animal kingdom than the liver, and to be in a manner subservient to the latter viscus; which, on the contrary, exists in every class and order of animals that is provided with a heart and circulating system.

It deserves to be remarked here, as a peculiarity of the liver of some four-footed mammalia, which live in or about the sea, namely, the polar bear and some seals, that it seems to possess some poisonous or noxious qualities when employed for food. Heemskerk's companions experienced this, in the former instance, at Nova Zemlia; and Lord Anson's squadron, in the latter, on the coast of Patagonia.

The liver of mammalia is in general divided into more numerous lobes; and the divisions are carried deeper into its substance than in the human subject. This is particularly the case in the carnivora, where the divisions of the lobes extend through the whole mass. But the utility, which Munro has assigned to this structure, *viz.* that of its allowing the parts to yield and glide on each other in the rapid motions of the animal, carries very little plausibility with it. "Essay on Comparative Anatomy," p. 11.

In many animals of this class, as the horse, the ruminantia, the pachydermata, and whales, the liver is not more divided than in man.

The ductus coledochus forms a pouch between the coats of the intestine, for receiving the pancreatic duct, in the cat and elephant.

All the quadrumana, carnivora, and edentata, have a gall-bladder.

Many rodentia, particularly among the rats, want it. The tardigrada; the elephant, rhinoceros, and pecari, among the pachydermata; the genus cervus and camelus, among the ruminating animals; the solipeda; the trichechus and porpoise also want this part. It does not exist in the ostrich and parrot; but is found in all the reptiles. Cuvier thinks that it belongs particularly to carnivorous animals; that it is connected with their habit of long fasting; and serves as a reservoir for the bile.

All the mammalia which want it, except the porpoise, are vegetable eaters: and most reptiles, which universally possess it, live on animal food.

The liver of birds is divided into two equal lobes. The hepatic duct opens separately from the cystic; and its termination is generally, but not always, preceded by one or more pancreatic ducts, and followed by that of the cystic duct.

The fundus of the gall-bladder receives branches from the hepatic duct ("ductus hepaticystici"); but the tube sometimes unites with the cystic, as in the duck.

Some fishes, which are most destitute of fat in the rest of their body, have an abundance of oil in their liver, as, for instance, the skate and cod.

The spleen gradually diminishes in size from the mammalia to fishes. In the porpoise there are several small spleens, supplied from the arteries of the first stomach. It is always attached to the first, when there are several stomachs.

In birds it is always near the bulbus glandulosus, but does not lie constantly very close to the stomach in reptiles, as it is found in the mesentery of the frog; neither is it very uniformly situated in fishes.

In the crustacea the liver is large, and consists of blind tubes, opening into the commencement of the intestine. It forms the soft high flavoured substance of the crab and lobster.

A liver exists in all the mollusca, and is very large; but this class has no gall-bladder. The liver is supplied with blood from the aorta, and there is consequently no vena portarum.

It is a completely mistaken notion, that the black fluid of the cuttle-fish is its bile. The ink-bag is indeed found between the two lobes of the liver in the sepia octopus; and in front of them in the calmar; but in the common cuttle-fish ("sepia officinalis"), it is at a considerable distance from this organ.

The real bile is poured, as usual, into the alimentary canal.

The structure of the pancreas in the mammalia, in birds, and in reptiles, is the same, on the whole, as in the human subject; its form and size, its colour and consistence, and its division into lobules, exhibit some slight and unimportant variations.

The termination of its duct or ducts is distinct in birds from that of the D. choledochus. In the mammalia they generally open together, or there is a branch terminating in the D. choledochus, and another opening into the intestine, as in the dog and elephant; or they may be quite distinct, as in the hare, porcupine, and marmot. They may be separate or distinct in different individuals of the same species, as in the monkeys.

The skate and shark have a pancreas similar to that of the three first classes of red-blooded animals. In other fishes the situation of this organ is occupied by numerous small tubes, called the cæcal appendices, or pyloric cæca; which afford a copious secretion, analogous, no doubt, to the pancreatic liquor. The internal surface of these tubes becomes very red on injection, and possesses a glandular and secreting appearance. Their number varies from one to several hundreds.

The description of the organs which are concerned in assimilating the food, and in converting it into chyle, will be naturally followed by that of the blood-vessels, which carry it to all parts of the body; of the organs of respiration, which subject it to certain important changes; and of the absorbent system.

ORGANS OF CIRCULATION.

A perfect circulating system, to which, on the one hand, fluids are brought by the absorbents to be converted into blood; and from which, on the other side, various juices are separated in glands, and viscera of a glandular structure, appears to belong universally and exclusively to red-blooded animals. A pericardium exists in all these animals. Parts of such a system, particularly a heart, and certain vessels connected with it, are found in some genera of the white blooded classes.

It has been supposed that the amphibious animals of this class, and the cetacea, have an open foramen ovale, like that of the fœtus, in their septum auricularum. And the necessity of such an opening has been inferred from their way of life, since they often pass a considerable time under water without breathing. This supposition has been fully refuted by the repeated dissection of adult animals of this kind; which has shewn that an exception from the general rule very rarely occurs.

In several genera and species of web-footed mammalia, and cetacea (that is, in the common and sea-otters, in the dolphin, &c.) particular vessels have been observed to be considerably and constantly enlarged and tortuous. This structure has been principally remarked in the inferior vena cava; where there can be no doubt that it serves, while the animal is under water, to receive a part of the returning blood, and to retain it until respiration can be again performed, and the lesser circulation be thereby again put in action.

There are some remarkable circumstances in the distribution of particular arteries in certain animals of this class. We may notice, as the most singular of these, the rete mirabile, formed by the internal carotid at its entrance into the cranium, in several ruminating biscula, and carnivorous animals; and that division of the arterial trunks of the extremities, which has been observed by Mr. Carlisle in the slow-moving animals, *viz.* the sloths, and lemur tardigradus. The arteries of the arm and thigh, in these cases, divide, as they leave the trunk, into numerous parallel branches, which are united again towards the elbow and knee.

All birds possess a very remarkable peculiarity in the structure of the heart. The right ventricle, instead of having a membranous valve (such as are found in both ventricles of mammalia, and also in the left of birds,) is provided with a strong, tense, and nearly triangular muscle. This singular structure assists in driving the blood with greater force from the right side of the heart into the lungs; since the expansion of the latter organs by respiration, which facilitates the transmission of the carbonated blood in mammalia, does not take place in birds, on account of the connection which their lungs have with the numerous air-cells, which will be afterwards described.

Frogs, lizards, and serpents, have a simple heart, consisting of a single ventricle and auricle.

The structure of this part is very different in the turtle, and has given rise to more controversy than that of any order of animals. Their heart possesses two auricles, which are separated by a complete septum, like those of warm blooded animals, and receive their blood in the same manner as in those animals, *viz*. the two venæ cavæ terminate in the right auricle, the pulmonary veins in the left. Each pours its blood into the corresponding ventricle, of which cavities there are two: thus the structure of the heart hitherto resembles that of mammalia.

The characteristic peculiarities which distinguish the heart of these animals consist in two circumstances: first, both the ventricles communicate together; there is a muscular, and as it were tubular valve, going from the left to the right cavity, by means of which the former opens into the latter. Secondly, the large arterial trunks arise altogether from the right ventricle only, (no vessel coming from the left.) The aorta, forming three grand trunks, is situated towards the right side and the upper part; the pulmonary artery comes as it were from a particular dilatation, which is not situated in the middle of the basis of the heart, but lower; (it must be understood that we apply these terms according to the horizontal position of the animal.)

We can now comprehend how this wonderful and anomalous structure, by which all the blood is propelled from the right ventricle only, is accommodated to the peculiar way of life of the animal, which subjects it frequently to remaining for a long time under water. For the greater circulation is so far independent of that which goes through the lungs, that it can proceed while the animal is under water, and thereby prevented from respiring, although the latter is impeded. In warm blooded animals, on the contrary, no blood can enter the aorta, which has not previously passed through the lungs into the left ventricle; and hence an obstruction of respiration most immediately influences the greater circulation.

The heart in this class of animals is extremely small in proportion to the body. Its structure is very simple, as it consists of a single auricle and ventricle, which correspond with the right side of the heart in warm-blooded animals. The ventricle gives rise to a single arterial trunk, (which is expanded in most fishes into a kind of bulb as it leaves the heart,) going straight forwards to the branchiæ, or organs of respiration. The blood passes from these into a large artery, analogous to the aorta, which goes along the spine, and supplies the body of the animal. It is then returned by the venæ cavæ into the auricle.

It appears that insects possess neither blood-vessels nor absorbents. Cuvier has examined, by means of the microscope, all those organs in this class, which in red-blooded animals are most vascular, without discovering the least appearance of a blood-vessel, although extremely minute ramifications of the tracheæ are obvious in every part. And Lyonet has traced and delineated in the caterpillar, parts infinitely smaller than the chief blood-vessels must be, if any such existed. "Anatomie de la Chenille," &c.

Yet insects, both in their perfect and in their larva state, have a membranous tube running along the back, in which alternate dilatations and contractions may be discerned. From this circumstance it has been supposed to be the heart; but it is closed at both ends, and no vessels can be perceived to originate from it.

It is obvious from these data, that the functions of nutrition and secretion must be performed, in the animals which we are now considering, in a very different manner from that which obtains in the more perfect classes. Cuvier expresses the mode in which he supposes growth and nutrition to be effected, by the term "imbibition." And he explains, from this circumstance, the peculiar kind of respiration which insects enjoy. Since the nutritive fluids have not been exposed to the atmosphere, before they arrive at the parts for whose nourishment they are destined, this exposure is effected in the parts themselves by means of the air-vessels, which ramify most minutely over the whole body. "En un mot, le sang ne pouvant aller chercher l'air, c'est l'air, qui va chercher le sang."

The heart of the crustacea, according to Cuvier, has no auricle; and it is what he calls an aortic heart. For it expels the blood into the arteries of the body; and this fluid passes through the gills previously to reaching the heart again. The different parts of the system are here found under a mode of connection exactly the reverse of what we observe in fishes, where the blood is sent into the gills, and passes subsequently into the aorta. The circulating organ in that class is therefore a pulmonary heart.

According to Cuvier, the cuttle-fish has three hearts, neither of which possesses an auricle. Two of these organs are placed at the root of the two branchiæ: they receive the blood from the body, (the vena cava dividing into two branches, one for each lateral heart,) and propel it into the branchiæ. The returning veins open into the middle heart; from which the aorta proceeds.

The other mollusca have a simple heart, consisting of one auricle and ventricle. The vena cava assumes the office of an artery, and carries the returning blood to the gills; whence it passes to the auricle; and is subsequently expelled into the aorta. Here therefore, as in the crustacea, the heart is a pulmonary one.

The vermes of Cuvier have circulating vessels, in which contraction and dilatation are perceptible, without any heart. They can be seen very plainly in the lumbricus marinus. The leech, naias, nereis, aphrodite, &c. are further examples of the same structure. This anatomist is of opinion that the mollusca, crustacea, and vermes, possess no absorbing vessels; and he thinks that the veins absorb, as he finds them to have communication with the general cavity of the body, particularly in the cuttle-fish. Hence the above mentioned classes will hold an intermediate rank between the vertebral animals, which possess both blood-vessels and absorbents, and the insects, which have neither.

ABSORBING SYSTEM.

The chyle of birds is transparent: and there are no mesenteric glands in these animals.

The lacteals are uncommonly numerous on the intestines and mesentery of the turtle, in which animal there are no absorbent glands.

The lymphatics of fishes have neither glands nor valves.

ORGANS OF RESPIRATION.

The incessant continuation of the great chemical process, by which oxygen is exchanged for hydrogen and carbon, is essentially necessary to the well being of the greater part of animals. Yet the organs and mechanism, by which this wonderful function is carried on, vary very considerably. In the mammalia, after birth; in birds, when they have left the egg; and in amphibia, when completely formed; the chief organ of this function is the lungs: in fish it is performed in the gills; in most insects in their tracheæ; in the vermes, in analogous, but at the same time very different parts.

The respiratory organs of birds constitute one of the most singular structures in the animal economy, on account of several peculiarities which they possess; but more particularly in consequence of their connection with the numerous air-cells, which are expanded over the whole body.

The lungs themselves are comparatively small, flattened, and adhering above to the chest, where they seem to be placed in the intervals of the ribs; they are only covered by the pleura on their under surface, so that they are in fact on the outside of the cavity of the chest, if we consider that cavity as being defined by the pleura: a great part of the thorax, as well as the abdomen, is occupied by the membranous air-cells, into which the lungs open by considerable apertures. Those of the thorax are divided, at least in the larger birds, by membranous transverse septa, into smaller portions; each of which, as well as the abdominal cells, has a particular opening of communication with the air-cells of the lungs, and consequently with the trachea. The membranes of these cells, in the larger birds, are provided here and there with considerable fasciculi of muscular fibres, which have been regarded as a substitute for the diaphragm, which is wanting in this class of animals. They also serve very principally, as we may ascertain by examining large birds in a living state, to drive back again into the lungs the air which they receive in inspiration; whence the repletion and depletion of the thoracic cells must alternate with those of the abdominal cavities.

Bsides these cells, a considerable portion of the skeleton is formed into receptacles for air in most birds, (for there are indeed exceptions and considerable variations in the different genera and species.) This structure is particularly marked in the larger cylindrical bones, as the scapula, clavicle, and femur. It is also found in most of the broad and multangular bones of the trunk, as the sternum, ossa innominata, dorsal vertebræ, &c. All these are destitute of marrow in the adult bird, at least in their middle; so that the cylindrical bones form large tubes, which are only interrupted towards the extremities by a sort of transverse bony fibres: the broad bones are filled with a reticulated bony texture, the cells of which are empty. They have considerable apertures, (most easily shewn in those extremities of the cylindrical bones which are turned towards the sternum) communicating with the lungs by small air-cells; which facts may be shewn by various experiments on living and dead birds.

These receptacles of air probably serve the purpose of lightening the body of the bird in order to facilitate its motions. This effect is produced in most birds to assist their flight; in some aquatic species for the purpose of swimming; in the ostrich and some others, for running. Hence we find the largest and most numerous bony cells in birds which have the highest and most rapid flight, as the eagle, &c. And hence also the bones of the bird which has just left the egg are filled with a bloody marrow, which is absorbed soon after birth, entirely in some, in others, particularly among the aquatic species, at least for the greater part.

Besides the uses which have been already pointed out, these receptacles of air diminish the necessity of breathing frequently, in the rapid and long continued motions of several birds, and in the great vocal exertions of the singing birds.

The lungs of amphibia are distinguished from those of warm-blooded animals, both by a great superiority in point of size, as well as by a greater looseness of texture, arising from the great size of their air-vessels. In frogs, lizards, and serpents, the lungs consist of a cavity, whose sides are cellular. The posterior part of the organ either forms a mere membranous bag, or else the cells are larger there than elsewhere. In the turtle the vesicles are very large, but the texture is uniform throughout.

In the tadpole, and the young of such lizards as bring forth in water, there are two organs, which somewhat resemble the gills of a fish (appendices fimbriatæ, Swammerdam.) These serve for the purposes of respiration while the animal lives in the water. They are connected to the sides of the neck, and hang loose from the animal; they are not permanent, but are gradually withdrawn into the chest, (within a few days, in the reptiles of this country,) where their remains may still be perceived for some time near to the true lungs. Instead of the branchial opening, by which fishes again discharge the water which they have taken in at the mouth, some tadpoles have for this purpose a canal on the left side of the head, near the eye; which must be distinguished from the small tube on the lower lip, by which they attach themselves to aquatic plants.

Instead of lungs, fishes are furnished with gills or branchiæ; which are placed behind the head, on both sides, and have a moveable gill cover (operculum branchiale,) which is wanting in the order of pisces chondropterygii only. By means of these organs, which are connected with the throat, the animal receives its oxyen from the air contained in the water; as those animals which breathe derive it immediately from the atmosphere. They afterwards discharge the water through the branchial openings (aperturæ branchiales;) and therefore they are distinguished from animals of the three preceding classes by this circumstance; *viz.* that they do not respire by the same way that they inspire.

We have already shewn, in speaking of the organs of circulation, how the gills receive the venous blood by means of the branchial artery, and how this blood is sent into the aorta after its conversion into the arterial state. The distribution of these vessels on the folds and divisions of the gills constitutes one of the most delicate and minute pieces of structure in the animal economy.

Each of the gills consists in most fishes of four divisions, resting on the same number of arched portions of bone or cartilage, connected to the os hyoides. Generally there is only a single opening for the discharge of the water; but in many cases, particularly among the cartilaginous fishes, there are several.

Many animals of this order possess a single or double swimming bladder; which has been found in different instances to contain azote, hydrogen, and oxygen. It has not been hitherto determined, whether it be subservient to any other functions, besides that well known one from which its name is derived. In the mean time, like the air receptacles of birds, it may be considered, without impropriety, in the present division of the work.

It is placed in the abdomen, and closely attached to the spine. It communicates generally with the œsophagus, and sometimes with the stomach, by a canal (ductus pneumaticus,) containing in some instances, as the carp, valves which seem to allow the passage of air from the bladder, but not to admit its entrance from without.

That white-blooded animals indispensably require a species of respiration would have been inferred, by analogy, from the wonderful apparatus of gills or tracheæ, which have been discovered in most orders of both classes of these beings. But in many cases direct proof has been obtained on this point: experiment has actually proved the exchange of carbon for oxygen.

White-blooded animals are moreover distinguished from those which have red blood by this circumstance: that none of the former, as far as we hitherto know, take in air through the mouth.

Many aquatic insects, as the genus cancer, have a species of gills near the attachment of their legs. The others, and particularly the land-insects, which constitute, as is well known, by far the greatest number of this class of animals, are furnished with air-vessels, or tracheæ, which ramify over most of their body. These tracheæ are much larger and more numerous in the larva state of such insects as undergo a metamorphosis, (in which state also the process of nutrition is carried on to the greatest extent) than after the last, or, as it is called, the perfect change has taken place.

A large air-tube (trachea) lies under the skin on each side of the body of larvæ, and opens externally by nine apertures (stigmata): it produces on the inside the same number of trunks of air-vessels (branchiæ.) which are distributed over the body in innumerable ramifications.

Both the tracheæ and branchiæ are of a shining silvery colour; and their principal membrane consists of spiral fibres. The most numerous and minute ramifications are distributed on the alimentary canal.

There is great variety in the number and situation of the external openings, by which insects receive their air.

In most instances the stigmata are placed on both sides of the body. The atmospheric air enters by an opening at the end of the abdomen in several aquatic larvæ, and even perfect insects. A very remarkable change in this respect takes place in several animals of this class during their metamorphosis. Thus in the larva of the common knats (culex pipiens,) the air enters by an opening on the abdomen: while in the nympha of the same animal it gains admission by two apertures on the head.

In the class of vermes, which comprehends such very different animals, the structure of the respiratory organs is proportionally various. Some orders, as those which inhabit corals, the proper zoophytes, and perhaps the intestinal worms, appear to be entirely destitute of these organs: so that if any vital function, analogous to respiration, is carried on in these animals, it must be effected by methods which yet remain to be discovered.

Those vermes, however, which are furnished with proper organs of respiration, have the same variety in their structure which was remarked in insects. Some, as the cuttle-fish, oyster, &c. have a species of gills, varying in structure in different instances. But the greatest number have air-vessels, or tracheæ. Several of the testaceous vermes have both kinds of respiratory organs. In some of the inhabitants of bivalve shells, as the genus venus, the air-vessels lie between the membranes of a simple or double tubular canal, found at the anterior part of the animal, and capable of voluntary extension and retraction. It serves also for other purposes, as laying the eggs. The margins of its mouth are beset with the openings of the tracheæ.

In the terrestrial gasteropodous mollusca, of which we may instance the snail and slug, there is a cavity in the neck receiving air by a small aperture, which can be opened or shut at the will of the animal. The pulmonary vessels ramify on the sides of the cavity.

ORGAN OF THE VOICE.

Aristotle has correctly observed, that those animals only which possess lungs, consequently the three first classes of the animal kingdom, possess a true voice. Several genera and species even of these are either entirely dumb, as the anteater, the manis, the cetacea, the genus testudo, several lizards, and serpents; or they lose their voice in certain parts of the earth, as the dog in some countries of America, and quails and frogs in several parts of Siberia.

Most mammalia have the following circumstances in common: their rima glottidis is provided with an epiglottis, which in most instances has a peculiar muscle, arising from the os hyoides, and not found in the human subject: the margins of this rima are formed by the double ligamenta glottidis (ligamenta thyreoarytænoidea); between which the ventriculi laryngis are formed. The epiglottis does not exist in most of the bat kind: and in some mouse-like animals, as the rell-mouse (glis esculentus,) it is hardly discernible. The superior ligamenta glottidis, as well as the ventriculi laryngis, are wanting in some bisulca, as the ox and sheep.

Some species of mammalia have a peculiar and characteristic voice; or at least certain tones, which are formed by additional organs. Of this kind are certain tense membranes in some animals; and in others peculiar cavities, opening into the larynx, and sometimes appearing as continuations of the ventriculi laryngis.

The neighing of the horse, for example, is effected by a delicate and nearly falciform membrane, which is attached by its middle to the thyroid cartilage, and has its extremities running along the external margins of the rima glottidis.

The peculiar sound uttered by the ass is produced by means of a similar membrane, under which there is an excavation in the thyroid cartilage. There are moreover two large membranous sacs openng into the larynx.

The mule does not neigh like the mare by which it was conceived, but brays like the ass which begot it. It possesses exactly the same larynx as the latter, without any of the peculiar vocal organs of the mother; a fact which, like many others, cannot be at all reconciled with the supposed pre-existence of previously formed germs in the ovarium of the mother.

Several apes and baboons, as also the rein-deer, have on the front of the neck large single or double laryngeal sacs, of various forms and divisions, communicating with the larynx by one or two openings between the os hyoides and thyroid cartilage.

Some of the cercopitheci, as the C. Seniculos, and beelzebub, have the middle and anterior part of the os hyoides formed into a spherical bony cavity, by which the animals are enabled to produce those terrific and penetrating tones, which can be heard at vast distances, and have gained them the name of the howling apes.

The most striking peculiarity in the vocal organs of birds, and which belongs to all birds, with very few exceptions, consists in their possessing what is commonly called a double larynx, but which might be more properly described as a larynx divided into two parts, placed at the upper and lower ends of the trachea. They have also two rimæ glottidis.

The superior, or proper rima glottidis, is placed at the upper end of the trachea; but is not furnished with an epiglottis. The apparent want of this organ is compensated in several cases by the conical papillæ placed at both sides of the rima.

The apparatus which is chiefly concerned in forming the voice of birds is found in the inferior or bronchial larynx. This contains a second rima glottidis, formed by tense membranes, which may be compared in several cases, particularly among the aquatic birds, to the reed at the mouth of musical instruments. It is furnished externally with certain pairs of muscles, varying in number in the different orders and genera; and with a kind of thyroid gland. The course and proportionate length of the trachea, and particularly the structure of the inferior larynx, vary very considerably in the different species, and even in the two sexes, especially among the aquatic birds. Thus, for example, the tame or dumb swan (anas olor) has a straight trachea; whilst in the male of the wild, or whistling swan (cygnus), this tube makes a large convolution, which is contained in the hollow of the sternum. In the spoonbill (Platalea leucorodia), as also in the Phasianus motmot, and others, similar windings of the trachea are found, not enclosed in the sternum. The males of the two genera, anas and mergus, have at their inferior or bronchial larynx a bony cavity, which contributes to strengthen their voice.

A very little comparison of the mechanism of wind musical instruments with the organs of the voice in birds, will shew how nearly they are allied to each other; and it may be observed, that the sound produced by some of the larger birds is exactly similar to the notes that proceed from a clarionet or hautboy in the hands of an untutored musician. The inferior glottis exactly corresponds to the reed, and produces the tone or simple sound. The superior larynx gives it utterance, as the holes of the instrument; but the strength and body of the note depend upon the extent and capacity of the trachea, and the hardness and elasticity of its parts. The convolution and bony cells of the windpipe, therefore, may be compared with the turns of a French horn, and the divisions of a bassoon; and they produce the proper effects of these parts in the voices of those birds in which they are found.

BRAIN AND NERVES, AND ORGANS OF SENSE.

The parts subservient to the animal functions, which, constituting the leading character of animals, have derived their name from that circumstance, afford to our observation a more clear and manifest gradation, from the most simple to the most compound structure, than any others in the animal economy.

In some of the most simple animals of the class vermes, particularly among what are called zoophytes, little or no distinction of similar parts (or structures) can be discerned, and we are unable to recognize any thing as a particular nervous system, or even as a part of such a system. The power of sensation and voluntary motion which these possess, as well as any other order or class of the animal kingdom, proves that the nervous matter must be uniformly spread throughout their homogeneous substance. The almost transparent polypes (hydra,) which are often found with a body of an inch in length, and arms or tentacula of a proportionate size, appear to consist, when surveyed in the best light by the strongest magnifying powers, of nothing but a granular structure connected into a definite form by a gelatinous substance.

In many other vermes, and in insects, particular nerves can be distinguished, arising in general from a chord running the whole length of the body, and called the spinal marrow, the superior extremity of which part, slightly enlarged, constitutes the brain. The latter organ, however, in both classes of cold and red-blooded animals, and still more in those which have warm blood, has a much more complicated structure, and a far greater relative magnitude: all animals are, however, exceeded in both these points by the human subject, which, according to the ingenious observation of the learned Sömmerring, possesses by far the largest brain, in proportion to the size of the nerves which arise from it.

The vast superiority of man over all other animals in the faculties of the mind, which may be truly considered as a general distinction of the human subject, led physiologists, at a very early period, to seek for some corresponding difference in the brains of man and animals. They naturally investigated the subject, in the first instance, by comparing the proportion which the mass of the brain bears to the whole body; and the result of this comparison in the more common and domestic animals was so satisfactory, that they prosecuted the inquiry no farther, but laid down the general proposition, which has been universally received since the time of Aristotle, that man has the largest brain in proportion to his body. Some more modern physiologists, however, in following up this comparative view in a greater number of animals, discovered several exceptions to the general position. They found that the proportion of the brain to the body, in some birds, exceeds that of man; and that several mammalia (some quadrumana, and some animals of the mouse kind) equal the human subject in this respect.

As these latter observations entirely overturned the conclusion which had been before generally admitted, Sömmerring has furnished us with another point of comparison, that has hitherto held good in every instance: *viz.* that of the ratio, which the mass of the brain bears to the nerves arising from it.

Let us divide the brain into two parts; that which is immediaely connected with the sensorial extremities of the nerves, which receives their impressions, and is therefore devoted to the purposes of animal existence. The second division will include the rest of the brain, which may be considered as connecting the functions of the nerves with the faculties of the mind. In proportion then as any animal possesses a larger share of the latter and more noble part; that is, in proportion as the organ of reflection exceeds that of the external senses, may we expect to find the powers of the mind more vigorous and more clearly developed. In this point of view man is decidedly pre-eminent: here he excels all other animals that have hitherto been investigated.

All the simiæ, says Sömmerring, are placed far behind man in this respect. Although the brain in some instances, particularly among the smaller kinds, which have prehensile tails, is larger in proportion to their body than that of the human subject; yet a very large share of that brain is required for the immense nerves which supply their organs of sense and mastication. Let us remove that portion of the brain, and a very small quantity will remain.

The researches of the same author on animals in general have led him to conclude, that the quantity of brain, over and above that which is necessary for a mere animal existence; that part, in short, which is devoted to the faculties of the mind, bears a direct ratio to the docility of the animal, to the rank which it would hold in a comparative scale of mental powers.

The largest brain, which Sömmerring has found in a horse, weighed *1lb. 4oz.* and the smallest, which he has seen in an adult man, was *2lb. 5½oz.* Yet the nerves arising from the former brain were at least ten times larger than those of the latter.

Generally speaking, small animals have a larger brain in proportion to their body than larger ones. The pachydermata have it very small; and in red-blooded animals, its size is very trifling when compared with the body.

It forms in man from $\frac{1}{22}$ to $\frac{1}{33}$ of the body.

In some simiæ	$\frac{1}{22}$
the Mole	$\frac{1}{36}$
Bear	$\frac{1}{265}$
Dog	$\frac{1}{161}$
Cat	$\frac{1}{94}$
Hare	$\frac{1}{228}$
Rat	$\frac{1}{76}$
Mouse	$\frac{1}{43}$
Elephant	$\frac{1}{500}$
Pig	$\frac{1}{451}$—$\frac{1}{672}$
Horse	$\frac{1}{400}$
Dolphin	$\frac{1}{50}$—$\frac{1}{102}$
Eagle	$\frac{1}{200}$
Sparrow	$\frac{1}{25}$
Chaffinch	$\frac{1}{27}$
Redbreast	$\frac{1}{32}$
Blackbird	$\frac{1}{68}$
Canarybird	$\frac{1}{14}$
Cock	$\frac{1}{25}$
Duck	$\frac{1}{257}$
Goose	$\frac{1}{360}$
Tortoise	$\frac{1}{2240}$
Turtle	$\frac{1}{5688}$
Coluber natrix	$\frac{1}{792}$
Frog	$\frac{1}{172}$
Shark	$\frac{1}{2496}$
Pike	$\frac{1}{1305}$
Carp	$\frac{1}{560}$

Many mammalia possess a bony tentorium cerebelli. It is difficult to give a physiological explanation of the use of this bony tentorium. The opinion which has been generally adopted by anatomists, that the structure in question belongs to such animals only as jump far, or run with great velocity, and that it serves the purpose of protecting the cerebellum from the pressure of the cerebrum in these quick motions, is obviously unsatisfactory. It exists in the bear, which is not distinquished for its activity; while several animals which excel in jumping or springing do not possess it; *viz.* the wild goat, (capra ibex.) Cheselden ascribes it to predaceous animals only, ("Anat. of the Bones," cap. 8;) but it exists in several others.

We have given these remarks on the generally assigned use of the bony tentorium, because a similar mechanical explanation has been assigned of the falx, and the tentorium of the human subject; *viz.* that the former protects the hemispheres from mutual pressure, when the person lies with his head resting on one side; and that the latter provides against the compression of the cerebellum by the superincumbent cerebrum. These explanations are assigned in the present day by anatomists of such distinguished reputation as Sömmerring and Cuvier ("de Corporis Humani Fabricâ," vol. 4, p. 27. "Léçons d'Anat. compar." tom. 2, p. 178.) If the futility of this piece of physiology were not sufficiently proved, by considering that the cranium is accurately filled, and that there is consequently no room for its contents to fall from one side to the other, it must immediately be rendered manifest by Mr. Carlisle's case; in which the falx was entirely absent, and the two hemispheres united throughout in one mass, without any perceptible inconvenience during the patient's life. ("Transactions of a Society for the Improvement of Medical and Chirurgical knowledge," vol. ii. p. 212.) We have met with four instances, in which the anterior half of the falx was deficient. This production of the dura mater commenced in a narrow form about the middle of the sagittal suture; and gradually expanding, had acquired the usual breadth at its termination in the tentorium. The two hemispheres adhered by the pia mater covering their opposed plane surfaces, but were formed naturally in other respects. A want of the falx has also been recorded by Garengeot, ("Splanchnologie," tom. ii. p. 24.)

The brain of the mammalia wants the digital cavity of the lateral ventricle, and in general the acervulus of the pineal gland. Its anterior lobes are elongated into a process called the mammillary, giving rise to the olfactory nerves. In birds, reptiles, and fishes, there is a successive and gradual change towards a more simple structure; the brain in these classes consisting merely of tubercular eminences. In the lower orders the brain seems to be really wanting. A nervous chord runs along the body, and possesses ganglia at different distances, from which the nerves arise. In insects and vermes the upper ganglion of the nervous chord, which represents the brain, is placed near the mouth, or œsophagus, and very generally surrounds that tube by a kind of collar.

ORGANS OF SENSE.

Few subjects in comparative anatomy and physiology have given rise to more various and contradictory opinions, than the organs of sense in some classes of animals. Much misunderstanding on this point has clearly arisen from the inconsiderate and unconditional application of inferences drawn from the human subject to animals. Thus it has been supposed that those which possess a tongue must have it for the purpose of tasting, and that the sense of smell must be wanting, where we are unable to ascertain the existence of a nose. Observation and reflection will soon convince us, that the tongue, in many cases (in the ant-eaters among the mammalia, and almost universally in birds,) cannot, from its substance and mechanism, be considered as an organ of taste; but must be merely subservient to the ingestion and deglutition of the food. Again, in several animals, particularly among insects, an acute sense of smell seems to exist, although no part can be pointed out in the head, which analogy would justify us in describing as a nose.

However universally animals may possess that feeling which makes them sensible to the impressions of warmth and cold, very few possess, like the human subject, organs exclusively appropriated to the sense of touch, and expressly constructed for the purpose of feeling, examining, and exploring the qualities of external objects.

This sense appears, according to our present state of knowledge, to exist only in three classes of the animal kingdom; *viz.* in most of the mammalia, in a few birds, and probably in insects.

The structure of the organ of touch is the most perfect, and similar to that of the human subject in the quadrumana. The ends of their fingers, particularly of the posterior extremities, are covered with as soft and delicately organized a skin as that which belongs to the corresponding parts of man.

Several of the digitata are probably provided with this sense; the organization of the under surface of the front toes of the raccoon (ursus lotor,) and the use which the animal makes of those parts, prove this assertion.

It is not so clear that we are authorised in considering the snout of the mole and pig, not to mention the tongue of the solidungula and bisulca, or the snout of these and other animals, as true organs of touch, according to the explanation above laid down.

Much less can we suppose the long bristly hairs, which constitute the whiskers of the cat-kind, and other mammalia, to be organs of touch, in the sense we are now considering, although they may be serviceable, when they come in contact with any object, in warning, and making the animal attentive. Bats have been supposed to possess a peculiar power of perceiving external objects without coming actually into contact with then. In their rapid and irregular flight amidst various surrounding bodies, they never fly against them; yet it does not seem that the senses of hearing, seeing, or smelling, serve them on these occasions; for they avoid any obstacles with equal certainty when the ear, eye, and nose, are closed. Hence naturalists have ascribed a sixth sense to these animals. It is probably analogous to that of touch. The nerves of the wing are large and numerous, and distributed in a minute plexus between the integuments. The impulse of the air against this part may possibly be so modified by the objects near which the animal passes, as to indicate their situation and nature.

In geese and ducks the bill is covered with a very sensible skin, supplied with an abundance of nerves from all the three branches of the fifth pair. This apparatus enables them to feel about for their food in mud, where they can neither see nor smell it. None of the amphibia or fishes seem to possess the sense of touch, according to the acceptation stated above.

All the observations and investigations of the structure of the antennæ, those peculiar organs which exist universally in the more perfect insects, and of the use which these animals generally apply them to, lead us inevitably to the conclusion, that they really are proper organs of touch, by which the animal examines and explores surrounding objects. Such organs are particularly necessary to insects, on account of the insensibility of their external coat, which is generally of a horny consistence, and also from their eyes being destitute in most instances of the power of motion.

TONGUE.

Most of the herbivorous mammalia, particularly among the bisulca, have their tongue covered with a firm and thick cuticular coat, which forms numberless pointed papillæ, directed backwards. These must assist, according to their consistence and direction, at least in the animals of this country, in tearing up the grass. Animals of the cat kind have their tongue covered with sharp and strong prickles, which must enable the animal to take a firm hold. Similar pointed processes are found in some other animals; as in the bat kind, and the opossum.

There seems to be no doubt, that in all the mammalia which we have now considered, the tongue is an organ of taste, at least towards its anterior part.

The toothless animals, on the contrary, as the ant-eater and manis, which swallow their aliment whole, have a worm-like tongue, which is obviously capable of no other use than that of taking their food.

The tongue of the woodpecker has a very singular structure, which admits of its being darted out of the mouth for some inches: It is used for the purpose of catching insects, and is horny and barbed at its extremity. In the frog and chameleon, the tongue is also the organ by which the prey is seized. In the former animal it is long, soft, and covered with a glutinous slime. In the quiescent state it lies from before backwards in the mouth, from which it is darted at the prey, consisting of insects, which become entangled by the viscid fluid. The tongue of the chameleon displays a very curious mechanism. It is contained in a sheath at the lower part of the mouth; and has its extremity covered with a glutinous secretion. It admits of being projected to the length of six inches, and is used in this manner by the animal in catching its food, which consists of flies, &c. It is darted from the mouth with wonderful celerity and precision, and the viscous secretion on its extremity entangles the small animals which constitute the food of the chameleon.

ORGAN OF SMELLING.

Two remarkable instances of anomalous structure in parts connected with the nose occur in the proboscis of the elephant, and the blowing holes of the cetacea. The former organ consists of two canals, separated from each other by an intervening partition. Innumerable muscular fasciculi, running in two directions, occupy the space between these and the integuments. There are fibres of a transverse course, passing like radii from the canals to the integuments, and others, which run in a more longitudinal direction, but have their extremities turned inwards. The former extend the trunk, without causing any contraction of the canals; the latter bend or contract it; and both tend to bestow on it that wonderful mobility which it possesses, in every direction.

The more longitudinal fibres are divided at short intervals by tendinous intersections, which enable the animal to bend any part of the organ, and to give it any requisite degree of curvature. The same structure will confer a power of bending different parts of the trunk in opposite directions; indeed, there is no kind of curvature which may not be produced by these longitudinal fibres. These fasciculi occupy the external surface of the organ. The transverse fibres are not all arranged like radii round the canals; but some pass across from right to left, and must therefore affect the diameter of those tubes by their action. The whole of these muscular fasciculi are surrounded and connected together by a white, uniform, adipous substance. The transverse ones are not more than a line in thickness. If the number of these which appears on a transverse section be ascertained, and if those portions of the longitudinal fasciculi, which pass from one tendon to another, be reckoned as separate muscles (for they must have a separate power of action) the whole trunk will contain about thirty or forty thousand muscles, which will account satisfactorily for the wonderful variety of motions which this admirable organ can execute, and for the great power which it is capable of exerting.

The blowing hole of the whale serves as well for respiration as for the rejection of the water which enters with the food. In consequence of its situation at the top of the head, it is easily elevated beyond the surface of the sea, while the mouth is usually under water.

The opening in the bones of the head is divided into two by a partition of bone; and is furnished with a valve opening outwards. On the side of this opening are two membranous bags lined with a continuation of the integuments, and opening externally. The water, which the animal wishes to discharge, is thrown into the fauces, as if it were to be swallowed; but its descent into the stomach is prevented by the contraction of the circular fibres of the œsophagus. It therefore elevates the valve placed at the entrance of the blowing-holes, and distends the membranous bag, from which it is forcibly expelled by surrounding muscular fibres.

This apparatus occupies the situation, which in other mammalia is filled by the nose; which organ, together with the sinuses of the head, the olfactory nerve, &c. is entirely wanting in these animals.

ORGAN OF HEARING.

Some Mammalia have not an external ear, particularly such as live in the water or under ground.

Most quadrupeds have a peculiar hemispherical bony cavity, communicating with the tympanum, and seeming to hold the place of mastoid cells.

The ornithorhynchus, whose structure is in every respect so anomalous, has only two ossicula auditus.

The cochlea, which belongs exclusively to the Mammalia, has in some cases one turn more than in man.

Whales have an organ of hearing, but the parts are very small.

Birds have no external ear; only a single ossiculum auditus; and a short, obtuse, hollow, bony process, instead of cochlea.

Reptiles have membranous semicircular canals and vestibulum; generally a single ossiculum auditus, resembling that of birds; and in some instances a tympanum, and membrana tympani, level with the surface of the body.

Fishes have a membranous vestibulum and canals, but no external organs.

THE EYE.

A sensibility to the impressions of light is common to all those animals, which in a natural state are exposed to this element; it appears at least very evidently to exist in some of the most simple zoophytes, as the armed polypes (hydra:) but the power of perceiving the images of external objects is confined to those who are provided with eyes for their reception. Nature has bestowed on some species, even of red-blooded animals, a kind of rudiment of eyes, which have not the power of perceiving light; as if in compliance with some general model for the bodily structure of such animals. This circumstance at least has been asserted of the blind rat (marmota typhlus) among mammalia; and of the myxine glutinosa among fishes.

The conjunctiva covering the front of the eye-ball, in the former animal, is covered with hair, so that the eye, which is exceedingly small, seems to be completely useless.

Large animals have small eye-balls in proportion to their size: this is very remarkably the case with the whales. Those which are much under ground have the globe also very small; as the mole and shrew: in the former of these instances its existence has been altogether denied; and it it is not in fact larger than a pin's head.

The eyes of man and the simiæ are directed forwards: in the latter animals, indeed, they are placed nearer to each other than in the human subject. The lemul tarsius has them more closely approximated than any other animal. All other Mammalia have these organs separated by a considerable interval, and directed laterally. The same circumstance obtains in birds, with the exception of the owl, who looks straight forwards. They are placed laterally in all reptiles. Their situation varies much in fishes: they look upwards in the uranoscopus: they are both on the same side of the body in the pleuronectes; but in general their direction is lateral.

The form of the globe varies according to the medium in which the organ is to be exerted. In man and the mammalia, it deviates very little from the spherical figure. In fishes it is flattened on its anterior part; in birds it is remarkably convex in front, the cornea being sometimes absolutely hemispherical. The convexity of the crystalline is an inverse ratio to that of the cornea. Thus in fishes it is nearly spherical, and projects through the iris, so as to leave little or no room for aqueous humour: the cetacea, and those quadrupeds and birds which are much under water, have this part of the same form. The aqueous humour, being of the same density with the medium in which these animals are placed, would have no power of refracting rays of light which come through that medium: its place is supplied by an increased sphericity of the lens. In birds these circumstances are reversed: they inhabit generally a somewhat elevated reigon of the atmosphere, and the rays which pass through this thin medium are refracted by the aqueous humour, which exists in great abundance. Man, and the mammalia, which live on the surface of the earth, hold a middle place between these two extremes.

The inner surface of the choroid coat, which in man is black throughout, is coloured very beautifully on the temporal side of the eye in most quadrupeds, and this part is called the tapetum.

The pigmentum nigrum is entirely deficient in the eye of the white rabbit, white ferret, &c. as well as in the variety of the human race called the albino.

The quadrumana alone possess the foramen centrale of the retina, besides man.

Most mammalia possess a membrana nictitans, or third eyelid, behind which the eyeball can be drawn, when offended by any extraneous matter.

Birds are distinguished by having a bony ring, composed of numerous flat and over-lapping thin plates, in the substance of the sclerotica, at its anterior part.

Another great peculiarity consists in the marsupium or pecten, which appears as a large folded process of the choroid, coming through the retina of the back of the eye, and running in the substance of the vitreous humour towards the crystalline lens, which it does not quite reach.

The third eyelid, or membrana nictitans of birds, is a thin semi-transparent fold of the conjunctiva; which, in the state of rest, lies in the inner corner of the eye, with its loose edge nearly vertical, but can be drawn out so as to cover the whole front of the globe. By this, according to Cuvier, the eagle is enabled to look at the sun.

It is capable of being expanded over the globe of the eye by the combined action of two very singular muscles, which are attached towards the back of the sclerotica. One of these, which is called from its shape the quadratus, arises from the upper and back part of the sclerotica; its fibres descend in a parallel course towards the optic nerve, and terminate in a semicircular margin, formed by a tendon of a very singular construction; for it has no insertion, but constitutes a cylindrical canal. The second muscle, which is called the pyramidalis, arises from the lower and back part of the sclerotica towards the nose. It gives rise to a long tendinous chord, which runs through the canal of the quadratus, as in a pulley. Having thus arrived at the exterior part of the eyeball, it runs in a cellular sheath of the sclerotica along the under part of the eye to the lower portion of the loose edge of the membrana nictitans, in which it is inserted.

By the united action of these two muscles, the third eyelid will be drawn towards the outer angle of the eye, so as to cover the front of the globe; and its own elasticity will restore it to its former situation.

Two kinds of eyes, very dissimilar in their structure, are found in insects: one sort in small and simple, (stemmata;) the others, which are large, seem to consist of an aggregation of smaller eyes; for their general convexity is divided into an immense number of small hexagonal convex surfaces, which may be considered as so many distinct corneæ. The first kind is found in different numbers in most of the aptera, as also in the larvæ of many winged insects. When these undergo the last or complete metamorphosis, and receive their wings, they gain at the same time the large compound eyes. Several genera of winged insects and aptera (as the larger species of monoculi,) have stemmata, besides their compound eyes.

The internal structure has hitherto been investigated only in the large polyedrous eyes. The back of the cornea (which is the part divided in front into the hexagonal surfaces, called in French, *facettes*) is covered with a dark pigment: behind this are numerous white bodies, of an hexagonal prismatic shape, and equal in number to that of the facettes of the cornea. A second coloured membrane covers these, and appears to receive the expansion of the optic nerve.

Further investigation is, however, required, in order to shew how these eyes enable the insect to see; and to determine the distinction between two such very different organs.

MUSCLES.

The nature and objects of the present work render it impossible for us to enter into the details of comparative myology; we shall therefore restrain our remarks to one or two subjects.

The differences which we discern in the muscles of the lower extremity, between man and the other mammalia, arise out of that characteristic feature, which so strikingly distinguishes man from all other animals, *viz.* his erect stature. The most minute investigation of this subject will shew us that the erect position belongs to man only; and thereby confirms the elegant observation of the Roman poet:

Pronaque cum spectent animalia cetera terram,
Os homini sublime dedit; cœlumque tueri
Jussit; et erectos ad sidera tollere vultus.

In order to enable any animal to preserve the erect position, the following conditions are required. 1st. That the parts of the body should be so disposed as to admit of being maintained with ease in a state of equilibrium. 2dly. That the muscles should have sufficient power to correct the deviations from this state. 3dly. That the centre of gravity of the whole body should fall within the space occupied by the feet; and lastly, That the feet themselves should have a broad surface, resting firmly on the ground, and should admit of being in a manner fixed to the earth. All these circumstances are united in the necessary degree in man only.

The broader the surface included by the feet, the more securely will the line of gravity rest within that surface. The feet of man are much broader than those of any animal, and admit of being separated more widely from each other. The sources of the latter prerogative reside in the superior breadth of the human pelvis, and in the length and obliquity of the neck of the femur, which, by throwing the body of the bone outwards, disengage it from the hip-joint.

The whole tarsus, metatarsus, and toes, rest on the ground in the human subject, but not in other animals. The simiæ, and the bear, have the end of the os calcis raised from the surface; while, on the contrary, it projects in man, and its prominent portion has a more important share in supporting the back of the foot. The exterior margin of the foot rests chiefly on the ground in the simiæ; which circumstance leaves them a freer use of their thumb and long toes in seizing the branches of trees, &c.; and renders the organ so much the less adapted to support the body on level ground.

The plantaris muscle, instead of terminating in the os calcis, expands into the plantar fascia in the simiæ; and in other quadrupeds it holds the place of the flexor brevis, or perforatus digitorum pedis, passing over the os calcis in such a direction, that its tendons would be compressed, and its action impeded, if the heel rested on the ground.

The extensors of the ankle joint, and chiefly those which form the calf of the leg, are very small in the mammalia, even in the genus simiæ. The peculiar mode of progression of the human subject sufficiently accounts for their vastly superior magnitude in man. By elevating the os calcis, they raise the whole body in the act of progression; and, by extending the leg on the foot, they counteract that tendency which the weight of the body has to bend the leg in standing.

The thigh is placed in the same line with the trunk in man; it always forms an angle with the spine in animals, and this is often even an acute one. The extensors of the knee are much stronger in the human subject than in other mammalia, as their double effect of extending the leg on the thigh, and of bringing the thigh forwards on the leg, forms a very essential part in the human mode of progression.

The flexors of the knee are, on the contrary, stronger in animals, and are inserted so much lower down in the tibia (even in the simiæ) than in the human subject, that the support of the body on the hind legs must be very insecure, as the thigh and leg form an angle, instead of continuing in a straight line.

The gluteus maximus, which is the largest muscle of the human body, is so small and insignificant in animals, that it may almost be said not to exist. This muscle, which forms the great bulk of the human buttock, extends the pelvis on the thighs in standing; and, assisted by the other two glutei, maintains that part in a state of equilibrium on the lower extremity which rests on the ground, while the other is carried forwards in progression. The true office of these important muscles does not therefore consist, as it is usually represented, in the common anatomical works, in moving the thigh on the pelvis, but in that of fixing the pelvis on the thighs, and of maintaining it in the erect position.

Such then are the supports, by which the trunk of the human body is firmly maintained in the erect position. The properties of the trunk, which contribute to the same end, do not so immediately belong to this article; but may be slightly mentioned, to complete the view of the subject. The breadth of the human pelvis affords a firm basis on which all the superior parts rest securely; the same part is so narrow, in other animals, that the trunk represents an inverted pyramid, and there must consequently be great difficulty in maintaining it in a state of equilibrium, if it were possible for the animal to assume the erect position. In those instances where the pelvis is broader, the other conditions of the upright stature are absent: the bear, however, forms an exception to this observation, and consequently admits of being taught to stand and walk erect, although the posture is manifestly inconvenient and irksome to the animal.

The perpendicular position of the vertebral column under the centre of the basis cranii, and the direction of the eyes and mouth forwards, would be as inconvenient to man, if he went on all-fours, as they are well adapted to his erect stature. In the former case, he would not be able to look before him; and the great weight of the head, with the comparative weakness of the extensor muscles, and the want of ligamentum nuchæ, would render the elevation of that organ almost impossible.

When quadrupeds endeavour to support themselves on the hind extremities; as, for instance, for the purpose of seizing any objects with the fore feet, they rather sit down than assume the erect position. For they rest on the thighs as well as on the feet, and this can only be done where the fore part of the body is small, as in the simiæ, the squirrel, &c.: in other cases, the animal is obliged also to support itself by the fore feet, as in the dog, cat, &c. The large and strong tail in some instances forms as it were a third foot, and thereby increases the surface for supporting the body, as in the kanguroo and the jerboa.

Various gradations may be observed in the mammalia, connecting man to those animals which are strictly quadrupds. The simiæ, which are by no means calculated for the erect position, are not, on the other hand, destined, like the proper quadrupeds, to go on all-fours. They live in trees, where their front and hind extremities are both employed in climbing, &c.

The true quadrupeds have the front of the trunk supported by the anterior extremities, which are consequently much larger and stronger than in man; as the hind feet of the same animals yield in these respects to those of the human subject. The chest is in a manner suspended between the scapulæ, and the serrati magni muscles, which support it in this position, are consequently of great bulk and strength. When viewed together, they represent a kind of girth surrounding the chest.

The chief agents in flying are the muscles, which move the anterior extremities of the bird, and which constitute what in common language is termed the breast of the animal.

Birds possess three pectoral muscles, arising chiefly from their enormous sternum, and acting on the head of the humerus. The first, or great pectoral, weighs of itself more than all the other muscles of the bird together. The keel of the sternum, the fork, and the last ribs, give origin to it; and it is inserted in a rough projecting line of the humerus. By depressing that bone, it produces the strong and violent motions of the wing, which carry the body forwards in flying. The middle pectoral lies under this, and sends its tendon over the junction of the fork, with the clavicle and scapula, as in a pulley, to be inserted in the upper part of the humerus, which bone it elevates. By this contrivance of the pulley, the elevator of the wing is placed at the under surface of the body. The third, or lesser pectoral muscle, has the same effect with the great pectoral, in depressing the wing.

One of the flexor tendons of the toes of birds, (produced from a muscle which comes from the pubis) runs in front of the knee; and all these tendons go behind the heel: hence the flexion of the knee and heel produces mechanically a bent state of the toes, which may be seen in the dead bird; and it is by means of this structure that the bird is supported, when roosting, without any muscular action.

This circumstance of the flexion of the toes accompanying that of the other joints of the lower extremity of birds was long ago observed by Borelli, and attributed by him to the connection which the flexors of the toes have with the upper parts of the limb, by which they are mechanically stretched when the knee is bent. This explanation has been controverted by Vicq d'Azyr, and others, who have referred the effect to the irritability of the muscles. The opinion of Borelli appears, notwithstanding, to be well founded; for not only the tendon of the accessory flexor passing round the knee, but the course of the flexor tendons over the heel, and along the metatarsus, must necessarily cause the contraction of the toes when either of these joints is bent; and if the phenomenon was not produced on mechanic principles, it would be impossible for birds to exhibit it during sleep, which they do, or to prove the effect on the limb of a dead bird, than which nothing is more easy. The utility of this contrivance is great in all birds, but particularly so in the rapacious tribe, which, by this means, grasp their prey in the very act of pouncing on it; and it is still more necessary to those birds which perch or roost during their sleep, as they could not otherwise preserve their position, when all their voluntary powers are suspended.

URINARY ORGANS.

The structure of the kidney in the mammalia displays two very opposite varieties, which may be called the simple and the conglomerated kidneys. In the former there is a single papilla, which is surrounded by an exterior crust of cortical substance. This is the case in all the feræ, and in many rodentia. The other kind of kidney consists of an aggregation of small kidneys, connected by cellular substance. It appears that this form of the gland is found in all those mammalia which either live in or frequent the water. I have observed it in the seal and porpoise, where the small kidneys are extremely numerous, and send branches to the ureter without forming a pelvis. Mr. Hunter states that it belongs to all the whales. ("Philos. Transact. 1807, pt. 2.") The otter has the same structure; but its small kidneys are not so numerous as in the animals above-mentioned. ("Home, of the sea-otter (lutra marina,) Philos. Trans. 1796, pt. 2.") It is remarkable that the brown bear (ursus arctos,) which lives on land, should have this structure as well as the white polar bear (ursus maritimus,) which, inhabiting the coasts and floating ice of the northern regions, spends much of its time in the water, Mr. Hunter concludes, that it is because nature wishes to preserve an uniformity in the structure of similar animals. But the badger, (ursus meles,) which is a very similar animal, has the uni-lobular kidney. The number of small kidneys in the bear is 50 or 60, and it appears that each consists of two papillæ.

The kidneys of birds form a double row of distinct, but connected glandular bodies, placed on both sides of the lumbar vertebræ, in cavities of the ossa innominata. The urinary bladder does not exist in this whole class, and the ureters open into cloaca.

Animals of the genus testudo and rana have a large bladder in the situation of the urinary receptacle of other animals. This is double in many of the frogs, properly so called. These bags are represented both by Blumenbach and Cuvier as urinary bladders; but Townson has already shown, that in the frog and toad they have no connection with the ureters, which open at the back of the rectum, while those receptacles terminate on the front of the intestine. ("Tracts and Observations," p. 66. fig. 3.) The writer of this article has observed the same structure in a male and female tortoise.

ORGANS OF GENERATION.

The nature of generation, which is the greatest mystery in the economy of living bodies, is still involved in impenetra ble obscurity. The creation of a living body, that is, its formation by the union of particles suddenly brought together, has not hitherto been proved by any direct observation. The comparison of this process to that of crystallization is founded in a false analogy; crystals are formed of similar particles, attracting each other indifferently, and agglutinated by their surfaces, which determine the order of their arrangement: living bodies, on the contrary, consist of numerous fibres or laminæ, of heterogenous composition, and various figures, each of which has its peculiar situation in relation to the other fibres and laminæ. Moreover, from the instant in which a living body can be said to exist, however small it may be, it possesses all its parts; it does not grow by the addition of any new laminæ, but by the uniform or irregular developement of parts which existed before any sensible growth.

The only circumstance common to all generation, and, consequently, the only essential part of the process, is, that every living body is attached at first to a larger body of the same species with itself. It constitutes a part of this larger body, and derives nourishment for a certain time from its juices. The subsequent separation constitutes birth; and may be the simple result of the life of the larger body, and of the consequent developement of the smaller, without the addition of any occasional action.

Thus the essence of generation consists in the appearance of a small organised body in or upon some part of a larger one; from which it is separated at a certain period, in order to assume an independent existence.

All the processes and organs, which cooperate in the business of generation in certain classes, are only accessory to this primary function.

When the function is thus reduced to its most simple state, it constitutes the gemmiparous, or generation by shoots. In this way the buds of trees are developed into branches, from which other trees may be formed. The polypes (hydra) and the sea-anemones (actinia) multiply in this manner; some worms are propagated by a division of their body, and must therefore be arranged in the same division. This mode of generation requires no distinction of sex, no copulation, nor any particular organ.

Other modes of generation are accomplished in appropriate organs: the germs appear in a definite situation in the body, and the assistance of certain operations is required for their further developement. These operations constitute fecundation, and suppose the existence of sexual parts: which may either be separate, or united in the same individual.

The office of the male sex is that of furnishing the fecundating or seminal fluid; but the manner in which that contributes to the developement of the germ is not yet settled by physiologists. Some, forming their opinions from the human subject and the mammalia, where the germs are imperceptible before fecundation, suppose that these are created by the mixture of the male fluid with that which they suppose to exist in the female; or that they pre-exist in the male semen, and that the female only furnishes them with an abode. Others consult the analogy of the other classes of animals and of plants. In several instances, particularly in the frog, the germ may be clearly recognised in the ovum, before fecundation: its pre-existence may be concluded, in other cases, from the manner in which it is connected to the ovum when it first becomes visible; for it is agreed on all sides, that the ovum exists in the female before fecundation, since virgin hens lay eggs, &c. From such considerations these physiologists conclude, that the germ pre-exists in all females, and that the fecundating liquor is a stimulus, which bestows on it an independent life, by awakening it, in a manner, from the species of lethargy in which it would otherwise have constantly remained.

The origin of the germs, and the mode of their existence in the female, whether they are formed anew by the action of life, or are pre-existent, and inclosed within each other; or whether they are disseminated, and require a concourse of circumstances to bring them into a situation favourable for their developement; are questions, which, in the present state of our knowledge, it is utterly impossible for us to decide. These points have for a long time been agitated by physiologists; but the discussion seems now to be abandoned by universal consent.

The combination of the sexes, and the mode of fecundation, are subject to great variety. In some instances they are united in the same individual, and the animal impregnates itself. The acephalous mollusca and the echinus exemplify this structure. In others, although the sexes are united in each individual, an act of copulation is required, in which they both fecundate and are fecundated. This is the case with the gasteropodous mollusca, and several worms. In the remainder of the animal kingdom the sexes belong to different individuals.

The fecundating liquor is always applied upon or about the germs. In many cases the ova are laid before they are touched by the semen; as in some fishes of the bony division, and the cephalopodous mollusca. Here, therefore, impregnation is effected out of the body; as it is also in the frog and toad. But in the latter instances the male embraces the female, and discharges his semen in proportion as she voids the eggs. In most animals the seminal liqour is introduced into the body of the female, and the ova are fecundated before they are discharged. This is the case in the mammalia, birds, most reptiles, and some fishes; in the hermaphrodite gasteropodous mollusca, in the crustacea, and insects. The act by which this is accomplished is termed copulation.

In all the last mentioned orders ova may be discharged without previous copulation, as in the preceding ones. But they receive no further developement; nor can they be fecundated when thus voided.

The effect of a single copulation varies in its degree; it usually fecundates one generation only; but sometimes, as in poultry, several eggs are fecundated; still, however, they only form one generation.

In a very few instances one act of copulation fecundates several generations, which can propagate their species without the aid of the male. In the plant-louse (aphis) this has been repeated eight times; and in some monoculi twelve or fifteen times.

When the germ is detached from the ovary, its mode of existence may be more or less complete. In most animals it is connected, by means of vessels, to an organised mass, the absorption of which nourishes and developes it until the period of its birth. It derives nothing, therefore, from the body of the mother, from which it is separated by coverings varying in number and solidity. The germ, together with its mass of nourishment, and the surrounding membranes, constitutes an egg or ovum; and the animals which produce their young in this state are denominated oviparous.

In most of these the germ contained in the egg is not developed until that part has quitted the body of the mother, or has been laid: whether it be necessary that it should be afterwards fecundated, as in many fishes, or required only the application of artificial heat for its incubation, as in birds; or that the natural heat of the climate is sufficient, as in reptiles, insects, &c. These are strictly oviparous animals.

The ovum, after being fecundated, and detached from the ovarium, remains, in some animals, within the body of the mother, until the contained germ be developed and hatched. These are false viviparous animals, or ovo-viviparous. The viper and some fishes afford instances of this process.

Mammalia alone are truly viviparous animals. Their germ possesses no provision of nourishment, but grows by what it derives from the juices of the mother. For this purpose it is attached to the internal surface of the uterus, and sometimes by accident to other parts, by a kind of root or infinite ramification of vessels called a placenta. It is not, therefore, completely separated from the mother by its coverings. It does not come into the world until it can enjoy an independent organic existence. The mammalia cannot, therefore, be said to possess an ovum, in the sense which we have assigned to that term.

From the above view of the subject, generation may be said to consist of four functions, differing in their importance, and in the number of animals to which they belong.

1st. The production of the germ, which is a constant circumstance; 2dly, fecundation, which belongs to only the sexual generations; 3dly, copulation, which is confined to those sexual generations, in which fecundation is accomplished within the body.

Lastly, uterogestation, which belongs exclusively to viviparous generation.

The testes, and sometimes the vesiculæ seminales and prostate, vary most remarkably in their magnitude in such animals as have a regular rutting season. They are very diminutive at other periods of the year, but swell at that particular time to a comparatively vast magnitude. This change is particularly observable in the testes of the mole, sparrow, and frog.

We may mention here, in a cursory and general manner, the peculiar organs possessed by the moles of some species, for the purpose of holding the female during the act of copulation. Of this kind are, the spur on the hind feet of the male ornithorhynchus; the rough black tubercle formed in the spring season on the thumb of the common frog; the two members, formed of bones articulated to each other, near the genitals of the male torpedo and other cartilaginous fishes; the forceps on the abdomen of the male dragon-fly, &c.

A scrotum belongs to the mammalia only; and is not found in all these. The aquatic genera, those which live under ground, and others, want it.

The testes remain constantly in the abdomen in the ornithorhynchus, the elephant, the amphibious mammalia, and the cetacea. Some animals have the power of protruding them from the abdomen, and retracing them again into the cavity; as the bats, mole, hedgehog, and shrew, besides several of the rodentia. They are thrust out of the cavity, particularly at the rutting season.

The tunica vaginalis exists constantly in the mammalia. As the horizontal position of the body obviates the danger of herniæ, the cavity of this membrane communicates by means of a narrow canal with the abdomen, in such animals as have the testes remaining constantly in the scrotum.

In some species, where the act of copulation requires a longer portion of time, as in the dog, badger, &c. the corpus spongiosum of the glans, and of the posterior part of the penis, swells during the act much more considerably than the rest of the organ, and thus the male and female are held together during a sufficient space of time for the discharge of the seminal fluid.

Several species of mammalia, both among those which possess no vesiculæ seminales, and thereby require a longer time for completing the act of copulation, and such as are not distinguished by this peculiarity, possess a peculiar bone in the penis, generally of a cylindrical form, but sometimes grooved. This is the case with some of the simiæ, most of the bat-kind, the hamster, and several others of the mouse-kind, the dog, bear, badger, weasel, seal, walrus, &c.

In most of the mammalia the urethra runs on the end of the glands, and forms a common passage for the urine, prostatic liquor, and semen. In some few species, the passage which conducts the two former fluids is distinct from that of the seminal liquor. The bifid fork-like glans, of the opossum has three openings, one at the point of bifurcation for transmitting the urine; and two for the seminal fluid at the two extremities of the glans. The short urethra of the ornithorynchus paradoxus opens directly into the cloaca, and the large penis of the animal serves merely to conduct the seminal fluid. It divides into two parts at its extremity, and each of these is furnished with sharp papillæ, which are perforated for the passage of the semen. A similar structure obtains in the ornithorhynchus hystrix, where the penis divides into four glands.

In some species of the cat-kind the glans is covered with retroverted papillæ, which, as these animals have no vesiculæ seminales, may enable the male to hold the female longer in his embraces.

Lastly, it deserves to be mentioned, that in some mammalia, the male penis, while unerected, is turned backwards; so that the urine is voided in the male in the same direction as in the female. The hare, lion, and camel, afford instances of this structure. But the statement which has been so often repeated since the time of Aristotle, that these retromingentia copulate backwards, is erroneous.

BIRDS.

The testes, which lie near the kidneys, and the ductus deferentes, are the only male organs which are constantly found in the whole class.

In a very few instances, as in the cock, the last mentioned canals terminate in a dilated part, which has been considered analogous to the vesiculæ seminales. In stead of a penis, most birds have in the cloaca two small papillæ, on which the seminal ducts terminate. This is the case in the cock, turkey and pigeon.

Some few species have a simple penis of considerable length, which is ordinarily concealed and retracted within the cloaca; but remains visible externally for some time after copulation. It forms a long worm-shaped tube in the drake, and constitutes a groove in the ostrich, which is visible when the animal discharges its urine.

AMPHIBIA.

The kidney, testes, and epididymis, lie close together in the testudines; but each of the three organs may be distinguished by its peculiar colour and structure on the first view. They appear to have no vesiculæ seminales: none at least could be discovered in a testudo græca, which was lately dissected. The penis on the contrary is very large; and retracted within the cloaca in its ordinary state. Instead of an urethra, this part contains a groove, whose margins approach to each other, when the part is erected, so as to form a closed canal. The glans terminates in an obtuse hook-like point, somewhat resembling the end of the elephant's trunk.

Serpents have long slender testicles; no vesiculæ seminales; but a double penis, each of which has a bifid point covered with sharp papillæ.

FISHES.

The male organs of generation possess very different structures in the different orders of this class. We shall take two species as examples; the torpedo for the cartilaginous, and the carp for the bony fishes.

In the former instance there are manifest testicles, consisting partly of innumerable glandular and granular bodies, and partly of a substance like the soft roe of bony fishes. We find also vasa deferentia, and a vesicula seminalis, which opens into the rectum by means of a small papilla.

The soft roe supplies the place of testes in the carp, and most other bony fishes. It forms two elongated flat viscera, of a white colour, and irregular tuberculated surface, placed at the sides of the intestines and swimming bladder, so that the left encloses the rectum in a kind of groove. Through the middle of each soft roe passes a ductus deferens, which opens behind into a kind of vesicula seminalis, and this terminates in the cloaca.

FEMALE ORGANS OF GENERATION.

An ovarium is the most essential and universal of all the female parts of generation. In addition to this, those animals which breathe by means of lungs, as well as some fishes, and several white-blooded animals, have, also oviducts, (Fallopian tubes, &c.) or canals leading from the ovarium to the uterus: and lastly, those, at least, which are impregnated by a real copulation, possess a vagina, or canal connecting the uterus to the external organs of generation.

In birds all the parts which we have just mentioned are single. Some cartilaginous fishes have two oviducts; beginning, however, by a common opening, and terminating in a simple uterus. The human female, as well as that of many other mammalia, has two ovaria, with an oviduct belonging to each; a simple uterus and vagina. The females of this class, in several other instances, possess an uterus bicornis: and in some cases the generative organs are double throughout; that is, there are two uteri, and, at least for some extent, a double vagina.

Ovaria are found in the females of all animals where the male possesses testicles; but their structure is in general more simple than that of the latter glands, particularly in the first class. These bodies were formerly called the female testicles; but the term ovary is much preferable, as it denotes the function which the parts perform in the animal economy. For, if the office of these bodies be at all dubious, when their structure is considered in man and most of the mammalia, their organization is so evident in the other classes, that no doubt can be entertained respecting their physiology. It is manifest in all these, that the ovaria serve for the growth and preservation of the germs or ova, which exist in these bodies, completely formed, before the act of copulation. Analogy leads us to conclude that these bodies have the same office in the mammalia; and thus our explanation and illustration of this most interesting part of physiology are entirely derived from researches in comparative anatomy.

Of all the external female sexual organs in the mammalia, the clitoris is found the most universally and invariably. It exists even in the whale, and probably is wanting in no other instance than the ornithorhynchus. As its general structure much resembles that of the male penis, it contains a small bone in several species, as the marmota citillus, the racoon, lioness, and sea-otter.

A true hymen, or one, at least, which in form and situation resembles that of the human subject, has been observed in no other animal.

The structure and form of the uterus vary very considerably in the mammalia. In no instance does it possess that thickness, nor has its parenchyma that density nor toughness, which are observed in the human female. Of those which I have dissected, the simia sylvanus had comparatively the firmest uterus. The two-toed ant-eater came the next in order in this respect. But in the greater number of mammalia, this organ is thin in its coats, resembling an intestine in appearance, and provided with a true muscular covering.

The variations in the form of the unimpregnated uterus may be reduced to the following heads:

1. The simple uterus without horns, (uterus simplex,) which is generally of a pyramidal or oval figure. This is exemplified in those animals, where we have stated that it possesses thick coats. Its circumference in some simiæ presents a more triangular form than in the woman: and towards the upper part, in the neighbourhood of the Fallopian tubes,

there is an obscure division into two blind sacs, (as in the gibbon, or long-armed ape:) this distinction is more strongly expressed in the lori, (lemur tardigradus,) so as to form a manifest approach to the uterus bicornis.

2. A simple uterus with straight or convoluted horns (uterus bicornis.) They are straight in the bitch, in the bats of this country, in the sea-otter, seal, &c.; somewhat convoluted in the cetacea, mare, and hedge-hog, and still more tortuous in the bisulca.

3. A double uterus, having the appearance of two horns, which open separately into the vagina; this is seen in the hare and rabbit, (uterus duplex.)

4. A double uterus, with extraordinary lateral convolutions, is met with in the opossum and kanguroo, (uterus anfractuosus.

These various forms undergo different changes in the pregnant state.

The alteration in the simple uterus is, on the whole, analogous to that which occurs in the human female.

The pregnant uterus bicornis suffers a different change in those animals which bear only one at a time, from that which it undergoes in the multipara. The fœtus of the mare is confined in its situation to the proper uterus. In the cow it extends at the same time into one of the horns, which is enlarged for its reception. In those, on the contrary, which bring forth many young at once, as also in the double uterus of the hare and rabbit, both cornua are divided by contracted portions into a number of pouches corresponding to that of the young; and where those horns are straight in the unimpregnated state, as in the bitch, they become convoluted.

The uterus of the opossum and kanguroo suffers the least change from its usual appearance in the impregnated state. For these strange animals bring their young into the world so disproportionately small, that they appear like early abortions.

The passage of the fœtus, in the opossum tribe and the kanguroo, from the cavity of the uterus into the false belly, where it adheres by its mouth to the nipple, presents one of the most singular and interesting phenomena in the whole circle of comparative anatomy. Physiologists have not yet ascertained, whether the embryo possesses, at any period, a connection with the uterus similar to that which is observed in the other mammalia: but it appears very probable, that the processes, which follow the passage of the ovum from the ovarium, are entirely different in these animals, from those which take place in the other mammalia. Neither has the precise period, at which the fœtus enters the false belly, been hitherto shewn,

The following statement of the subject, as far as it is at present known, is derived from Mr. Home's paper. (Phil. Trans. 1795.)

The uterus and lateral canals, in their pregnant state, are distended with a very adhesive jelly of a bluish white colour; which also fills the oval enlargements of the Fallopian tubes.

"In the cavity of the uterus," says Mr. Home, "I detected a substance which appeared organized; it was enveloped in the gelatinous matter, and so small as to make it difficult to form a judgment respecting it; but when compared with the fœtus after it becomes attached to the nipple, it so exactly resembled the backbone with the posterior part of the skull, that it is readily recognized to be the same parts in an earlier stage of their formation."

This substance has been represented in a plate; but the engraving does not, in our opinion, possess the slightest similitude to the parts mentioned by Mr. Home.

The size of the fœtus at the time it leaves the uterus is not yet ascertained. The smallest, which has been hitherto found in the false belly, weighed twenty-one grains, and was less than an inch in length. In another instance it was "thirty-one grains in weight from a mother of fifty-six pounds. In this instance the nipple was so short a way in the mouth, that it readily dropped out; we must therefore conclude that it had been very recently attached to it.

"The fœtus at this period had no navel string, nor any remains of there ever having been one; it could not be said to be perfectly formed, but those parts which fit it to lay hold of the nipple were more so than the rest of the body. The mouth was a round hole, just enough to receive the point of the nipple; the two fore-paws, when compared to the rest of the body, were large and strong, the little claws extremely distinct; while the hind-legs, which are afterwards to be so very large, were both shorter and smaller than the fore ones."

"The mode in which the young kanguroo passes from the uterus into the false belly has been matter of much speculation; and it has even been supposed that there was an internal communication between these cavities; but after the most diligent search, I think I may venture to assert that there is no such passage. This idea took its rise from there being no visible opening between the uterus and vagina in the unimpregnated state; but such an opening being very apparent, both during pregnancy and after parturition, overturns this hypothesis; for we cannot suppose that the fœtus, when it has reached the vagina, can pass out in any other way than through the external part." This passage will be facilitated by the power which the animal possesses, of drawing down the false belly to the vulva, which has naturally a considerable projection.

The female organs of generation of birds consist of an ovarium, and an oviduct, which opens into the cloaca. Its aperture is placed towards the left of that organ. The tube itself is convoluted, somewhat like an intestine. Its inner coat is furnished with numerous papillæ. Its diameter is the most considerable at the cloaca, from which it gradually diminishes. It opens towards the abdomen by an expanded orifice, called the infundibulum; which is analogous to the fimbriated orifice of the Fallopian tube.

The ovarium, resembling in its appearance a bunch of grapes, lies under the liver, and contains in a young laying hen about five hundred yolks, varying in size from a pin's head to their perfect magnitude: the largest always occupy the external circumference of the part. Each yolk is inclosed in a membrane (calyx) which is joined to the ovarium by means of a short stalk or pedicle (petiolus) A white shining line forms on the calyx when the yolk has attained its complete magnitude. The membrane bursting in this part, the contained yolk escapes, and is taken up by the infundibulum in a manner which we cannot easily conceive. It then passes along the oviduct, and acquires in its passage the white and shell. The calyx, on the contrary, remains connected to the ovarium; but it contracts and diminishes in size, so that in old hens, which have done laying, the whole internal organs of generation nearly disappear.

AMPHIBIA.

The tortoise has a manifest clitoris lying in the cloaca. The oviduct and ovarium have on the whole much analogy with those of birds; but all these parts are double, and have two openings into the cloaca.

The frogs of this country have a large uterus, divided by an internal partition into two cavities, from which two long convoluted oviducts arise, and terminate by open orifices at the sides of the heart. The ovaria lie under the liver, so that it is difficult to conceive how the ova get into the above mentioned openings. The uterus opens into the cloaca.

The toads have not the large uterus; but their oviducts terminate by a common tube in the cloaca.

The lizards of this country have on the whole a similar structure to that of the last mentioned animals. Their oviducts are larger, but shorter, and the ovaria contain fewer ova.

Female serpents have double external openings of the genitals for the reception of the double organs of the male. The oviducts are long and much convoluted. The ovaria resemble rows of beads composed of yellow vesicles.

FISHES.

We shall take the torpedo and the carp as examples of the two chief divisions of the class, as we did in speaking of the male organs.

In the former fish there are two uteri, communicating with the cloaca by means of a common vagina. The oviducts form one infundibulum, which receives the ova as they sucessively arrive at maturity. These are very large in comparison with those of the bony fishes. The yolk, in its passage through the oviduct, acquires its albumen and shell. The latter is of a horny consistence, and is known by the name of the sea-mouse. It has an elongated quadrangular figure, and its four corners are curved and pointed in the skate, while they form horny plaited eminences in the sharks. The secretion of the albumen, and the formation of the shell, are performed by the papillous internal surface of the duct; and chiefly by two glandular swellings which appear towards its anterior extremity in the summer months, while the eggs are being laid.

The structure is much more simple in the carp, and probably also in the other oviparous bony fishes. The two roes occupy the same position as the soft roe of the male does. They are placed at the side of the intestines, liver, and swimming bladder, as far as the anus. They consist of a delicate membrane inclosing the ova, which are all of one size, and extremely numerous (more than 200,000 in the carp); and terminate by a common opening behind the anus.

The immense number of ova contained in the ovaria of fishes accounts to us satisfactorily for the astonishing multitudes in which some species are formed. In a perch weighing one pound two ounces, there were 69,216 ova in the ovarium; in a mackarel of one pound three ounces, 129,200; in a carp of eighteen inches, Petit found 342,144; and in a sturgeon of one hundred and sixty pounds, there was the enormous number of 1,467,500.

EMBRYO OF THE MAMMALIA.

The mode of connexion of the pregnant uterus with the membranes of the ovum, and thereby with the embryo itself, display three chief differences in the various mammalia.

Either the whole external surface of the ovum adheres to the cavity of the uterus, or the connection is effected by means of a simple placenta, or by more numerous small placentæ (cotyledons.)

The first kind of structure is observed in the sow, and is still more manifest in the mare. In the latter case, the external membrane of the ovum, the chorion, may be said to form a bag-like placenta. Numerous and large branches of the umbilical vessels ramify through it, particularly in the latter half of the period of pregnancy; and its external surface is covered with innumerable flocculent papillæ, which connect it to the inside of the uterus.

In those animals of this class, where the embryo is nourished by means of a placenta, remarkable varieties occur in the several species; sometimes in the form and successive changes of the parts; sometimes in the structure of the organ, as being more simple or complicated.

In most of the digitated mammalia, as well as in the quadrumana, the placenta has a roundish form; yet it consists sometimes of two halves lying near together; and in the dog, cat, martin, &c. it resembles a belt (cingulum or zona.) Its form in the pole-cat holds the middle between these two structures, as there are two round masses joined by an intervening narrower portion

The placenta of the bisulca is divided into numerous cotyledons, the structure of which is very interesting, as it elucidates the whole physiology of this organ. The parts designated by this appellation are certain fleshy excrescences (glandulæ uterinæ) produced from the surface of the impregnated uterus, and having a corresponding number of flocculent fasciculi of blood-vessels (carunculæ) which grow from the external surface of the chorion implanted in them. Thus the uterine and fetal portions of the placenta are manifestly distinct from each other, and are easily separable as the fœtus advances to maturity. The latter only are discharged with the after-birth, while the former, or the cotyledons, gradually disappear from the surface of the uterus after it has parted with its contents. The number and form of these excrescences vary in the different genera and species. In the sheep and cow they sometimes amount to a hundred. In the former animal and the goat they are, as the name implies, concave eminences; while, on the contrary, in the cow, deer, &c. their surface is rounded or convex.

The trunks of the veins which pass from the placenta or carunculæ, and of the arteries which proceed towards these parts, are united in the umbilical chord, which is longer in the human embryo than in any other animal.

In the foal, as in the child, the chord possesses a single umbilical vein; whilst most other quadrupeds have two, which unite, however, into a common trunk near the body of the fœtus, or just within it.

The amnion, or innermost of the two membranes of the ovum, which belongs to the pregnant woman, as well as to the mammalia, is distinguished in some of the latter, as for instance in the cow, by its numerous blood-vessels; while, on the contrary, in the human subject it possesses no discernible vascular ramification.

Between the chorion and amnion there is a part found in most pregnant quadrupeds, and even in the cetacea, which does not belong to the human ovum, *viz.* the allantois, or urinary membrane. The latter name is derived from the connection which this part has, by means of the urachus, with the urinary bladder of the fœtus: whence the watery fluid which it contains has been regarded as the urine of the animal. The term allantois has arisen from the sausage-like form which the part possesses in the bisulca and the pig; although this shape is not found in several other genera and species; thus, in the hare, rabbit, guinea-pig, &c. it resembles a small flask; and it is oval in the pole-cat. It covers the whole internal surface of the chorion in the solidungula, and therefore incloses the foal with its amnion. It contains, most frequently in these animals (although not rarely in the cow,) larger or smaller masses of an apparently coagulated sediment in various forms and number, which has been long known by the singular name of the horse-venom, or hippomanes.

Some orders and genera of mammalia resemble the human subject in having no allantois, as the quadrumana and the hedge-hog; nay, in the latter animal, the urinary bladder has no trace whatever of urachus.

ON THE INCUBATED EGG.

The various vital processes of nutrition and formation, which are carried on in the fœtus of the mammalia while in its mother's body, and by means of the most intimate connection with the parent, are effected in the incubated chick by its own powers, quite independently of the mother, and without any extraneous assistance, except that of the atmospheric air and a certain degree of warmth.

The egg is covered within the shell, by a white and firm membrane (membrana albuminis) which contains no blood-vessels. The two layers of this membrane, which in other parts adhere closely to each other, leave at the large end a space which is filled with atmospheric air.

This membrane includes the two whites of the egg, each of which is surrounded by a delicate membrane. The external of these is the most fluid and transparent; the inner one thicker and more opaque; they may be separated in eggs which are boiled hard.

The internal white surrounds the yolk, which is contained in a peculiar membrane called the yolk-bag. From each end of this proceeds a white knotty body, which terminates in a flocculent extremity in the albumen. These are called the chalazæ, or grandines.

A small round milk-white spot, called the tread of the cock (cicatricula, or macula), is formed on the surface of the yolk-bag. It is surrounded by one or more whitish concentric circles (halones, or circuli), the use of which, as well as that of the cicatricula itself, and of the chalazæ, is not yet ascertained.

We now proceed to notice the wonderful successive changes which go on during the incubation of the egg, and the metamorphoses which are observed, both in the general form of the chick and in particular viscera. The periods of these changes will be set down from the hen, as affording the most familiar example. It will be best to give, first, a cursory chronological view of the whole process, and then to make a few remarks on some of the most important parts of the subject.

A small shining spot, of an elongated form, with rounded extremities, but narrowest in the middle, is perceived at the end of the first day, not in nor upon the cicatricula, but very near that part on the yolk-bag (nidus pulli; colliquamentum; areola pellucida.) This may be said to appear before-hand, as the abode of the chick which is to follow.

No trace of the latter can be discerned before the beginning of the second day; and then it has an incurvated form, resembling a gelatinous filament with large extremities, very closely surrounded by the amnion, which at first can scarcely be distinguished from it.

About this time the halones enlarge their circles, but they soon after disappear entirely, as well as the cicatricula.

The first appearance of red blood is discerned on the surface of the yolk-bag towards the end of the second day. A series of points is observed which form grooves; and these, closing, constitute vessels, the trunks of which become connected to the chick. The vascular surface itself is called figura venosa, or area vasculosa; and the vessel, by which its margin is defined, vena terminalis. The trunk of all the veins joins the vena portæ; while the arteries, which ramify on the yolk-bag, arise from the mesenteric artery of the chick.

On the commencement of the third day, the newly-formed heart (the primary organ of the circulating process which now commences) is discerned by means of its triple pulsation, and constitutes a threefold punctum saliens. Some parts of the incubated chicken are destined to undergo successive alterations in their form; and this holds good of the heart in particular. In its first formation it resembles a tortuous canal, and consists of three dilatations lying close together, and arranged in a triangle. One of these, which is properly the right, is then the common auricle; the other is the only ventricle, but afterwards the left; and the third is the dilated part of the aorta (bulbus aortæ.)

About the same time, the spine, which was originally extended in a straight line, becomes incurvated; and the distinction of the vertebræ is very plain. The eyes may be distinguished by their black pigment, and comparatively immense size; and they are afterwards remarkable, in consequence of a peculiar slit in the lower part of the iris.

From the fourth day, when the chicken has attained the length of four lines, and its most important abdominal viscera, as the stomach, intestines, and liver, are visible, (the gall bladder, however, does not appear till the sixth day,) a vascular membrane (chorion, or membrana umbilicalis) begins to form about the navel, and increases in the following days with such rapidity, that it covers nearly the whole inner surface of the shell within the membrana albuminis, during the latter half of incubation. This seems to supply the place of the lungs, and to carry on the respiratory process instead of those organs. The lungs themselves begin indeed to be formed on the fifth day; but, as in the fœtus of the mammalia, they must be quite incapable of performing their functions while the chick is contained in the amnion.

Voluntary motion is first observed on the sixth day; when the chick is about seven lines in length.

Ossification commences on the ninth day, when the ossific juice is first secreted, and hardened into bony points (puncta ossificationis.)

These form the rudiments of the bony ring of the sclerotica, which resembles at that time a circular row of the most delicate pearls.

At the same period, the marks of the elegant yellow vessels (vasa vitelli lutea) on the yolk-bag, begin to be visible.

On the fourteenth day, the feathers appear; and the animal is now able to open its mouth for air, if taken out of the egg.

On the nineteenth day it is able to utter sounds; and on the twenty-first to break through its prison, and commence a second life.

We shall conclude with one or two remarks on those very singular membranes, the yolk-bag and chorion, which are so essential to the life and preservation of the animal.

The chorion, that most simple yet most perfect temporary substitute for the lungs, if examined in the latter half of incubation in an egg very cautiously opened, presents, without any artificial injection, one of the most splendid spectacles that occurs in the whole organic creation. It exhibits a surface covered with numberless ramifications of arterial and venous vessels. The latter are of the bright scarlet colour, as they are carrying oxygenated blood to the chick; the arteries, on the contrary, are of the deep or livid red, and bring the carbonated blood from the body of the animal. Their trunks are connected with the iliac vessels; and, on account of the thinness of their coats, they afford the best microscopical object for demonstrating the circulation in a warm-blooded animal.

The other membrane, the membrana vitelli, is also connected to the body of the chick, but by a twofold union, and in a very different manner from the former. It is joined to the small intestine, by means of the ductus vitello-intestinalis (pedunculus, apophysis;) and also by the blood vessels, which have been already mentioned, with the mesenteric artery and vena portæ.

In the course of the incubation the yolk becomes constantly thinner and paler, by the admixture of the inner white. At the same time innumerable fringe-like vessels, with flocculent extremities of a most singular and unexampled structure, form on the inner surface of the yolk-bag, opposite to the yellow ramified marks above mentioned, and hang into the yolk. There can be no doubt that they have the office of absorbing the yolk, and conveying it into the veins of the yolk-bag, where it is assimilated to the blood, and applied to the nutrition of the chick. Thus, in the chicken which has just quitted the egg, there is only a remainder of the yolk and its bag to be discovered in the abdomen. These are completely removed in the following weeks, so that the only remaining trace is a kind of cicatrix on the surface of the intestine.

Comparative *degree*, among grammarians, that between the positive and superlative degrees, expressing any particular quality above or beneath the level of another.

COMPARISON *of ideas*, among logicians, that operation of the mind, whereby it compares its ideas one with another, in regard of extent, degree, time, place, or any other circumstance, and is the ground of relations. This is a faculty which the brutes seem not to have in any great degree.

Comparison, in rhetoric, a figure that illustrates and sets off one thing, by resembling and comparing it with another, to which it bears a manifest relation and resemblance, as the following figure in Shakspeare:

"She never told her love,
But let concealment, like a worm i' the bud,

Feed on her damask cheek: she pined
in thought,
And sat like Patience on a monument,
Smiling at Grief."

COMPARTMENT, or COMPARTIMENT, in general, is a design composed of several different figures, disposed with symmetry, to adorn a parterre, a ceiling, &c. A compartment of tiles, or bricks, is an arrangement of them, of different colours, and varnished, for the decoration of a building. Compartments, in gardening, are an assemblage of beds, plats, borders, walks, &c. disposed in the most advantageous manner that the ground will admit of. Compartments in heraldry are otherwise called partitions.

COMPASS, or *mariner's compass*, an instrument whereby the ship's course is determined. See MAGNETISM.

COMPASS is also an instrument in surveying of land, dialling, &c. whose structure is chiefly the same with that of the mariner's compass; and, like that, consists of a box and needle; the principal difference being this, that instead of the needle's being fitted into the card, and playing with it on a pivot, it here plays alone. See SURVEYING.

COMPASS *dials* are small horizontal dials fitted in brass or silver boxes for the pocket, to show the hour of the day, by the direction of a needle, that indicates how to place them right, by turning the dial about till the cock or style stand directly over the needle, and point to the northward; but these can never be very exact, because of the variations of the needle itself.

COMPASSES, or *pair of compasses*, a mathematical instrument for describing circles, measuring figures, &c. They consist of two sharp pointed branches or legs of iron, steel, brass, or other metal, joined at top by a rivet, whereon they move as on a centre.

COMPASSES *of three legs* are, setting aside the excess of a leg, of the same structure with the common ones: their use being to take three points at once, and so to form triangles; to lay down three positions of a map to be copied at once, &c.

COMPASSES, *beam*, consist of a long branch or beam, carrying two brass cursors, the one fixed at one end, the other sliding along the beam, with a screw to fasten it on occasion. To the cursors may be screwed points of any kind, whether steel for pencils, or the like. It is used to draw large circles, to take great extents, &c. See INSTRUMENTS, *mathematical*.

COMPASSES, *caliber*. See the article CALIBER.

COMPASSES, *clockmakers'*, are joined, like the common compasses, with a quadrant or bow, like the spring compasses; only of different use, serving here to keep the instrument firm at any opening. They are made very strong, with the points of their legs of well-tempered steel, as being used to draw lines on pasteboard or copper.

COMPASSES, *elliptic*, consist of a cross with grooves in it, and an index which is fastened to the cross by means of dovetails that slide in the grooves; so that when the index is turned about, the end will describe an ellipsis, which is the use of these compasses.

COMPENSATION, in horology, is a contrivance in the pendulum of a clock, by means of which, while the expansion from increase of temperature depresses the centre of gravity of some of the vibrating parts, other parts are made to ascend nearer the centre of suspension, or else to draw up the pendulum, so as to preserve the centre of oscillation of the compound pendulum at an invariable distance; and in consequence to keep all the vibrations to the same time.

Compensation pendulums have the part which expands upwards made either of brass or zinc, or some very expansible metal, while the descending parts are usually iron or steel, and some of these have leaves or machinery in their construction: in others the compensation-part does not vibrate, but serves to alter the length of a simple pendulum; and in others a fluid is used, most commonly mercury. See HOROLOGY and PENDULUM.

COMPENSATION *balance*. See HOROLOGY.

COMPLEMENT, in astronomy, the distance of a star from the zenith: or the arch comprehended between the place of the star above the horizon and the zenith.

COMPLEMENT, in geometry, is what remains of a quadrant of a circle, or of 90° after any certain arch has been taken away from it. Thus, if the arch taken away be 40°, its complement is 50: because $50 + 40 = 90$. The sine of the complement of an arch is called the cosine, and that of the tangent, the cotangent, &c.

Complement *of the course*, in navigation, is the number of points the course wants of 90°, or eight points, *viz.* of a quarter of the compass.

Complement *of life*, in the doctrine of annuities, denotes the difference, according to M. De Moivre's hypothesis, between the age of any given life and 86 years. Thus the complement of a life of 45 years is 41: of 30 it is 56. According to this hypothesis, the probabilities of life, through every period of existence, are supposed to decrease in an arithmetical progression, so that out of 86 persons just born, one is supposed to die every year, till at the end of 86 years, which is considered as the utmost limit of human life, the last survivor becomes extinct. On this supposition, the number of years that a person has an equal chance of surviving, is made to be the same with the expectation which M. De Moivre finds to be equal to half the complement of life; so that if the age be 4, the expectation will be $\frac{82}{2}=41$; if the age be 82, the expectation will be $\frac{4}{2}=2$; while the chance that a child aged 4 survives 41 years is $\frac{41}{82}$, and the chance that a person aged 82 survives 2 years is $\frac{2}{4}$. Since each of these fractions is $=\frac{1}{2}$, it follows that the one has an equal chance of living 41, and the other of living 2 years. But by tables founded on observation, the expectation of these lives are $40\frac{2}{3}$ and $3\frac{1}{2}$, while the chance of the younger living $40\frac{2}{3}$ years is 464, and the chance of the elder living $3\frac{1}{2}$ is 53: that is, in the first instance the chance is less, and in the second greater than an even one, that a person lives such a number of years as shall be equal to his expectation, which proves the incorrectness of M. De Moivre's hypothesis.

Complements, *in a parallelogram*, are the two smaller parallelograms made by drawing two right lines through a point in the diagonal, and parallel to the side of a parallelogram. In every parallelogram these compliments are equal.

COMPLEX, *terms, or ideas*, in logic, are such as are compounded of several simple ones.

Complex ideas are often considered as single and distinct beings, though they may be made up of several simple ideas, as a body, a spirit, a horse, a flower; but when several of these ideas of a different kind are joined together, which are wont to be considered as distinct, single beings, they are called a compounded idea, whether these united ideas be simple or complex. Complex ideas, however compounded and recompounded, though their number be infinite, and their variety endless, may be all reduced under these three heads, modes, substances, and relations.

Complex *proposition*, is either that which has at least one of its terms complex, or such as contains several members, as causal propositions; or it is several ideas offering themselves to our thoughts at once, whereby we are led to affirm the same thing of different objects, or different things of the same object. Thus, "God is infinitely wise, and infinitely powerful." In like manner, in the proposition, "Neither kings nor people are exempt from death.

COMPLEXION, a term technically denoting the temperament, habitude, and natural disposition of the body; but popularly signifying the colour of the face and skin. Few subjects have engaged the attention of naturalists more than the diversities among the human species, among which that of colour is the most remarkable. The great differences in this respect have given occasion to several authors to assert, that the whole human race have not sprung from one original: but that as many different species of men were at first created, as there are now different colours to be found among them. It remains, in reality, a matter of no small difficulty, to account for the remarkable variations of colour that are to be found among different nations. Dr Hunter, who considered the matter more accurately than has commonly been done, determines absolutely against any specific difference among mankind. He introduces his subject by observing, that when the question has been agitated, whether all the human race constituted only one species or not, much confusion has arisen from the sense in which the term species has been adopted. He therefore thinks it necessary to set out with a definition of the term. He includes under the same species all those animals which produce issue capable of propagating others resembling the original stock from whence they sprung. This definition he illustrates by having recourse to the human species as an example. And in this sense of the term he concludes, that all of them are to be considered as belonging to the same species. And as, in the case of plants, one species comprehends several varieties, depending upon climate, soil, culture, and similar accidents; so he considers the diversities of the human race to be merely varieties of the same species, produced by natural causes.

Upon the whole, colour and figure may be styled habits of the body. Like other habits, they are created, not by great and sudden impressions, but by continual and almost imperceptible touches. Of habits, both of mind and body, nations are susceptible as well as individuals. They are transmitted to the offspring, and augmented by inheritance. Long in growing to maturity, national features, like national manners, become fixed only after a succession of ages. They become, however, fixed at last; and if we can ascertain any effect produced by a given state of weather or of climate, it requires only repetition, during a sufficient length of time, to augment and impress it with a permanent character. The sanguine countenance will, for this reason, be perpetual in the highest latitudes of the temperate zone; and we shall for ever find the swarthy, the olive, the tawny, and the black, as we descend to the south.

COMPOSER, in music, a practical musical author; so called, in contradistinction to one who merely speculates in acoustics, and writes on the laws of harmony and melody, but does not concern himself with their practical application in composition.

COMPOSITE *numbers*, are such as can be measured exactly by a number exceeding unity: as 6 by 2 or 3, or 10 by 5, &c. so that 4 is the lowest composite number. Composite numbers, between themselves, are those which have some common measure besides unity; as 12 and 15, as being both measured by 3.

Composite *order*, in architecture, the richest of the five orders, being a combination of the Ionic capital, with the bell and foliage of the Corinthian. Its cornice has simple modillions or dentils. See Architecture.

COMPOSITION *of ideas*, an act of the mind, whereby it unites several simple ideas into one conception, or complex idea.

Composition, in music, the art of disposing musical sounds into airs, songs, &c. either in one or more parts, to be sung by a voice, or played on instruments.

Composition, in oratory, the coherence and order of the parts of a discourse.

To composition belong both the artful joining of the words, whereof the stile is formed, and whereby it is rendered soft and smooth, gentle and flowing, full and sonorous, or the contrary; and the order, which requires things first in nature and dignity to be put before those of inferior consideration.

Composition, in painting, consists of two parts, invention and disposition; the first whereof is the choice of the objects which are to enter into the composition of the subject the painter intends to execute, and is either simply historical or allegorical. The other very much contributes to the perfection and value of a piece of painting.

Composition, in commerce, a contract between an insolvent debtor and his creditors, whereby the latter accept of a part of the debt in compensation for the whole, and give a general acquittance accordingly.

Composition, in printing, commonly termed composing, the arranging of several types or letters in the composing-stick, in order to form a line; and of several lines ranged in order in the galley, to make a page; and of several pages to make a form,

Composition *of motion*, is an assemblage of several directions of motion, resulting from several powers acting in different, though not opposite directions. See Mechanics.

Composition *of proportion*, is the comparing the sum of the antecedent and consequent with the consequent, in two equal ratios; as, suppose, 4 : 8 :: 3 : 6, they say, by composition of proportion 12 : 8 :: 9 : 6.

COMPOST, in husbandry and gardening, several sorts of soils or earthy matter mixed together, in order to make a manure for assisting the natural earth in the work of vegetation, by way of amendment or improvement.

COMPOUND *flower*, in botany, a flower formed of the union of several fructifications, or lesser flowers, within a common calyx; each lesser flower being furnished with five stamina, distinct at bottom, but united by the anthers into a cylinder, through which passes a style considerably longer than the stamina, and crowned by a stigma or summit, with two divisions that are rolled backwards. These are the essential characters of a compound flower. Compound flowers, which make up four classes in Tournefort's system, are all reduced to the class Syngenesia, which see. See Botany.

COMPOUND *interest*. See INTEREST.

COMPOUND *motion*, that affected by the concurring action of several different powers. Thus, if one power act in the direction of, and with a force proportional to the end of a parallelogram, and another act in the direction of, and with a force proportional to its side, the compound motion will be in the direction of, and proportional to, the diagonal of the said parallelogram.

COMPOUND *numbers*, those which may be divided by some other number besides unity, without leaving any remainder: such are, 18, 20, &c. the first being measured by the numbers 2, 6, or 9 : and the second by the numbers 2, 4, 5, 10.

COMPRESS, in surgery, a bolster of soft linen cloth, folded in several doubles, frequently applied to cover a plaster, in order not only to preserve the part from the external air, but also the better to retain the dressing. See SURGERY.

COMPRESSION, the act of pressing or squeezing some matter, so as to set its parts nearer to each other, and make it possess less space.

Water was, during a very long period, considered as a fluid perfectly unelastic: that is, unyielding, or incompressible; and this opinion was corroborated by an experiment of the Academy del Cimento in Italy. About a century and a half ago, the members of that academy endeavoured to ascertain whether water was capable of being compressed in any degree. For this purpose they filled a hollow metallic sphere with that fluid, and stopped the aperture very accurately. This ball then was pressed in a proper machine, but no contraction could be observed; nor, indeed, was the apparatus capable of manifesting small degrees of compression. Hence they concluded that water was not capable of compression. This opinion prevailed until the year 1761, when the ingenious Mr. Canton discovered the compressibility of water, and of other liquids, which he immediately made known to the Royal Society. He took a glass tube, having a ball at one end, filled the ball and part of the tube with water, which he had deprived of air as much as it was in his power; then placed the glass thus filled under the receiver of an air-pump; and on exhausting the receiver, which removed the pressure of the atmosphere from over the water and the glass vessel which contained it, in consequenee of which the water rose a little way into the tube, *viz.* expanded itself. He then placed the apparatus under the receiver of a condensing engine, and on forcing the air into it, which increased the pressure upon the water, a diminution of bulk evidently took place; the water descending a little way within the tube. "In this manner," Mr. Canton says, "I have found by repeated trials, when the heat of the air has been about 50°, and the mercury at a mean height in the barometer, that the water will expand and rise in the tube by removing the weight of the atmosphere, one part in 21740, and will be as much compressed under the weight of an additional atmosphere. Therefore the compression of water by twice the weight of the atmosphere is one part in 10870." "Water has the remarkable property of being more compressible in winter than in summer, which is contrary to what I have observed both in spirits of wine and oil of olives." By the same means, and in the same circumstances, Mr. Canton ascertained the property of being compressed in some other fluids, and the results are as in the following table :

		Millionth part.
Compression	of spirit of wine	66
- - - - - -	oil of olives	48
- - - - - -	rain water	46
- - - - - -	sea water	40
- - - - - -	mercury	3

COMPTONIA, in botany, so called in honour of Henry Compton, Lord Bishop of London, a genus of the Monoecia Triandria class and order. Essential character: male ament. calyx two-leaved; corolla none; anthers two-parted. Female ament. calyx six-leaved; corolla none; styles two: nut. ovate. There is but one species, *viz.* C. asplenifolia, fern-leaved Comptonia, a native of North America. It is an astringent, and is in considerable estimation as a remedy for fluxes. It is brought to the Philadelphia market abundantly for this purpose.

COMPUTATION *of a planet's motion*. See PLANET.

COMPUTATION, in law, is used in respect of the true account or construction of time, so understood as that neither party to an agreement, &c. may do wrong to the other; and that the determination of time be not left at large, or taken otherwise than according to the judgment and intention of law.

If a lease is ingrossed, bearing date January 1, 1808, to have and to hold for three years from henceforth, and the lease is not executed till the second of January; in this case the words from henceforth shall be accounted from the delivery of the deed, and not by any computation from the date. And if the lease be delivered at four o'clock in the afternoon on the said second day, it shall end the first day of January, in the third year; the law, in such computations, rejecting all fractions or divisions of the day.

CONCAVE, an appellation used in speaking of the inner surface of hollow bodies, but more especially of spherical ones.

CONCAVE *glasses*, such as are ground hollow, and are usually of a spherical figure, though they may be of any other, as parabolical, &c. All objects seen through concave glasses appear erect and diminished.

CONCENTRATION, in chemistry, the act of increasing the strength of fluids, which are rendered stronger by abstracting a portion of the mere menstruum. This is generally effected by evaporation, where the menstruum is driven off at a lower heat than is required to drive off the substance with which it is united. Thus, dilute sulphuric acid may be considered as a mixture of the real acid with water; and by applying a certain heat the water may be evaporized, leaving the acid behind in a state of concentration. When concentrated as much as possible, its specific gravity is about twice as great as that of water; but it can rarely be obtained denser than 1.85. When concentrated to 2.000 it contains a considerable portion of water, as has been proved by combining it with barytes or potash, in which case water remains behind, and does not enter into the combination. Again, vinegar consists of an acid and water, and brandy of alcohol and water; and in proportion as the acid and alcohol are freed from the water, they are said to be more or less concentrated. This may be performed, (1.) either by simple distillation, in which case the acid or spirit comes over first, leaving the water behind; or, (2,) by exposing the vinegar or brandy to severe frost, when the water will be frozen, and the acid or alcohol will be found in a state of concentration in the middle of the ice; the greater the cold the higher the state of concentration. M. Lowitz has found that the acid, however concentrated, congeals at 22°. Sulphuric acid, on the other hand, exposed to a much less severe cold, crystallizes, and to effect this it must not be greatly concentrated. (3.) Another mode of concentrating the acetic acid is by distilling acetate of copper reduced to a powder in a retort. At first there comes over a liquid nearly colourless, and almost insipid, and afterwards a highly concentrated acid, tinged with green; but being distilled a second time in a moderate heat, it is colourless, transparent, exceedingly pungent, and concentrated. (4.) The most perfect method of obtaining this acid in a concentrated state was discovered by Mr. Lowitz, of Petersburgh. It is thus: distil a mixture of three parts of acetate of potash, and four parts of sulphuric acid, till the acetic acid has come over into the receiver. To separate it from the sulphuric acid, with which it is slightly contaminated, it must be distilled over a portion of acetate of barytes.

CONCENTRIC, in mathematics, something that has the same common centre with another: it stands in opposition to eccentric. Concentric is chiefly used in speaking of round bodies and figures, or circular and elliptical ones, &c. but may be likewise used for polygons, drawn parallel to each other upon the same centre. The method of Nonius, for graduating instruments, consists in describing with the same quadrant 45 concentric arches, dividing the outermost into 90 equal parts, the next into 89, &c.

CONCEPTION, in logic, is the simple apprehension or perception which we have of any thing, without proceeding to affirm or deny any thing about it. There are rules by which we may guide and regulate our conceptions of things, which is the main business in logic: for most of our errors in judgment, and the weakness, fallacy, and mistakes of our argumentation, proceed from the darkness, confusion, defect, or some other irregularity, in our conceptions. The rules are these: 1. To conceive of things clearly and distinctly in their own natures. 2. Completely in all their parts. 3. Comprehensively in all their properties and relations. 4. Extensively in all their kinds. 5. Orderly, or in a proper method.

CONCESSION, in rhetoric, a figure whereby something is freely allowed that yet might bear dispute, to obtain something that one would have granted to him, and which he thinks cannot fairly be denied, as in the following concession of Dido, in Virgil:

"The nuptials he disclaims, I urge no
more;
Let him pursue the promis'd Latian
shore.
A short delay is all I ask him now;
A pause from grief, an interval from
woe."

CONCHIUM, in botany, a genus of the Tetrandria Monogynia class and order. Calyx none; petals four, supporting the stamina; stigma turbinate, mucronate; capsule one celled, two-seeded; seeds winged.

CONCINNOUS, in music, a term generally confined to performance in concert. It applies to that nice discriminating execution, in which the band not only gives with mechanical exactness every passage of the composition, but enters into the design or sentiment of the composer, and, preserving a perfect concord and unison of effect, moves as if one soul inspired the whole orchestra.

CONCHOID, in geometry, the name of a curve, given it by its inventor, Nicomedes, and is thus generated.

Draw the right line QQ (see Plate III. Miscel. fig. 14.) and AC perpendicular to it in the point E; and from the point C draw many right lines CM, cutting the right line QQ in Q; and make QM=QN, AE=EF, *viz.* equal to an invariable line: then the curve, wherein are the points M, is called the first conchoid; and the other wherein are the points N, the second; the right line QQ being the directrix, and the point C the pole: and from hence it will be very easy to make an instrument to describe the conchoid.

The line QQ is an asymptote to both the curves, which have points of contrary flection. See ASYMPTOTE. If QM=AE$=a$, EC$=b$, MR=EP$=x$, ER=PM$=y$: then will $a^2 b^2 - 2 a^2 b x + a^2 x^2 = b^2 x^2 - 2 b x^3 + x^4 + x^2 y^2$, and express the nature of the second conchoid; and $x^4 + 2 b x^3 + y^2 x^2 + b^2 x^2 = a^2 b^2 + 2 a^2 b x + a^2 x^2$, the nature of the first; and so both these curves are of the same kind.

This curve was used by Archimedes and other ancients in the construction of solid problems; and Sir Isaac Newton says, that he himself prefers it before other curves, or even the conic sections, in the construction of cubic and biquadratic equations, on account of its simplicity and easy description, shewing therein the manner of their construction by help of it.

END OF VOL. III.

Plate IV.

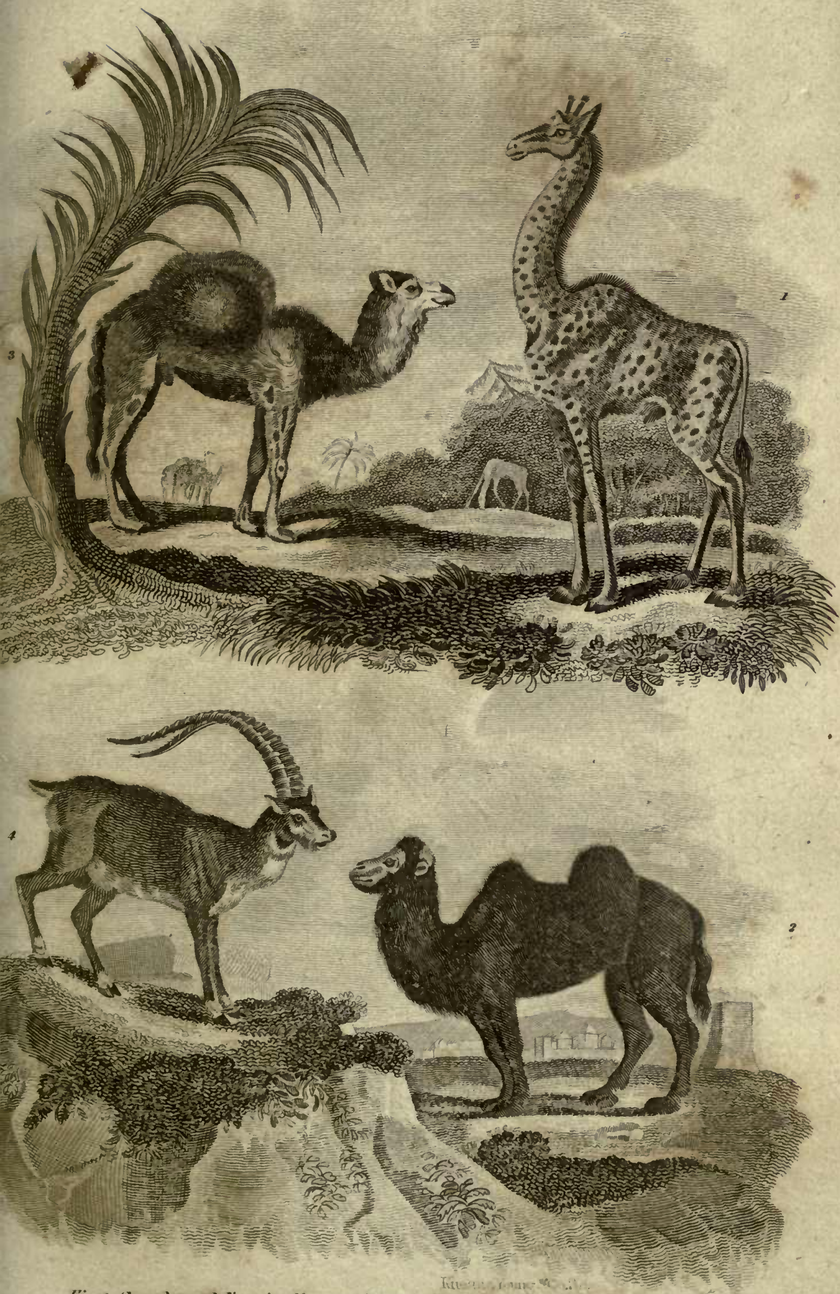


Fig. 1. Camelopardalis *giraffe : camelopard* *Fig. 2.* Camelus *bactrianus Bactrian camel.*
Fig. 3. Camelus *dromedarius : dromedary* *Fig. 4.* Capra *ægagrus : ibex.*

Fig. 1. Canis *familiaris: shepherd's dog. Fig. 2. Australasian dog. Fig. 3. Pomeranian dog. Fig. 4. Siberian dog. Fig. 5. Iceland dog. Fig. 6. Great Barbet, or water dog.*

Fig. 1. Canis *hyæna: striped Hyæna. Fig. 2. C. lupus. Wolf. Fig. 3. C. aureus: Jackal. Fig. 4. C. vulpes: Fox. Fig. 5.* Capra *ægagrus: Chamois goat. Fig. 6. Syrian goat.*

Fig. 1. Ardea *virgo: Numidian Crane. Fig. 2.* Columba *œnas: stock pigeon. Fig. 3.* Certhia *sannio: mocking creeper. Fig. 4.* Charadrius *oedicnemus: Great Plover. Fig. 5. C. pluvialis: golden Plover. Fig. 6.* Columba *palumbus: Ring dove. Fig. 7. C. turtur: turtle dove.*

Rowntrees Beer Engine

Fig. 1.

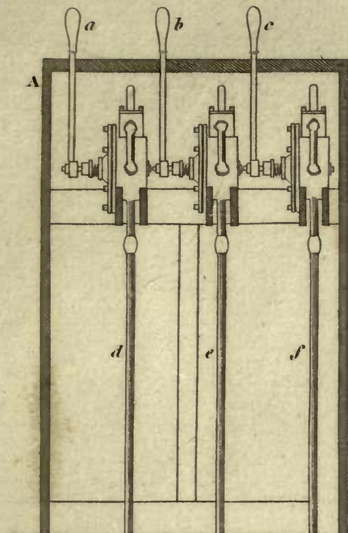


Fig. 2.

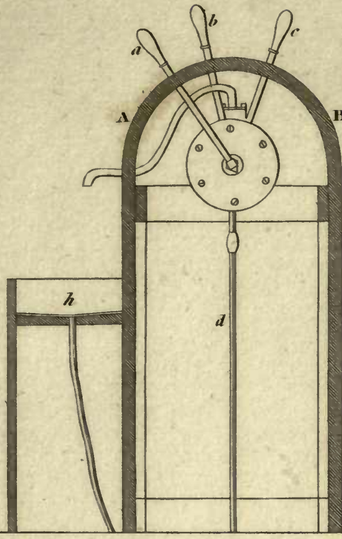


Fig. 3.

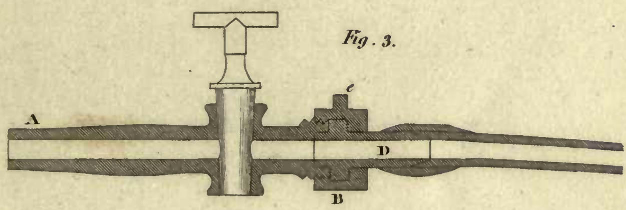
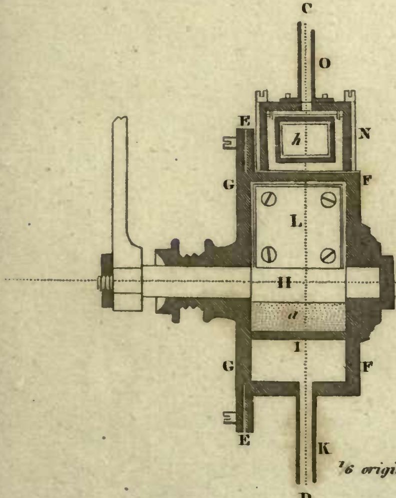
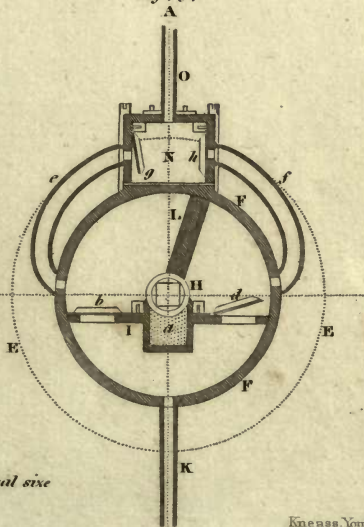


Fig. 4.



1/6 original size

Fig. 5.



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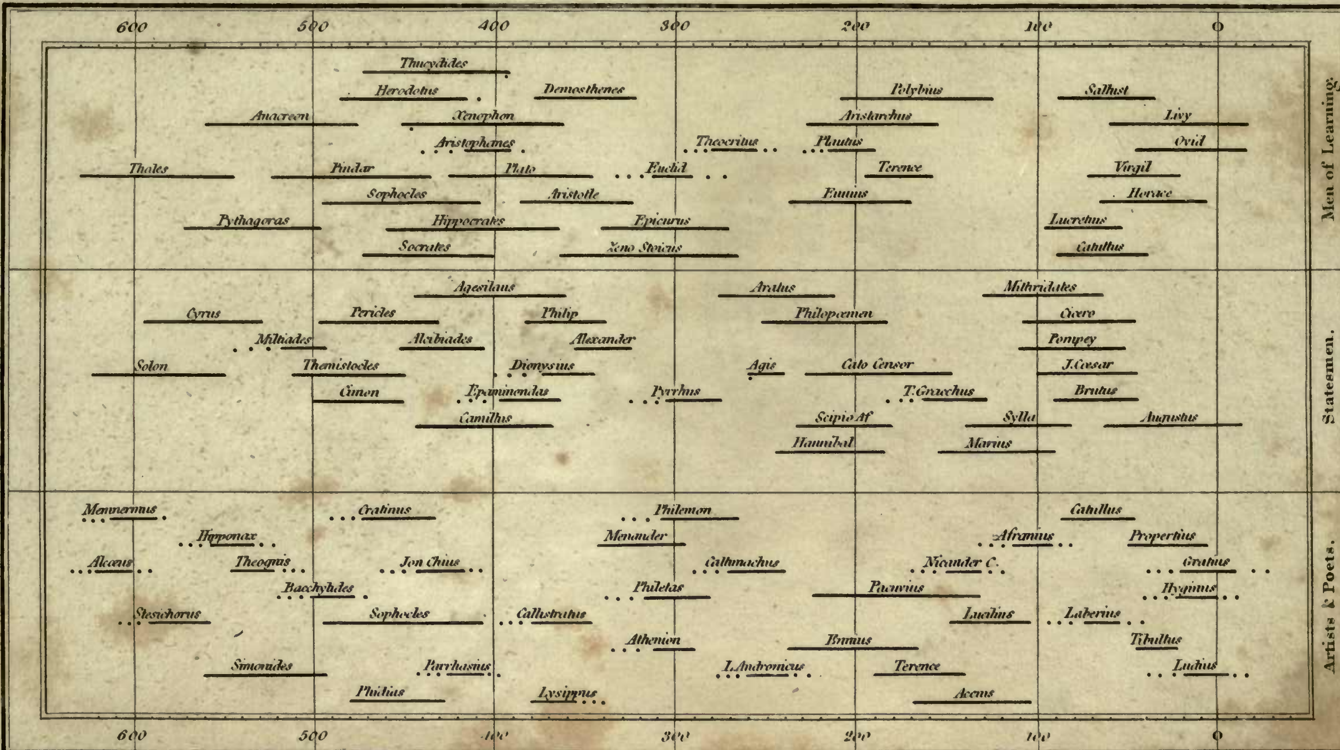
BIOGRAPHY.



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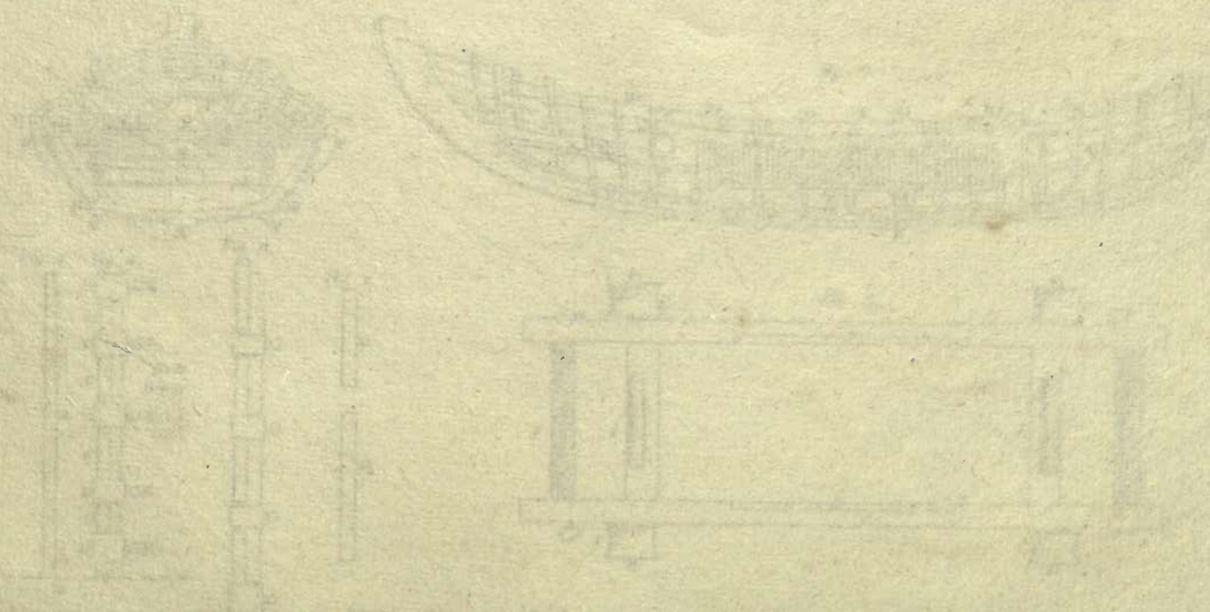
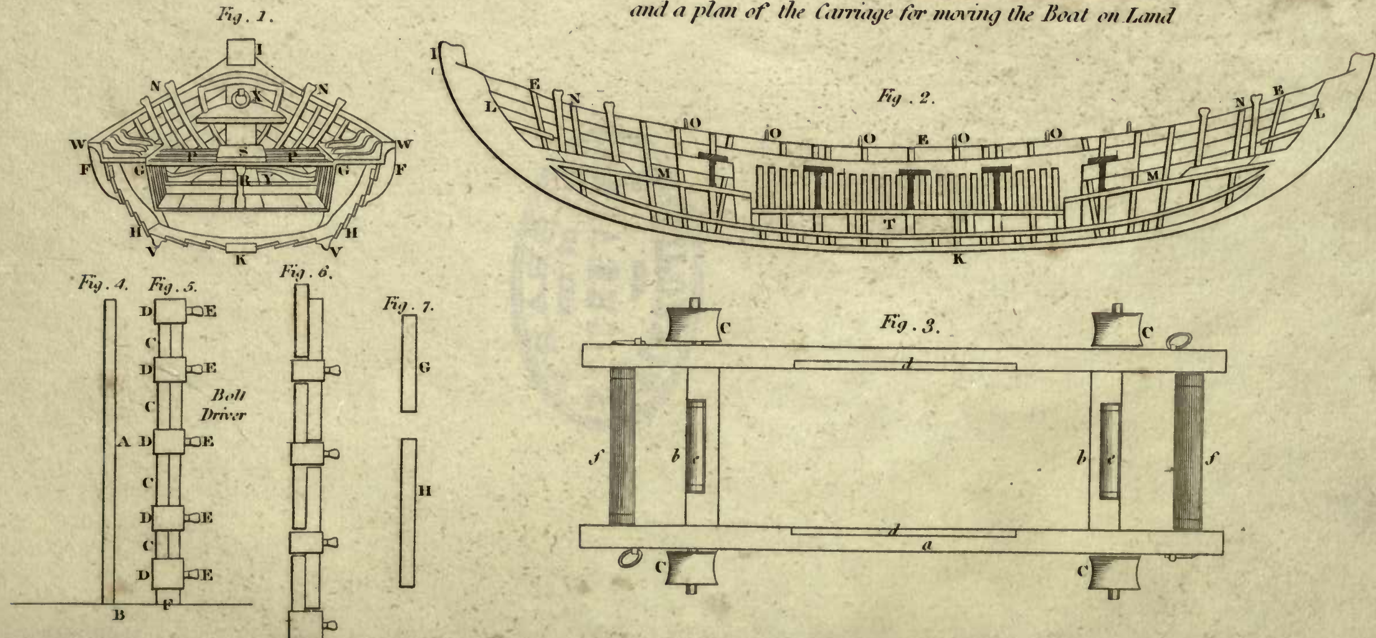


[illegible]

LIFE BOAT &c.

Sections of Mr. Greatheads Life Boat

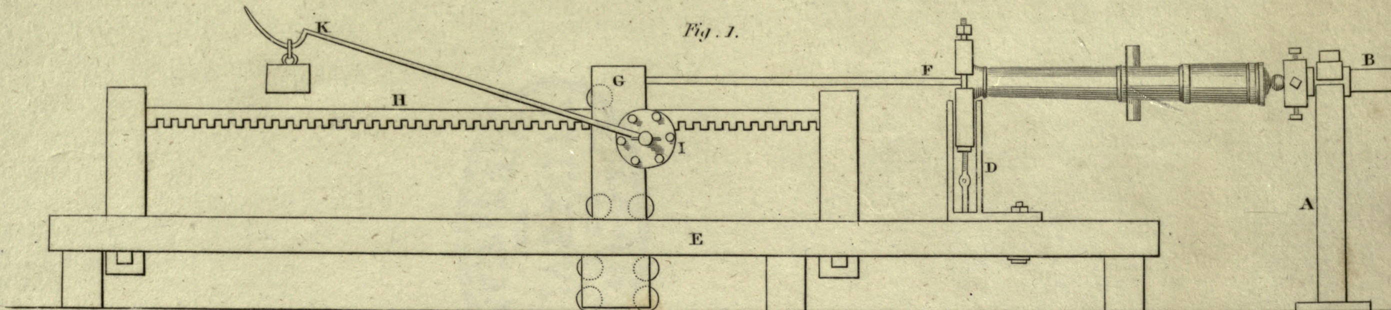
and a plan of the Carriage for moving the Boat on Land



CANNON BORING.

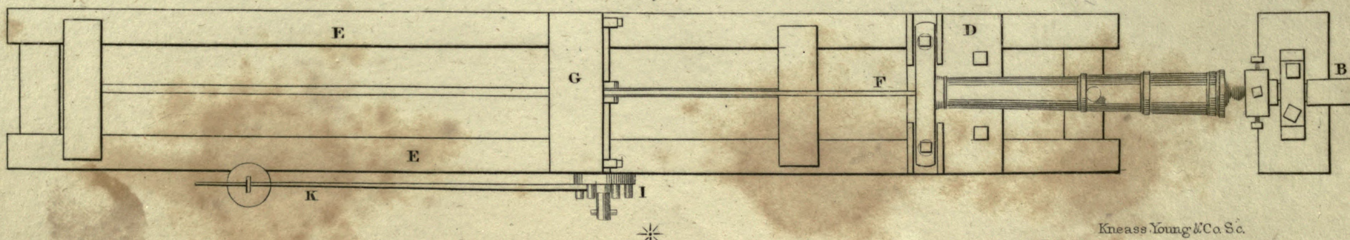
Elevation.

Fig. 1.



Plan

Fig. 2.



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CLOCK WORK.

Fig. 1.

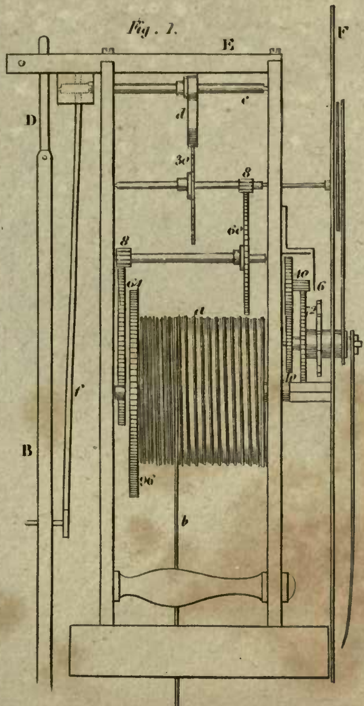

Fig. 2.

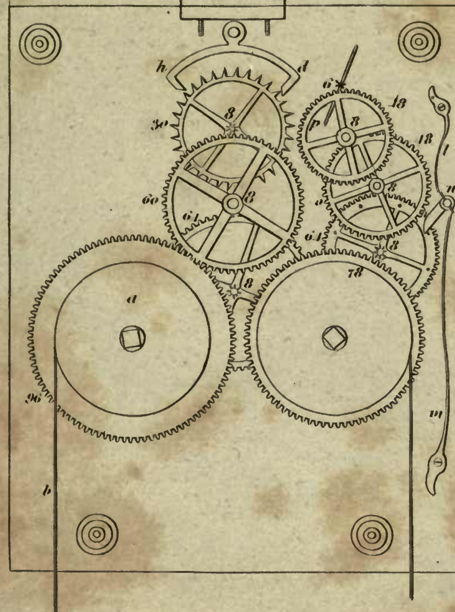

Fig. 3.

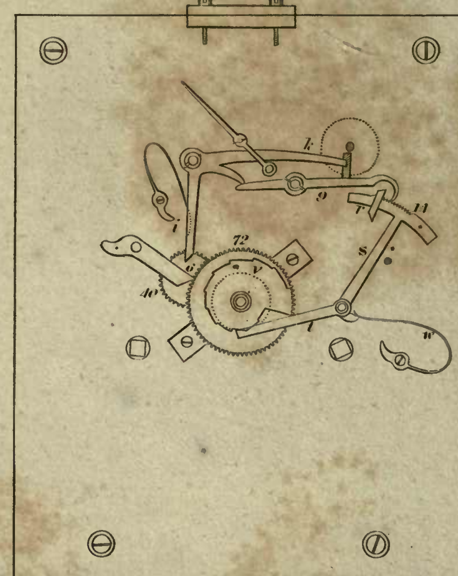

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Fig.1. **Acarus** *autumnalis: harvest bug – Fig.2.* **A** *siro: cheese mite – Fig.3.* **Aphis** *ulmi* – **Apis** *mellifica: common bee – Fig.5. queen – Fig.6. drone – Fig.7.* **Aranea** *diadema: garden spider – Fig.8.* **A.** *tarantula: tarantula spider – Fig.9.* **Buprestis** *gigantea – Fig.10.* **Byrrhus** *musœorum – Fig.11.* **Cerambyx** *coriarius.*

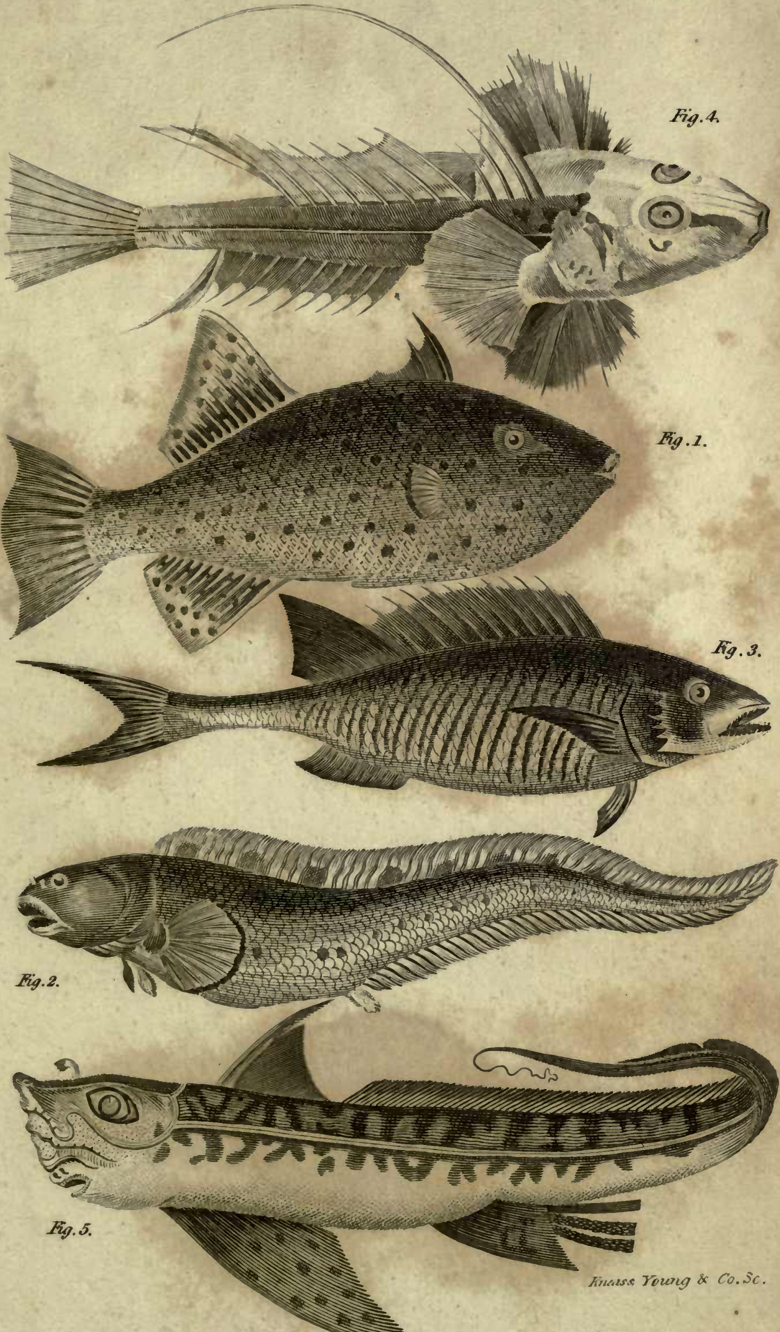

Fig. 1. Balistes *maculatus: spotted file-fish.* *Fig. 2.* Blennius *viviparus viviparous blenny.* — *Fig. 3.* Bodianus *pentacanthus: five spined bodian.* *Fig. 4.* Callionymus *lyra: gemmous dragonet*

TROUGHTON'S *Portable Circular Instruments.*

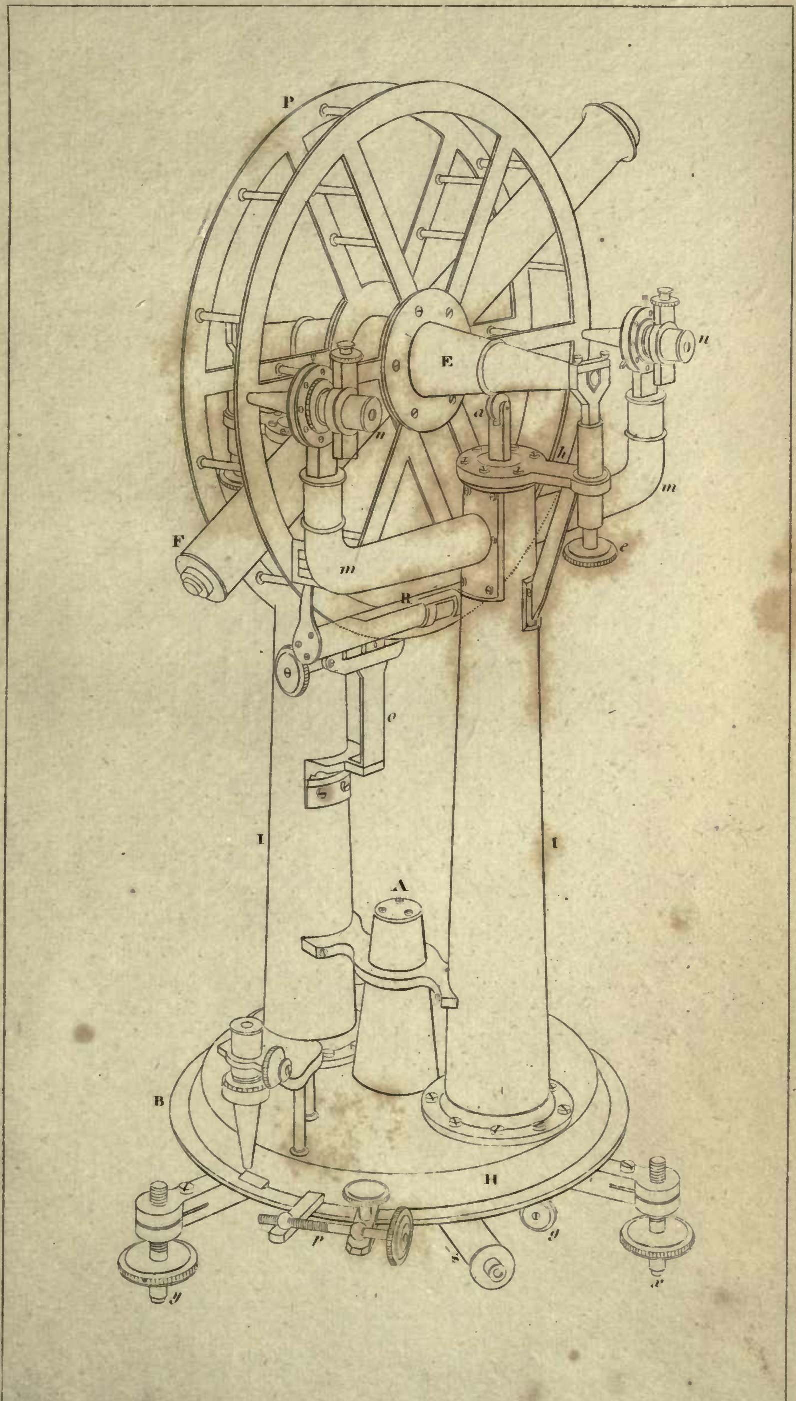

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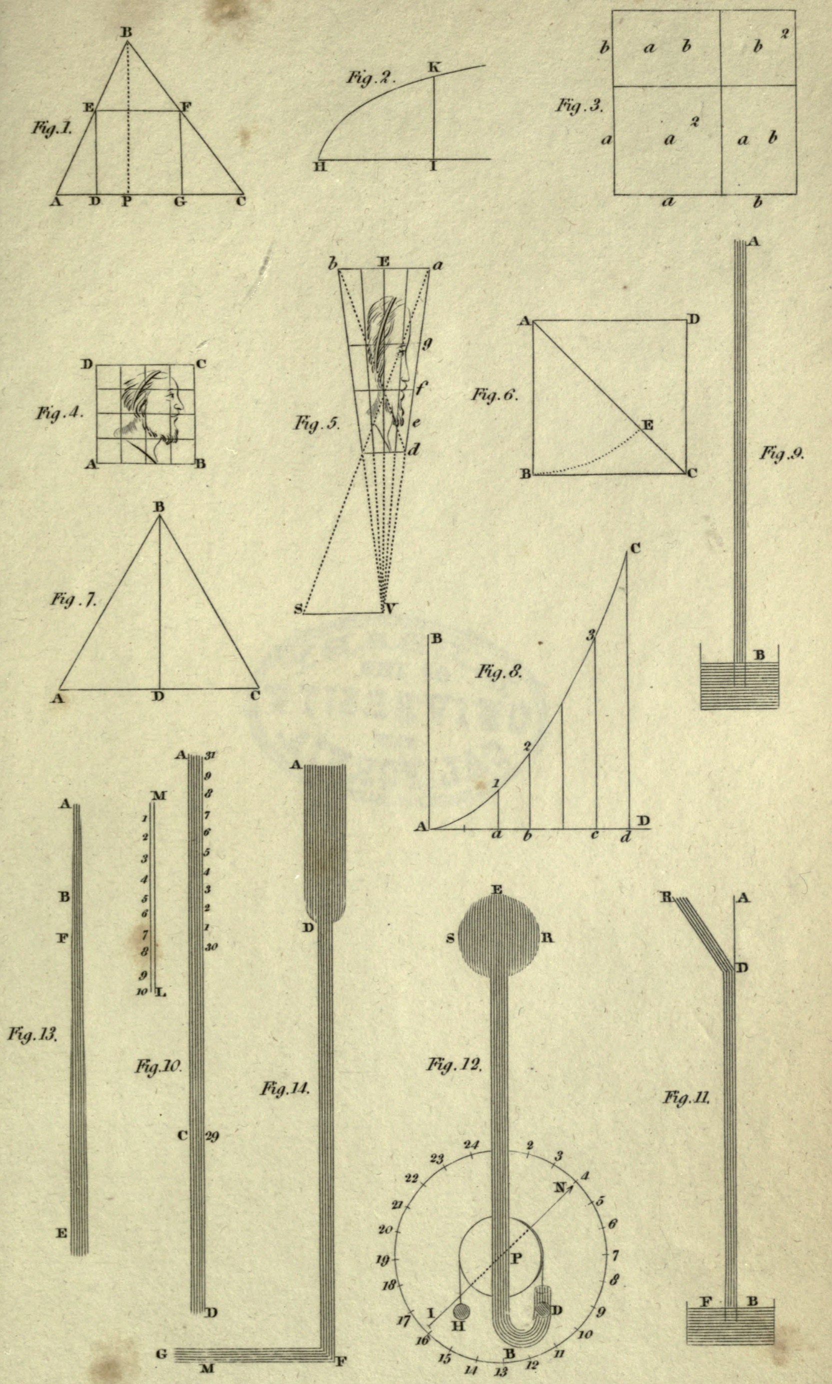
Plate 1.

MISCELLANIES.



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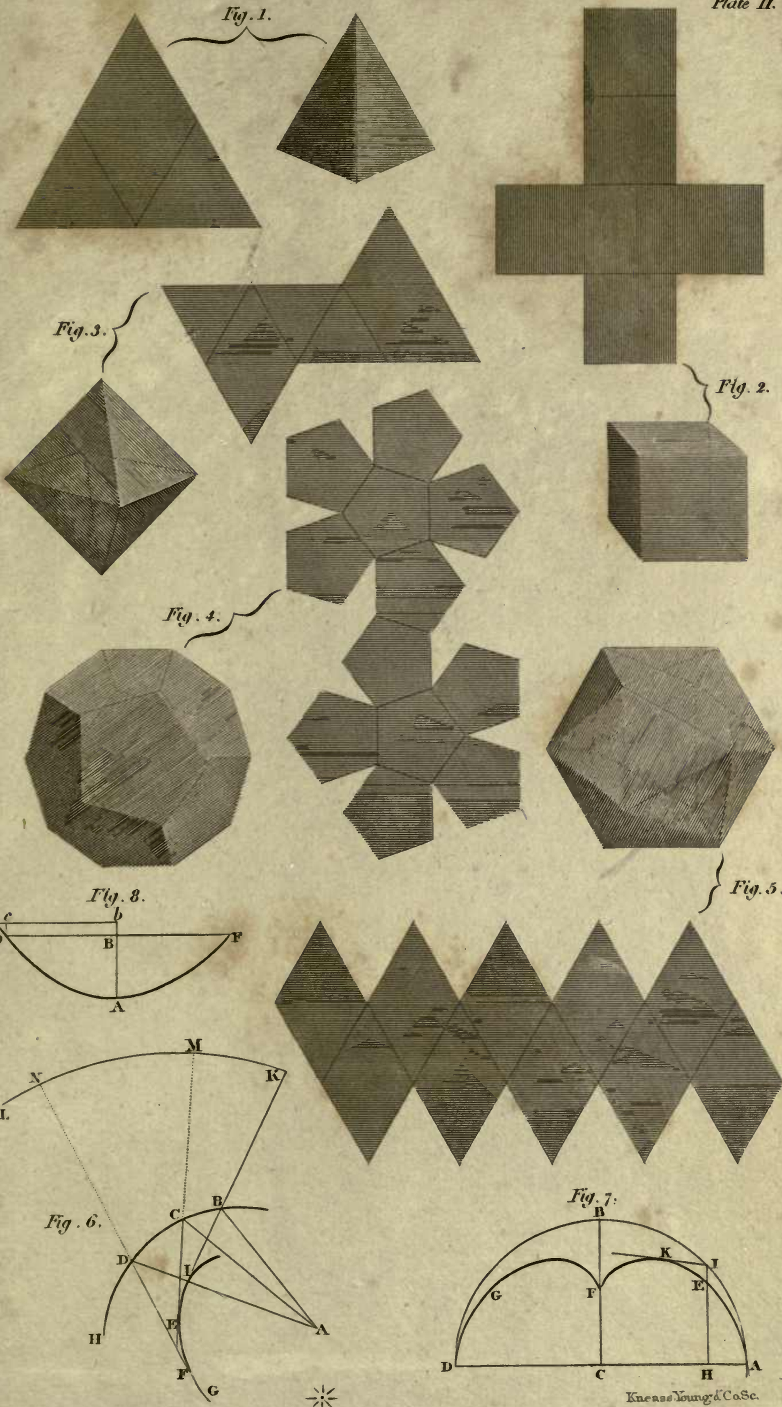
MISCELLANIES.

Plate II.



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