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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BRITISH ENCYCLOPEDIA,

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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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GIFT, in law, a transferring the property in a thing from one to another without a valuable consideration; for to transfer any thing upon a valuable consideration is a contract or sale. He who gives any thing is called the donor, and he to whom is given is called the donee. By the common law, all chattels, real or personal, may be granted or given without deed, except in some special cases, and a free gift is good without a consideration, if not to defraud creditors. But no leases, estates, or interests, either of freehold or term of years, or any uncertain interest, not being copyhold or customary interest of, in, to, or out of any messuages, manors, lands, tenements, or hereditaments, shall at any time be assigned, granted, or surrendered, unless it be by deed or note in writing, signed by the party so assigning, granting, or surrendering the same, or their agents, thereunto lawfully authorized by writing, or by act and operation of law. 29 Car. I. c. 3. A gift of any thing without a consideration, is good, but it is revocable before delivery to the donee of the thing given.

GILBERTIA, in botany, a genus of the Decandria Monogynia class and order. Calyx five-toothed; corolla deeply five-parted; nectary deeply ten-parted, with lanceolate segments; antheræ sessile, in the segments of the nectary; fruit six-celled. Only one species. G. racemosa, found in Peru; branches reddish and downy; leaves alternate, elliptic, acute, entire, reddish, downy underneath; racemes axillary.

GILD, or GUILD. See GUILD.

GILDING, *art of.* The art of gilding, or of laying a thin superficial coating of metal on wood, metal, and other substances, has been long practised and highly esteemed, both for its utility, and the splendid effect which it produces. Gold, from the extreme beauty of its colour, and from the length of time during which it may be exposed to the action of the air without tarnishing, is perhaps the most valuable of all substances for the purpose of decoration; but on account of its dearness and weight, it can very seldom be employed in substance, and its ornamental use would be limited, indeed, if it were not at the same time the most extensible of all substances; so that a given weight of gold, notwithstanding its high specific gravity, may, by beating, be made to cover a larger surface than an equal quantity of any other body. Among the ancients, the Romans, and, among the moderns, the French have been remarkable for their large and profuse consumption of gold; not only the temples, theatres, and other public building, being adorned with gilding, but even the private houses of the wealthier classes.

The materials for gilding, or rather the different states in which gold is used for the purpose, are the following: leaf-gold of different thicknesses, and formed either of the pure metal, or of an alloy of this with silver, amalgam of gold, and gold-powder. The leaf-gold is procured by the gilder from the gold-beater, for an account of which we shall refer the reader to the article Gold; but the other two substances being prepared by the gilder himself, may be with propriety described here. The amalgam of gold is made, by heating in a crucible some pure quicksilver; and when it is nearly boiling, adding to it about a sixth of its weight of fine gold in thin plates, heated red hot; the mixture, after being kept hot for a few minutes, becomes of a perfectly homogeneous consistence, and may then be allowed to cool: when cold, it is to be put in a piece of soft leather, and, by gradual pressure, the fluid part of the amalgam, consisting almost wholly of mercury, may be forced through the pores of the leather, while the gold combined with about twice its weight of mercury will remain behind, forming a yellowish silvery mass of about the consistency of soft butter. This, after being bruised in a mortar, or shaken in a strong phial, with repeated portions of salt and water, till the water ceases to be fouled by it, is fit for use, and may be kept for any length of time without injury in a corked phial. It is of essential importance that the materials of this amalgam, and especially the mercury, should be perfectly pure, as the least portion of lead or bismuth would very materially injure the beauty of the gilding, by deteriorating the colour of the gold, and filling it with black specks; on this account no mercury ought to be employed, that has not been procured by distillation from the red precipitate (nitrous red oxide of mercury) either alone or mixed with a little charcoal powder.

Gold is prepared in three different ways. The first and simplest is, to put into a glass or earthen mortar some gold-leaf, with a little honey or thick gum-water, and grind the mixture for a considerable time, till the gold is reduced to extremely minute fragments; when this is done, a little warm water will wash out the honey or gum, leaving the gold behind in a flaky pulverulent state. A less tedious and more effectual way of comminuting the gold is, to dissolve it in nitro-muriate acid, and then precipitate it with a piece of copper: the precipitate, after being digested in distilled vinegar, and then washed in water and dried, is in the form of a very fine powder, and both works better, and is easier to burnish, than the ground leaf-gold. The finest ground gold is however produced by heating very gradually the gold amalgam in an open earthen vessel, and continuing the fire till the whole of the mercury is evaporated, taking care that the amalgam shall be constantly stirred with a piece of glass, rod, or tobacco-pipe, in order to prevent the particles of gold from adhering as the mercury flies off. When the mercury is completely evaporated, the residual gold being then ground in a Wedgewood-ware mortar, with a little water, and afterwards dried, it is fit for use.

Gilding is performed either with or without heat. By the first of these methods those substances are gilt, which are not liable to alteration by exposure to a moderate heat, such as metals, and sometimes glass and porcelain: the second method is practised with those substances, such as wood, paper, lead, silk, lacquered and japanned ware, &c. which would be injured, and even destroyed, at the temperature requisite for gilding the former. The last of these methods, being the simplest, shall be first described, and we shall begin with the art of gilding on wood.

There are two methods for gilding on wood, namely, oil gilding and burnished gilding. Oil gilding is thus performed: the wood must first be covered, or primed, with two or three coatings of boiled linseed oil and white-lead, in order to fill up the pores, and to conceal the irregularities of the surface occasioned by the veins in the wood. When the priming is quite dry, a thin coat of gold-size must be laid on. This is prepared by grinding together some strongly calcined red ochre, with the thickest drying oil that can be procured, and the older the better: that it may work freely, it is to be mixed, previously to being used, with a little oil of turpentine, till it is brought to a proper consistence. If the gold-size is good, it will be sufficiently dry in twelve hours, more or less, to allow the artist to proceed to the last part of the process, which is the application of the gold. For this purpose a leaf of gold is spread on the cushion (formed by a few folds of flannel secured on a piece of wood, about eight inches square, by a tight covering of leather), and is cut into strips of a proper size by a blunt pallet-knife: each strip being then taken up on the point of a fine brush is applied to the part intended to be gilded, and is then gently pressed down by a ball of soft cotton; the gold immediately adheres to the sticky surface of the size, and after a few minutes the dexterous application of a large camel's hair brush sweeps away the loose particles of the gold leaf without disturbing the rest. In a day or two the size will be completely dried, and the operation is finished. The advantages of this method of gilding are, that it is very simple, very durable, not readily injured by changes of weather, even when exposed to the open air, and when soiled it may be cleaned by a little warm water and a soft brush; its disadvantage is, that it cannot be burnished, and therefore wants the high lustre produced by the next method. Its chief employment is in out-door work.

Burnished gilding, or gilding in distemper, is thus performed. The surface to be gilt must be carefully covered with strong size, made by boiling down two pieces of white leather, or clippings of parchment, till they are reduced to a stiff jelly; this coating being dried, eight or ten more must be applied, consisting of the same size, mixed with fine Paris plaster or washed chalk: when a sufficient number of layers have been put on, varying according to the nature of the work, and the whole is become quite dry, a moderately thick layer must be applied, composed of size and bole, or yellow ochre: while this last is yet moist, the gold leaf is to be put on in the usual manner; it will immediately adhere on being pressed by the cotton ball, and before the size is become perfectly dry, those parts which are intended to be the most brilliant are to be carefully burnished with agate or dog's tooth. In order to save the labour of burnishing, it is a common, but bad practice, slightly to burnish the brilliant parts, and to deaden the rest by drawing a brush over them dipped in size: the required contrast between the polished and the unpolished gold is indeed thus obtained; but the general effect is much inferior to that produced in the regular way, and the smallest drop of water falling on the sized part occasions a stain. This kind of gilding can only be applied on in-door work, as rain, and even a considerable degree of dampness, will occasion the gold to peel off. When dirty, it may be cleaned with a soft brush, and hot spirit of wine, or oil of turpentine. It is chiefly used on picture frames, mouldings, and stucco.

Letters written on vellum or paper are gilded in three ways: in the first, a little size is mixed with the ink, and the letters are written as usual; when they are dry, a slight degree of stickiness is produced by breathing on them, upon which the gold leaf is immediately applied, and by a little pressure may be made to adhere with sufficient firmness. In a second method, some white-lead or chalk is ground up with strong size, and the letters are made with this by means of a brush: when the mixture is almost dry, the gold-leaf may be laid on, and afterwards burnished. The last method is, to mix up some gold powder with size, and make the letters of this by means of a brush. The edges of the leaves of books are gilded, while in the binder's press, by first applying a composition formed of four parts of Armenian bole and one of sugar candy, ground together to a proper consistence, and laying it on with a brush with the white of egg: this coating, when nearly dry, is smoothed by the burnisher; it is then slightly moistened with clean water, and the gold-leaf applied, and afterwards burnished. In order to impress the gilt figures on the leather covers of books, the leather is first dusted over with very fine rezin, or mastich, then the iron tool by which the figure is made is moderately heated, and pressed down on a piece of leaf-gold, which slightly adheres to it; being then immediately applied to the surface of the leather with a certain force, the tool at the same time makes an impression, and melts the mastich which lies between the heated iron and the leather; in consequence of this the gold with which the face of the tool is covered is made to adhere to the leather, so that on removing the tool a gilded impression of it remains behind.

Drinking glasses, and other utensils of this material, are sometimes, especially in Germany, gilt on their edges; this is done in two ways, either by a simple adhesive varnish, or by means of fire. The varnish is prepared, by dissolving in drying linseed oil a quantity of gum amine, or still better of clear amber, equal in weight to the linseed oil; a very drying and adhesive varnish is thus prepared, which being diluted with a proper quantity of oil of turpentine, is to be applied as thin as possible to those parts of the glass which are intended to be gilded; when this is dry, which will be about a day, the glass is to be placed by the fire side, or in a stove, till it is so warm as almost to burn the fingers when handled; at this temperature the varnish will become glutinous, and a piece of gold leaf applied in the usual way will immediately adhere; when the gilding is thus put on, and before it is grown quite cold, it may be burnished, taking care only to interpose a piece of very thin paper between the gold and burnisher. If the varnish is very good, this is the best method of gilding glass, as the gold is thus fixed on more evenly than in any other way: it often happens, however, when the varnish is but indifferent, that by repeated washing the gold soon wears off: on this account, the practice of burning it in is sometimes had recourse to.

For this purpose some gold powder is tempered with borax, and in this state applied to the clean surface of the glass, with a clean camel's hair pencil: when quite dry, the glass is put in a stove heated to about the temperature of an annealing oven, the gum burns off, and the borax by vitrifying cements the gold with great firmness to the glass; after which it may be burnished. The gilding upon porcelain is in like manner fixed by fire and borax; and this kind of ware being neither transparent nor liable to soften, and thus injure its form in a low red heat, is free from the risk and injury, which the finer and more fusible kinds of glass are apt to sustain from such treatment.

All the methods of gilding hitherto described resemble each other, by being accomplished by means of some adhesive medium; this, however, is not the case with gilding upon metals; the gold is brought into immediate contact with the other metal, and they both remain firmly united merely by the attraction of adhesion subsisting between them. The simplest of all the kinds of gilding on metal, and which strikingly demonstrates the power of the affinity of adhesion, is one which is sometimes practised on plane surfaces of copper and iron, with considerable success. The metal, being previously polished, is heated to about the temperature of melted lead, and covered with a double layer of gold leaf: by the cautious application of a blood stone burnisher, applied gently at first, and increasing the force of the pressure by degrees, the surface of the gold and copper are brought to touch each other in almost every point, and then adhere with a force proportionate to the completeness of the contact. The first layer being thus burnished down, a second is made to adhere in the same manner, and sometimes a third, if the gilding is intended to be very solid. The objection to this kind of gilding is its tediousness, and the almost impossibility of using a sufficient pressure without injuring the evenness of the gilded surface: where these objections do not apply, there cannot be a more effectual mode of gilding, as is evident from the manufacture of gilt silver and copper wire. The bar, before it is committed to the wire-drawer, is plated with gold, by having several plates of gold successively burnished down upon it, and being then subjected to the stronger compression which takes place in wire-drawing, the gold and the other metal become so perfectly united as to form in a manner but one substance.

The most usual method of covering the face of a metal with gold is by means of an amalgam, or, as it is technically called, water-gilding. If the metal to be gilt is silver, the best method of proceeding is, first to soak it in warm dilute muriatic acid, that the surface may be rendered perfectly clean; it must then be washed in clean water, changed two or three times, to get rid of the whole of the acid: being afterwards dried, and made moderately warm, a little gold amalgam, also warm, is to be carefully and evenly spread upon the silver, to which it will immediately adhere: when this is completed, the piece is placed upon a convenient support over a charcoal fire, and while the mercury is evaporating, if any specks or places appear, which have escaped the amalgam, a small piece is to be laid on and spread with a brush, to supply the deficiency, without removing the article from the fire. After a time, the whole of the mercury will be driven off, and the piece, after cooling, being accurately examined, will be found to be entirely covered with a thin coating of pale dull gold. The small roughnesses, and loosely-adhering particles, are now to be removed with a scratch-brush, which is made of some extraordinary fine brass wire, bound together into a tuft; by it the surface is rendered perfectly smooth and bright; but it still remains of a pale yellowish colour: this defect is next removed by warming the piece, and smearing it over with gilders' wax, a composition of bees' wax, red ochre, verdigris, and green vitriol or alum. The wax being burnt over a charcoal fire, and the piece quenched in urine, the colour of the gilding will be found to be much heightened; if it is not sufficiently so, the application of a succeeding one will complete the desired effect, after which the work may be burnished or not, according to the taste of the artist. Instead of the common gilders' wax, a mixture of equal parts of nitre, sal-ammoniac, green vitrol, and verdigris moistened with water, will answer the purpose.

Copper, and the alloys formed by its combination with zinc, are gilded nearly in the same manner as silver; but as their affinity for mercury is coniderably less that that of silver, it would be difficult to made the amalgam of gold adhere to the burnished surface of these metals by the same means, and with the same evenness, as takes place in the case last described. To obviate this inconvenience, advantage is very ingeniously taken of the action of nitric acid to facilitate the adhesion of the copper and mercury, in the following manner. A piece of copper, a button for example, is cleaned, by steeping it in acid, and subsequent washing, and is then burnished, either in a lathe, or by any other means: after this it is dipped in a neutralized solution of nitrate of mercury, and in the space of a few minutes, owing to the strong affinity of nitric acid for copper, the mercurial salt is decomposed, the copper takes the place of the mercury, and at the same time the mercury is deposited in the metallic state on the surface of the copper, covering it entirely, and strongly adhering to it; the gold amalgam is now applied, and the rest of the process goes on as already described. By this method of proceeding, a given quantity of gold may be made to cover a larger surface than in any other way of gilding on metals; five grains of gold will completely gild both the upper and under surfaces of one hundred and forty-four copper buttons, each of them an inch in diameter.

There is no metal, the gilding of which presents so many difficulties as iron, or rather steel. If the method of simple burnishing down is had recourse to, the heat requisite for this purpose will, in many cases, bring the temper of the steel too low: on such occasions, the way already described for gilding on copper is sometimes practised; that is, the parts of the steel to be gilded are pencilled over with nitrate of mercury, by which they are covered with a slightly adhering coat of mercury; then the amalgam is applied, and the gilding finished in the usual way. The objections to this mode of proceeding are, first, that a considerable heat is required, though inferior to that requisite for burnishing down; and, secondly, that, even with all possible care, the gilding is apt to be rough and scale off. A very considerable improvement in this way of gilding is, to trace the figure of the gilding on the steel first of all, with a brush charged with a strong solution of sulphated copper, in consequence of which a pretty thick plate of this metal is deposited on the steel, to which it may be made to adhere, with considerable firmness, by means of the burnisher; thus the gilding is, in fact, performed upon the copper.

A new method of gold-gilding upon steel has lately been published, possessed of many advantages over the others, and probably in time may attain to a very high degree of perfection. It depends upon the well known fact, that, if sulphuric ether and nitro-muriate of gold are mixed together, the ether will, by degrees, separate from the acid nearly the whole of the gold, and retain it for some time in solution, in nearly a metallic state. If ether, thus charged with gold, is spread, by means of a pen or fine brush, on the surface of highly polished steel, the ether presently evaporates, leaving the gold behind in close contact with the steel, and the adhesion is considerably improved by the subsequent application of the burnisher. The dearness, and especially the rapid volatility of ether, are, at first, objections of some moment, but may be got over by using the best oil of turpentine instead of ether, which has nearly the same efficacy in decomposing the nitro-muriate of gold, and is both cheaper, and not so very quickly evaporable.

Gold-gilding upon silver is, we believe, at present entirely disused. It was performed in the following manner: a saturated solution of gold, in nitro-muriatic acid, was poured upon some linen rags, and, when they were become dry, they were heaped in a plate, and touched with a hot coal. The fire gradually spread through the mass, and reduced it to a heavy black ash. A soft cork, being moistened in water, was dipped in this ash, to which a part of it adhered, and was then rubbed on the surface of polished silver, upon which the minute particles of gold became fixed, and covered it with an extremely thin coating, which, when burnished, exhibited the genuine colour and lustre of the precious metal. *Aikin's Dict.*

GILL, a measure of capacity, containing a quarter of a pint.

GILT *varnish.* See VARNISH.

GIMBALS, in sea affairs, the brass rings by which a sea compass is suspended in its box, so as to counteract the effect of the ship's motion, and keep the card horizontal.

GIMBLETING, a term applied to the anchor, to denote the action of turning it round by the stock, so that the motion of the stock appears similar to that of the handle of a gimblet when it is employed.

GIN. See GENEVA.

GIN, in mechanics, a machine for driving piles, fitted with a windlass and winches at each end, where eight or nine men heave, and round which a rope is reeved that goes over the wheel at the top.

GINANNIA, in botany, a genus of the Enneandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx double, both one-leafed; petals three, fringed, spreading; germ pedicelled, with a membranaceous wing at top; legume. There is but one species, *viz.* G. guianensis, a shrub about fifteen feet high; a native of the forests of Guiana.

GINGER, in botany. See ZINZIBER.

GINORA, in botany, so called in honour of the Marquis Carlo Ginori, a genus of the Dodecandria Monogynia class and order. Natural order of Salicariæ, Jussieu. Essential character: calyx six-cleft; petals six; capsule one-celled, four-valved, coloured, containing many seeds. There is but one species, *viz.* G. Americana, an elegant little shrub about four feet high; it is a native of Cuba, grows by river sides, and called there rosa del rio, or river rose.

GINSENG, in botany. See PANAX.

GIRDERS, in architecture, some of the largest pieces of timber in a floor. Their ends are usually fastened into summers and breast-summers, and joists are framed in at one end to the girders. The size of girders and summers, upon the rebuilding of London, were fixed, by act of Parliament, to be in length from ten to twenty-six feet, in breadth from eleven to seventeen inches, and in depth from eight to fourteen inches. It was also fixed by the same statute, that no girder or summer should be less than ten inches in the wall, and that their ends should be laid in loam; as also that they be of good oak, as free from knots as may be, because the least subject to breaking, and may with more safety be relied on in cross and transverse work.

GIRT, in the measuring of timber, is the circumference of a tree, though some use this word for the fourth part of the circumference only, on account of the use made of it. The square of the fourth part is considered as equal to the area of the section of the tree, which square therefore, multiplied by the length of the tree, is accounted the solid content. This content is about one fourth less than the true quantity, being nearly equal to what it will be after the tree is hewn square, and is probably intended to make an allowance for the squaring the tree.

GIRT, in naval affairs, the situation of a ship which is moored so tight by her cables as to be prevented turning to any change of the wind or tide, to the current of which her head would otherwise be directed. The cables, to produce this, are extended by a strong application of mechanical powers within the ship, so that as she veers, or endeavours to swing about, her side bears upon one of the cables, which interrupts her in the act of traversing.

GIRTH *line*, a rope passing through a single block on the head of the lower masts, to hoist up the rigging, and the persons employed to place the rigging and cross-trees on the mast heads. The girth-line is the first rope employed to rig a ship, after which it is removed till the ship is to be unrigged.

GISEKIA, in botany, so named in honour of Paulus Dietericus Giseke, a genus of the Pentandria Pentagynia class and order. Natural order of Succulentæ. Portulaceæ, Jussieu. Essential character: calyx five-leaved; corolla none; capsule five, approximating, roundish, one-seeded. There is but one species, *viz.* G. pharnacioides, trailing Gisekia, an annual plant, and a native of the East Indies.

GIVEN, among mathematicians and philosophers, the same with data. If a magnitude be known, or we can find another equal to it, it is said to be given in magnitude. Or when the position of any thing is known, it is said to be given in position: when the diameter or radius of a circle is known, the circle is given in magnitude. The circle is given in position, when the position of the centre is given. See DATA.

GLABRARIA, in botany, a genus of the Polyadelphia Polyandria class and order. Essential character: calyx five-cleft; petals five; nectary composed of bristles the length of the calyx; stamens thirty, always in sixes; pericarpium a drupe. There is but one species, *viz.* G. tersa, a large tree resembling the champhor tree, the wood of which is very light and pale coloured, and not being liable to rot or to be injured by insects, it is much used for building both houses and ships. It is a native of the East Indies.

GLACIERS. Those vast piles of eternal ice, with which it has pleased the author of nature to crown the immense chasms between the summits of the Alps, objects more grand, sublime, and terrific, than are any others of the phenomena of nature which remain stationary. These tremendous spires and towers, of uncertain and brittle fabric, seem to forbid the attempts of travellers to explore the depth between them, or even the rocks and rich vallies around them; but courage and perseverance have been attended with commensurate success, and we are enabled by their labours to learn previously concealed wonders, and to reason upon the causes which produced them. In treating on this subject, it must be remembered, with satisfaction, that great part of our information is derived from the exertions of several gentlemen distinguished for patient investigation and intrepid exploration.

M. Bourrit, Precentor of the Cathedral Church at Geneva, mentions, in the relation of his journey to the glaciers of Savoy, the enterprise of Messrs. Windham and Pocock, in 1741, who, inspired by the artless relations of the peasants, descriptive of the sublimity of their country, when they descended with honey and chrystals for sale, determined to visit those frightful regions of ice which had received the appellation of Les Montagnes Maudites, or the accursed mountains; the gentlemen alluded to took every precaution for securing their safety; but entertaining many well-grounded fears, naturally arising from a first attempt, they did not reach any considerable distance beyond the edge of the ice in the valley of Montanvert, yet their example operated so powerfully as to induce several others to imitate them, and proceed to the boundary whence they returned; at length M. de Saussure had the resolution and courage to penetrate across the ice to the very extremities of the vallies; Mr. Coxe followed soon after; and every possible information may be obtained from their publications which the nature of the subject will permit.

The most astonishing phenomenon attending the glaciers is their near approach to the usual vegetation of summer; for what can be more wonderful than to view wheat ready for the sickle, parched brown by the rays of the sun, separated only by the intervention of a few feet from the chilling influence of an endless bed of ice, which seems impenetrable to its rays.

Many systems and theories have been ingeniously suggested to ascertain the first cause of the glaciers, their maintenance, and whether they increase or diminish in extent, of which Grunner's, improved and illustrated with actual observation by M. de Saussure, is the most rational and probable, and Mr. Coxe implicitly adopts it. Admitting that a person could be raised sufficiently above the summits of the Alps of Switzerland, Savoy, and Dauphine, to comprehend the whole at one view, he would observe a vast chaos of mountains and vallies, with several parallel chains, the highest of which are situated in the centre, and the remainder gradually lessening as they retire from it. The central chain he would find to be surmounted by stupendous fragments of rock, towering in rude masses, which bear vast accumulations of snow and ice, where they are not decidedly perpendicular, or do not overhang their bases; on each side he would see the intervening chasms and gulphs, filled with ice, descending thence even into the verdant vallies rich with foliage and cultivation. The inferior ranges of mountains, next the central, present the same appearance in a lesser degree, but in those more remote the snow and ice is confined to the most elevated points; and others, still further removed, are covered with grass and plants, which, in their turn, give place to the hills and vallies common in any part of the world.

Mr. Coxe divides the glaciers, in the above general survey, into two classes; the first occupy the deep vallies situated in the bosom of the Alps, and the second adhere to the sides and summits of the mountains. Those in the vallies are far more extensive than the upper glaciers, some are several leagues in length, and that of Des Bois is three miles broad and fifteen long; but they do not communicate with each other, and there are few parallel to the central chain; their upper extremities are connected with inaccessible precipices, and the lower proceed, as already mentioned, quite into the vales; the depth of these astonishing accumulations of frozen fluid vary from eighty to six hundred feet, and they generally rest on an inclined plane; urged forward by their own enormous weight, and but weakly supported by the pointed rocks inserted in their bases, they are universally intersected by yawning chasms, of dreadful aspect to the curious investigator, who beholds fanciful representations of walls, towers, and pyramids, on every side of him; but upon reaching those parts where the glacier rests upon an horizontal plane, his progress is seldom impeded by considerable fissures, and he walks in safety over a surface nearly uniform, and not so perfectly polished as that of ponds and rivers suddenly and violently frozen. The absence of transparency, the various marks of air bubbles, and the general roughness, so perfectly resemble the congelation of snow, when half restored to fluidity, that M. de Saussure was immediately led to form the following probable theory of the formation of the glaciers.

Snow is constantly accumulating in the recesses or depths of the mountains, during nine months of the year, by the usual fall of moisture, and the descent of vast masses borne down by their weight from the precipices and crags above. Part of this is necessarily reduced to water by slight thaws and casual rains, and being frozen in this state, the glacier is composed of a porous opaque ice.

The upper glaciers, Mr. Coxe subdivides into those which cover the summits, and those which extend along the sides of the Alps; the former originate from the snow frequently falling, and congealing into a firm body, though not becoming actual ice, which the brilliancy of the projections has induced some philosophers to suppose it. M. de Saussure, having explored Mont Blanc, ascertained that the top was encrusted with ice, which might be penetrated by a stick, covering a mass of snow on the declivities, so chilled and dry as to be incapable of coherence.

The sides of the Alps support a congelation of half dissolved snow, which is different from the pure snow of the summits and the ice of the lower glaciers. Two causes operate to produce this effect; the first is the descent of water from the higher regions, where a dissolution of the snow sometimes occurs; and the second arises from the more favourable situatian of these parts for reflecting the rays of the sun, and the consequent melting of the snow. From hence downwards the ice adhering to the cavities becomes gradually more solid by the freezing of the snow-water, then nearly divested of that air, which in the less dissolved portions renders the ice, formed from it, porous, opaque, and full of bubbles.

Considerable difference of opinion has prevailed amongst philosophers, whether the masses of ice and snow in these regions of endless winter increase, decrease, or remain nearly stationary; Mr. Coxe seems inclined to think they vary in their size; that gentleman observes, that the glacier of Montanvert is generally bordered with trees; near the base of this vast body of frozen matter the ice is excavated into an arch, perhaps one hundred feet in height, whence the Arveron rushes with impetuosity and in a large sheet of water. As he approached the ice he passed through a forest of firs, those near the arch were very ancient and about eighty feet high, the trees between them and the glacier were evidently younger, from the inferiority of their size and other intrinsic marks; others, still less, had been enveloped by the ice, and many were thrown down; arguing from this gradation in the appearance of the firs, he concludes that the glacier has originally extended to the full grown ancient trees, and, dissolving, young ones have grown on its former site, which have been overturned by a fresh increase of ice.

Thisinference seems almost conclusive, but it is still further supported by the fall of large pieces of granite, called moraine by the inhabitants, which, borne along by the ice, sinks through it as it dissolves, and, falling into the plain, form a border along its extremity; those have been urged forward by the pressure of new ice, and extend even to the place occupied by the large firs.

Exclusive of these circumstances, Mr. Coxe discovered, that the glacier of Grindelwald had diminished, at least, 400 paces between the dates of his two visits in 1776 and 1785; and in the valley of Chamouny, the Muraille de Glace, which he had described as forming the border of the glacier of Bosson, in 1776, no longer existed in 1785, and young trees had grown on the site of the edge of the glacier of Montanvert.

In opposition to the evidence thus adduced, it is argued that the operations observable in the vallies, arising from the concentration of solar heat, form no data for judging of those on more elevated situations, where, it is asserted, a greater quantity of snow falls and becomes ice than can possibly be dissolved annually; and experience proves, beyond doubt, that mountains have been covered, passages obstructed, pastures and habitations destroyed by the ice, within the memory of man. In replying to these arguments, the result obtained is extremely satisfactory. The rain and sleet falling during summer not only thaws the ice and snow, but forms various channels in it, the water descending must wear and carry along part of the frozen sides and depths, and prepare the way for separating and throwing down large masses of each, which are termed avalanches in some parts of the country, and lauwine in others; those tremendous bodies, accumulating by adhesion in their progress, overwhelm every thing in their way, and rush to the vallies from the highest summits, whence various other causes serve to detach them. Here the traveller often meets a dreadful and instantaneous fate; but humanity has endeavoured to obviate it as far as human abilities will permit. Matthison, who visited the monastery of St. Bernard, founded for the relief of those who cross the Alps, speaks thus of the lauwine or avalanche, and the excellent canons of St. Bernard: "In the very worst seasons, as often as it snows, or the weather is foggy, some of these benevolent persons go forth with long poles, and, guided by their excellent dogs, seek the highway, which these sagacious animals never miss, how difficult soever to find. If then the wretched traveller has sunk beneath the force of the falling lauwine, or is immersed in the snow in a benumbing swoon, how deeply soever he may be buried, the dogs never fail of finding the place of his interment, which they point out by scratching and snuffling, when the sufferer is dug out and carried to the monastery, where every possible exertion is used for his restoration. The number of those who lose their lives in the field of battle is known to all Europe, but no one could give me an account what number have thus had the gift of life conferred on them a second time. Yet, notwithstanding all the care and attention of these real friends of mankind, and their faithful dogs, scarcely a year passes, but, as the snow melts away in summer, the dead bodies of travellers are discovered, who, remote from their homes, and all that was dear to them, have perished here unnoticed and unknown. As the ground for a considerable extent round the monastery is solid rock, the dead bodies are collected together in a chapel, lying on its eastern side, which is made to admit a thorough draft of air by openings in the walls, guarded by large iron bars. The sight of so many unfortunate persons, probably collected from various parts of the world, yet, howsoever remote from each other in life, brought hither by an unfortunate similarity of fate to rest together in death, afflicted my inmost soul. They are all covered with palls, and as in this frozen region no exanimate body moulders, but only gradually shrivels and dries away, so the features remain undisfigured for a considerable length of time, and some have even been recognized by friends and relations, after having lain here for two or three years. The bodies are not disposed one over the other, but are all placed upright, and each fresh corpse leans its head on the breast of the former; this disposition has something familiar in it, and gives them the semblance of being united only in a general slumber. Four rows of these slumberers already rest here, from the faces and hands of many of whom the palls have slipped off and left them uncovered: these have all a perfect mummy-like appearance." The fall of the avalanche necessarily reduces the quantity of snow and frozen fluid on the summits, and the transfer of it to a warmer region must facilitate its dissolution. The lower glaciers, though not subject to equally precipitate descent, cannot otherwise than gradually advance towards the vallies, which may be inferred from the constant passage of torrents under them, and their own enormous weight; besides the chasms that universally intersect them plainly evince, that their foundations being partially undermined, they glide slowly downward, overturning trees, and pushing stones before them; the edges obtruded on the earth by this means naturally dissolve far more rapidly than if they remained stationary.

Another means of dissolution arises from evaporation, which takes place on every portion of the globe, however elevated. Exclusive of the above causes, are the constant play of the beams of the sun on the surfaces of the glaciers, which being capable of redoubled heat by concentration and refraction in some favourable positions, must produce very violent thaws; the air heated by this and similar means, in other parts of the mountains, often meets the traveller in streams, which seem as if proceeding from a hot bath, consequently those projections subject to their influence must vanish rapidly; but a more certain and regular change occurs from the mean temperature of the earth, where the transition from summer heats to winter colds cannot ever take place. "This mean temperature," says Mr. Coxe, "termed by some philosophers the internal heat of the earth, is always above the freezing point, as is evident from the heat of the springs which issue from the bowels of the earth. In winter, therefore, or in those high regions of the globe, where the cold is usually below the freezing point, when any spot of ground is covered with only a thin coat of snow, it may be so far cooled, to a certain depth, by the influence of the external air, as not to be capable of dissolving any part of the superincumbent snow. But when the mass of snow is of such a thickness as to protect the surface of the ground from the effects of the atmospherical cold, the mean temperature, which is always above the freezing point, will be sufficient to melt the contiguous surface of snow, and to occasion a constant thaw, which supplies those currents of water that flow at all seasons from the upper and lower glaciers."

Having endeavoured to explain the causes of the glaciers and their changes, it will be proper to give an idea of their sublimity in the words of M. Bourrit, who appears to have viewed and described them with all that enthusiasm which such splendid objects must have inspired. "To come at this collected mass of ice (Des Bois) we crossed the Arve, and travelling in a tolerable road, passed some villages or hamlets, whose inhabitants behaved with much politeness; they invited us to go in and rest ourselves, apologizing for our reception, and offered us a taste of their honey. After amusing ourselves some time amongst them, we resumed our road, and entered a beautiful wood of lofty firs, inhabited by squirrels. The bottom is a fine sand, left there by the inundations of the Arveron; it is a very agreeable walk, and exhibits some extraordinary appearances. In proportion as we advanced into this wood, we observed the objects gradually to vanish from our sight; surprised at this circumstance, we were earnest to discover the cause, and our eyes sought in vain for satisfaction, till, having passed through it, the charm ceased. Judge of our astonishment, when we saw before us an enormous mass of ice, twenty times as large as the front of our cathedral of St. Peter, and so constructed, that we have only to change our situation to make it resemble whatever we please. It is a magnificent palace, cased over with the purest crystal: a majestic temple, ornamented with a portico, and columns of several shapes and colours; it has the appearance of a fortress, flanked with towers and bastions to the right and left, and at bottom is a grotto, terminating in a dome of bold construction. This fairy dwelling, this enchanted residence, or cave of fancy, is the source of the Arveron, and of the gold which is found in the Arve. And if we add to all this rich variety, the ringing tinkling sound of water dropping from its sides, with the glittering refraction of the solar rays, whilst tints of the most lively green, or blue, or yellow, or violet, have the effect of different compartments, in the several divisions of the grotto, the whole is so theatrically splendid, so completely picturesque, so beyond imagination great and beautiful, that I can hardly believe the art of man has ever yet produced, nor ever will produce, a building so grand in its construction, or so varied in its ornaments. Desirous of surveying every side of this mass, we crossed the river about four hundred yards from its source, and mounting upon the rocks and ice, approached the vault; but while we were attentively employed in viewing all its parts, astonished at the sportiveness of fancy, we cast our eyes at one considerable member of the pile above us, which was unaccountably supported; it seemed to hold by almost nothing: our imprudence was too evident, and we hastened to retreat; yet scarcely had we stepped back thirty paces before it broke off all at once, with a prodigious noise, and tumbled, rolling to the very spot where we were standing just before.

GLACIS, in fortification, that mass of earth which serves as a parapet to the covered way, sloping easily towards the champaign, or field. The glacis, otherwise called esplanade, is about six feet high, and loses itself by an insensible diminution in the space of ten fathoms.

GLADIATORS, persons who fought for the amusement of the public in the arenas of amphitheatres in the city of Rome, and at other places under the dominion of the Romans. The term is derived from their use of the gladius, or sword; and the origin of this horrid custom is said to have been the practice of sacrificing captives to the manes of chiefs killed in battle. It seems, however, more probable, that it arose from the funeral games of antiquity, when the friends of the deceased fought in honour of his memory; an instance of which occurs in the twenty-third book of the Iliad, at the burning of the body of Patroclus. Achilles having ordained every solemn rite usual upon those occasions, Homer adds,

> "The prizes next are ordered to the field,
> For the bold champions who the cæstus wield."

The leather which composed the cæstus being loaded with lead, enabled the combatants to give each other mortal blows, though the hands only were used. Epeus, of gigantic stature, challenged the whole of the Grecian chiefs, who were terrified at his bulk, and Euryalus alone accepted his defiance:

"Him great Tydides urges to contend,
Warm with the hopes of conquest for his friend;
Officious with the cincture girds him round,
And to his wrists the gloves of death are bound."

The captives slain on this occasion were not commanded to fight; they had been led to the pile, and died with the sheep, oxen, coursers, and dogs, that their bodies might be burnt by the flames which consumed that of Patroclus:

"Then, last of all, and horrible to tell,
Sad sacrifice! twelve Trojan captives fell."

The above quotations positively prove, that the Romans deviated from their predecessors in the practice of this barbarous custom. The Greeks appear to have destroyed their prisoners on a revengeful principle, and despatched them immediately; but the former refined upon cruelty, and would rather purchase captives, or destroy the lives of ill-disposed slaves, than send the ashes of their friends to the urn bloodless, or the spectators of the obsequies home, without the gratification of witnessing wretches cutting each other to death, though not under the influence of previous anger. According to Valerius Maximus, and Lampridius in Heliogabalus, gladiators were first introduced at Rome by M. and D Brutus, at the funeral of their father, in the consulship of Ap. Claudius and M. Fulvius.

The examples of great men, however detestable, ever produce imitators. Hence, though the brothers may have acted from motives of family vanity only, other great personages, perceiving that the people delighted in the sight of blood, determined to gratify them by adopting the custom; which was afterwards extended to public exhibitions given by the priests in the Ludi Sacerdotales, and the magistrates, solely for the amusement of the populace, or perhaps to confirm them in an habitual contempt for wounds and military death.

Thus the family alluded to, introducing perhaps three pair of gladiators to the citizens of Rome, was the means of multiplying their number to an amount which is shocking to humanity; for the subsequent emperors appear to have attempted to excel each other in assembling them at their birth-day celebrations, at triumphs, the consecration of edifices, at their periodical games, and at the rejoicings after great victories.

As the dispositions of several of the chief magistrates, who are recorded as having exhibited gladiators, were mild and merciful, it is but fair to suppose, that Julius Cæsar, who produced three hundred and twenty pairs in his edileship, Titus, Trajan, and others, submitted to the custom in compliance with the temper of the people, rather than from any predilection to it in themselves. But there are few pernicious practices which do not carry their punishment with them. The prevailing frenzy had at length arrived to such an excess, that the gladiators became sufficiently numerous to threaten the safety of the state; as when the Cataline conspiracy raged, an order was issued to disperse the gladiators in different garrisons, that they might not join the disaffected party; yet, although the fears of the government were excited, it doth not appear that any steps were taken to lessen their number, as the Emperor Otho had it in his power long after the above event to enlist two thousand of them to serve against Vitellius.

The people thus cut off from society, and rendered murderers per force, were fully justified in considering the whole Roman state their enemy; nor was it surprising that they were sometimes willing to revenge themselves upon their oppressors. Spartacus, a gladiator, gave a bold but unavailing example to his brethren, by rushing out of an amphitheatre at Verona, at the head of those collected there for public exhibition, declaring war against the Romans, and assembling so great a force, as to make the citizens of Rome tremble. Similar apprehensions were entertained at intervals by enlightened people, and Cicero observed, "The shows of gladiators may possibly to some persons seem barbarous and inhuman; and, indeed, as the case now stands, I cannot say that the censure is unjust. But in those times, when only guilty persons composed the number of combatants, the ear perhaps might receive many better instructions; but it is impossible that any thing which affects our eyes should fortify us with more success against the assaults of grief and death." Still he had the good sense to propose a law, prohibiting all candidates for offices from exhibiting gladiators within two years before they became such. Julius Cæsar limited their number in Rome. Augustus ordained that not more than sixty pairs of combatants should fight at one exhibition, and that there should be only two of the latter in a year. During the reign of Tiberius it was decreed, that gladiators were not to be brought before the public by persons worth less than 400,000 sesterces. Constantine the Great had the humanity and courage to abolish the custom, after it had prevailed near six hundred years; but it revived under Constantius Theodosius and Valentinian, and was finally suppressed by the Emperor Honorius.

The guilty persons alluded to by Cicero must apply to those slaves whose masters sold them, for disobedience or malpractices, to the Lanistæ, who, instructing them in the arts of attack and defence, hired them to any rich man disposed to exhibit them. Had they been entirely confined to this class of people, we might have been less inclined to censure the custom; but when we reflect that honest and courageous soldiers were condemned to undergo the lash of their captors, and afterwards perish by the swords of slaves, or each other, we cannot fail of being astonished that the high-spirited Roman should expose himself to their vengeance, by voluntarily entering the arena with them, there to meet almost certain death. Strange, however, as it appears, freemen fought for hire under the term of auctorati; and even knights, nobles, and senators, who had wasted their property by extravagance, have deigned to become gladiators. Augustus, offended at their conduct, forbid the senatorian order and knights to enter the lists as such; but preceding princes, less influenced by a sense of honour, permitted them to act as they pleased. The contagion at length extended to the females of Rome; and, lastly, dwarfs were taught the use of the sword, and fighting with the women, or each other, furnished a new description of diversion. Kennet classes the various sorts of gladiators under the terms of the Retiarii, the Secutores, the Myrmyllones, the Thracians, the Samnites, the Essedarii, and the Andabatæ; the Gladiatores Meridiani fought in the afternoon; the Gladiatores Fiscales were paid from the Emperor's private treasury; the Gladiatores Postulatitii were men of consummate art in their profession; the Gladiatores Catervarii fought in small companies; and the Gladiatores Ordinarii were not particularly distinguished, but fought in a common way.

The dress of the Retiarius was a short habit, and a hat tied under the chin. His means of offence were a weapon called a fuscina, and a net. With the latter in his right hand, he endeavoured to entangle his adversary, and with the fuscina in the left he aimed mortal blows at him; but as this description of gladiator was invariably opposed to a Secutor, armed with a scymeter, a buckler, and a helmet, the Retiarius had no means of escape, if he failed in casting his net, except by flight round the arena, during which he adjusted it for a new trial.

The best gladiators were Thracians. Those men, with their faulchion and small round shields, possessed more national ferocity and cruelty than any of their opponents. Kennet says, "The original of the Samnite gladiators is given by Livy. The Campanians (says he) bearing a great hatred to the Samnites, they armed a part of their gladiators after the fashion of that country, and called them Samnites. They wore a shield, broad at the top, to defend the breast and shoulders, and growing more narrow towards the bottom, that it might be moved with the greater convenience. They had a sort of belt coming over their breasts, a greave on their left foot, and a crested helmet on their heads." The Epedarii sometimes engaged from chariots, and at others on foot; and the Andabatæ, mounted on horses, fought with a helmet which covered their faces and eyes.

The exhibition of gladiators was announced to the public by bills affixed in the public places, sometimes accompanied by paintings of the intended combat, or the most celebrated combatants; and when the time mentioned had arrived, and the people assembled, the gladiators marched slowly round the arena; they were then matched, by persons appointed for that purpose, as equally as possible, and they proceeded to prepare for the contest by fencing with blunted swords, &c.; after which the trumpets were sounded, and the battles began in serious earnest. When a severe wound was given, the gladiator who inflicted it, and the people, exclaimed, 'He has it.' If that proved decisive, the vanquished person resigned his weapon, and acknowledged himself conquered. But this submission was not alone sufficient to save his life: the people were to decide his fate. He therefore turned to them, and supplicated for mercy, which was granted, or refused, according to their opinion of his skill and courage. Several learned authors have differed as to the exact manner in which the hands and fingers were placed, to express praise or disapprobation on those occasions. According to Juvenal, the bending of the thumbs back authorised the conqueror to kill his adversary as a coward. The Emperor might, however, interfere, if he was present, and save the gladiator; it is supposed, besides, that his entrance at the instant of defeat was favourable to the vanquished party, as far as his life was concerned.

The rewards of the victors consisted of money collected from the spectators; and when they happened to be slaves, they received the pileus, or cap, denoting that from that moment they became free; or the rudis, or wand, which signified their services, as gladiators, were thenceforth dispensed with, whether slaves or freemen. It was customary for the persons thus situated either to become Lanistæ, or to suspend their arms in the Temple of Hercules.

There are few nations which have not imitated this strange custom, in a greater or less degree, at different periods of their history; and less than a century past there were gladiators in London, who fought and bled, but never killed each other.— Malcolm's Anecdotes of the Manners and Customs of this great Metropolis contains numerous particulars relating to those modern swords-men, whose exertions were rivalled by several females in the art of boxing and cutting. One of their challenges, from the publication alluded to, will be a proper conclusion to this article. "In Islington Road, on Monday, being the 17th of July, 1727, will be performed a trial of skill by the following combatants: We, Robert Barker and Mary Welsh, from Ireland, having often *contaminated* our swords in the *abdominous corporations* of such antogonists as have had the insolence to dispute our skill, do find ourselves once more necessitated to challenge, defy, and invite Mr. Stokes, and his bold Amazonian virago, to meet us on the stage; where we hope to give a satisfaction to the honourable lord of our nation, who has laid a wager of twenty guineas on our heads. They that give the most cuts to have the whole money, and the benefit of the house. And if swords, daggers, quarter-staff, fury, rage, and resolution will prevail, our friends shall not meet with a disappointment."— "We, James and Elizabeth Stokes, of the city of London, having already gained an universal approbation by our agility of body, dextrous hands, and courageous hearts, need not *preambulate* on this occasion, but rather choose to exercise the sword to their sorrow, and corroborate the general opinion of the town, than to follow the custom of our repartee antagonists. This will be the last time of Mrs. Stokes performing on the stage. There will be a door on purpose for the reception of the gentlemen, where coaches may drive up to it, and the company come in without being crowded. Attendance will be given at three, and the combatants mount at six. They all fight in the same dresses as before."

GLADIOLUS, in botany, English *corn-flag*, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: corolla six-parted, irregular, unequal; stigmas three. There are thirty species: these are herbaceous, perennial plants, with a tuberous-coated root; a simple stalk; the flowers specious, in spikes, with a spathe to each flower.

GLAMA, a species of Peruvian camel, with the back even, and the breast gibbose. See CAMELUS.

GLANCE, in mineralogy, one of the ores of cobalt, found in beds of mica, in Sweden: its colour is tin-white, it is massive in various forms, and crystallized in cubes and octahedrons; the surface of the crystals is smooth and splendent; it is brittle, and the specific gravity is 6.45.

GLAND, in anatomy, a small body formed by the interweaving of vessels of every kind, covered with a membrane, usually provided with an excretory duct, and destined to separate some particular fluid from the mass of blood, or to perfect the lymph. See ANATOMY and PHYSIOLOGY.

The glands have been chemically examined by Fourcroy and others. There are two sets of them: the conglobate, which are small, scattered in the course of the lymphatics: and the conglomerate, such as the liver, kidneys, &c. Fourcroy supposes the first to be composed of gelatine; the composition of the others has not been ascertained.

GLANDERS. See FARRIERY.

GLANS. See ANATOMY.

GLAREOLA, the *pratincole*, in natural history, a genus of birds of the order Grallæ. Generic character: bill strong, strait, short, hooked at the end; nostrils at the base linear and oblique; feet four toed; toes long, slender, connected at the base by a membrane: tail forked, consisting of twelve feathers. There are three species, of which the principal is P. austriaca; this is about as large as a black-bird, lives on water-insects and on worms; is found in great numbers on the banks of the Rhine in the neighbourhood of Strasburgh, and in innumerable flocks in the deserts of the Caspian Sea; it is a bird particularly clamorous and restless. See Aves, Plate VII. fig. 5.

GLASS, a substance too well known to admit of a definition. It is a compound of the fixed alkalies, or alkaline earths, with silica, brought into complete fusion, and then suddenly congealed. Silica, when mixed with the fixed alkalies, and exposed to a strong heat, readily enters into fusion. In this state the mixture may be moulded into any shape, and if suddenly cooled below the temperature at which it assumes the solid state, it retains the transparency, and those peculiar properties that belong to the substance called glass. Metallic oxides are sometimes added, as well to assist in the fusion, as to communicate certain colours to the mass. If the melted glass be suffered to cool very slowly, the different tendency of the constituent parts to assume solid forms, at certain temperatures, will cause them to separate successively in crystals, as salts held in solution in water assume the form of crystals as the liquid is slowly evaporated. But if the glass be suddenly cooled down to the point of congelation, the constituents have not time to separate in succession, and the glass remains the same homogenous compound as while in a state of fusion. Hence it should seem that the vitreous quality depends entirely, 1. upon the fusibility of the mixture, and 2. on the suddenness with which it is cooled down to the point of congelation. It was discovered by Sir James Hall, that glass always loses its vitreous state, and assumes that of a stone, if more than a minute or two elapses while it is cooling down from complete fusion to the point at which it congeals.

There are several kinds of glass adapted to different uses. The best and most beautiful are the flint and the plate glass. These, when well made, are perfectly transparent and colourless, heavy and brilliant. They are composed of fixed alkali, pure siliceous sand, calcined flints, and litharge in different proportions. The flint glass contains a large quantity of oxide of lead, which by certain processes is easily separated. The plate glass is poured in the melted state upon a table covered with copper. The plate is cast half an inch thick, or more, and is ground down to a proper degree of thinness, and then polished.

Crown-glass, that used for windows, is made without lead, chiefly of fixed alkali fused with siliceous sand, to which is added some black oxide of manganese, which is apt to give the glass a tinge of purple.

Bottle-glass is the coarsest and cheapest kind; into this little or no fixed alkali enters the composition. It consists of an alkaline earth combined with alumina and silica. In England it is composed of sand and the refuse of the soap-boiler, which consists of the lime employed in rendering his alkali caustic, and of the earthy matters with which the alkali was contaminated. The most fusible is flint-glass, and the least fusible is bottle-glass.

Flint-glass melts at the temperature of 10° Wedgewood; crown glass at 30°; and bottle-glass at 47°. The specific gravity varies between 2.48 and 3.33.

Good glass is perfectly transparent, and when cold very brittle, but at a red heat it is one of the most ductile bodies known, and may be drawn into threads so very delicate, as to become almost invisible to the human eye. It is extremely elastic, and one of the most sonorous of bodies. See Harmonica.

There are but few chemical agents which have any action upon it. Mr. Davy, in one of his lectures delivered in May, 1808, exhibited a method of decomposing it by means of the Voltaic battery: he, however, first reduced it to powder. Fluoric acid, as we have seen, has a great power over it, and dissolves it very quickly (see Fluoric Acid): so also have the fixed alkalies, when assisted by heat. The continued action of hot water is said to be capable of decomposing glass, which it is thought will fully explain how the siliceous earth was obtained by Boyle and others, when they subjected water to very tedious distillations in glass vessels. It has also been supposed, that the deflagration of the oxygen and hydrogen gases, in the formation of water, has decomposed the glass, which will account for an acid as part of the result.

In making glass, the materials are completely fused together, and in this state the hot mixture is called frit. The frit is introduced into large pots made of prepared clay, and exposed to a heat sufficient to melt it completely. When the fusion has continued the proper time, the furnace is allowed to cool a little. In this state the glass is exceedingly ductile, and will assume any shape, according to the fancy of the workman. The vessels thus formed must not be permitted to cool too quickly, hence they are put into a hot furnace, in order that the heat may pass off very gradually; this is called annealing.

Glass is often tinged of various colours, which is performed by mixing with it, while in fusion, some one of the metallic oxides. Thus blue glass is formed by the oxide of cobalt; green by the oxide of iron, or copper; violet by the oxide of manganese; red by a mixture of the oxides of copper and iron; purple by the oxide of gold; white by the oxide of arsenic and zinc; and yellow by the oxide of silver, and by combustible bodies.

We shall give now a detail of the manual operations in the manufacture of glass.

Glass-blowing, the art of forming vessels of glass; the term, however, is exclusively applied to those vessels which are blown by the mouth. The operation is exceedingly simple; the workman has a tube of iron, the end of which he dips into a pot of melted glass, and thus gathers a small quantity of glass on the end of it; he then applies the other end of the tube to his mouth, and blows air through it; this air enters into the body of the fluid glass, and expands it out into a hollow globe, similar to the soap bladders blown from a tobacco pipe. Various methods are used to bring these hollow globes into forms of the different utensils in common domestic use, and several tools; the chief part of these are represented in PLATE-GLASS MAKING.

The first and greatest of the glass-blowers' implements is the furnace; it consists of two large domes set one over the other, the lower one stands over a long grating, (on a level with the ground) on which the fuel is placed; beneath the grate is the ash pit, and a large arch, leading to it, conveys air to the furnace. In the sides of the lower dome, as many holes or mouths are made as there are workmen to make use of the furnace, and before each mouth a pot of melted glass is placed; the pots are very large, like crucibles, and will hold from three to four hundred weight of liquid glass; they are supported upon three small piers of brickwork, resting on the floor of the furnace. The form reverberates the flame from the roof down upon the pots, and they are placed at some distance within the furnace, that the flame may get between the wall and the pots. The upper dome is built upon the other, and its floor made flat by filling up round the roof of the lower dome with brickwork; there is a small chimney opens from the top of the lower dome into the middle of the floor of the upper one, which conveys the smoke away from it, and a flue from the upper dome leads it completely from the furnace.

The upper dome is used for annealing the glass, and is exactly similar to a large oven, it has three mouths, and in different parts a small flight of steps lead up to each. We now come to describe the smaller implements.

Fig. 1 and 2, is a bench or stool with two arms *a b* at its ends, which are a little inclined to the horizon; the operator, when at work, sits upon the stool, and lays his blowing tube *d* across the arms, as shown in the figure.

Fig. 3, are a pair of shears, or rather pliers, formed of one piece of steel; they have no sharp edges, and spring open when permitted; the workman has several of these of different sizes, which are hung upon hooks at *e* in the stool, fig. 4.

Fig. 4, is a pair of compasses to measure the work, and ascertain when it is brought to the proper size; the workmen should have three or four of these.

Fig. 5, a common pair of sheers, for cutting the soft glass.

Fig. 6, a very coarse flat file.

Fg. 7, is the blowing pipe; it is simply a wrought iron tube, about three feet long, at *x* it is covered with twine, to prevent it burning the workman's hand.

Fig. 8, a small iron rod, of which there should be several.

Fig. 9, is a stool with a flat plate of cast iron laid upon it, and *f* is another flat plate upon the ground behind the stool.

To explain the use of these tools, we shall describe the manner of forming a lamp or urn of glass, Fig. 10, with a wide mouth at top and a small neck *g* at bottom, through which the candle is inserted, and which is fitted into a brass cap to support the lamp by.

The operation is conducted by three workmen. The first takes the blowing pipe 7, and after heating it to a red heat at the mouth of the furnace, dips it into the pot of melted glass, at the same time turning it round, that it may take up the glass, which has then much the consistence of turpentine; in the quantity of metal he is guided by experience, and must proportion it to the size of the vessel to be blown; he then brings it from the furnace to the stool, fig. 9, and rolls the lump of glass upon it to bring it to a round form, after which he blows through the pipe, resting the glass upon the iron plate *f* behind the stool, as in the figure, and rolling it backwards and forwards. The blowing makes the glass hollow, and he has several methods of bringing it to a proper shape to be worked; by simply blowing, it would assume a figure nearly globular; if he wants it any bigger, in the equatorial diameter *g g*, fig. 11, he lays the pipe on a hook driven in the side of the stool, and turns it round very quickly; the centrifugal force soon enlarges it in the equator. If, on the other hand, he wishes to lengthen its polar diameter, he holds the pipe perpendicular, the glass hanging downwards, its weight lengthening it, and to shorten the polar diameter, he holds the pipe upright, the glass at the top; by blowing through the pipe the capacity is increased, and the thickness of the glass of the vessel diminished.

We now suppose, that by a very dexterous application of the above methods the workman has brought it to the shape of fig. 11; he now carries it to the mouth of the furnace, and holds it in to get a fresh heat, (for by this time it is become too stiff to work easily) taking care to turn it round slowly, that it may not alter its figure. The vessel in this stage is delivered to the second, or principal workman, the other two being only assistants; he is seated upon the stool, figs. 1 and 2, and lays the blowing pipe, with the glass at its end, across its arm *a b*, and with his left hand rolls the pipe along the arms, turning the glass and pipe round at the same time; in his right hand he holds the pliers, fig. 3, whose blades are rubbed over with a small piece of bees'-wax, and as the glass turns round presses the blade of the shears against it, following it with the shears as it rolls, at the end or side, as occasion requires, until he has brought it to the proper size, which he determines by the compasses, fig. 4, though not materially altering its figure, the first workman kneeling on the ground and blowing with his mouth at the end of the pipe, which hangs over the arm *b*, when directed by his principal. The third workman now produces the small rod, fig. 8, which is dipped into the melting pot, to take up a small piece of metal to serve as cement; the end of this rod he applies to the centre of the glass, just opposite the blowing pipe, the principal workman directing it, by holding its end between his pliers, the rod by the small piece of glass on its end immediately sticks to the glass vessel, and the third workman draws it away, both workmen turning their rods round, but in contrary directions; this operation forms a short tube on the end, as in fig 12. The principal workman then takes the short tube at *i*, between the blades of a pair of pliers, exactly like the others, but which are not covered with bees'-wax; the cold of these pliers instantly cracks the glass all round, and a very slight jerk struck upon the rod 8 breaks it off. A hole is now made in the end of the glass, which is enlarged by the pliers while the glass is turned, as in fig. 13, until the neck is brought to the proper size and length to fit the brass cap, as before described, and the inferior half of the lamp is brought to its shape and size in the same manner.

In order to form the upper half, the third workman has in the meantime been preparing a round lump of glass K, fig. 14, on the end of one of the rods, fig. 8, this he applies hot to the end of the neck, it being guided by the principal workman, and it immediately holds tight, he then breaks off the other neck at 7, by the cold pliers, and thus separates it from the blowing pipe.

The glass is now heated a third time, and brought from the furnace in the state, fig. 15, to the principal workman, who enlarges the small orifice at the end by turning it round, and holding the pliers against it, until he enlarges it, as in fig. 16, to the shape of fig. 10; it is now finished, and the third workman takes it to a stool strewed over with small coals, he rests the rod upon the edge of the stool, and with the file, fig. 6, files the joint at the bottom neck, which soon breaks off, and the lamp falls upon the coals, the distance being so very small, as to be in no danger of breaking; a boy now puts the end of a long stick into the open mouth of the glass, and thus carries it up the steps before described, places it in the annealing oven, where it remains some hours; when taken out it must be cooled gradually, and is fit for sale.

In the history of glass, there is a fact deserving record; it is related by Pliny, that the discovery was owing to the following accident. Some merchants, with soda as part of their freight, had cast anchor at the mouth of the river Belus, in Phœnicia, and were dressing their dinner on the sand, making use of large lumps of the soda as supports for their kettles. The heat of the fire melted the soda, and the siliceous earth together; the result was glass. The hint was not lost, and a manufacture in that trading country was instantly established, and to this place it was for a long time confined. Glass was undoubtedly made in great perfection among the ancients. In their accounts, we read of drinking-glasses, glass prisms, and coloured glasses of various kinds. Glass was first used for windows in the 3d century of the Christian æra, but it did not come into common use till very long after this.

Glass, *painting on*. See Enamelling.

Glass, in sea affairs, the usual appellation for a telescope. A night-glass is a telescope made for viewing objects at night. Half-hour glass, called also the watch-glass, is used to measure the time which each watch has to stay upon deck. Half and quarter-minute glasses are used to ascertain the rate of the ship's velocity, measured by the log; these glasses should be frequently compared with a good stop-watch, to determine exactly how many seconds they run.

GLAUBER (John Rudolph,) an industrious chemist, was born in Germany. After passing a considerable time in travel, he settled at Amsterdam, about the middle of the seventeenth century. He wrote a number of works, mostly infected with the enigmatical jargon and unintelligible theory of the hermetic philosophy, yet containing some useful facts in true chemistry, and some processes of his own invention. His name is perpetuated in the purgative neutral salt called Glauber's, composed of the sulphuric acid and soda; a valuable remedy, but, together with others of his invention, extolled by himself to an extravagant degree. He kept several of his medicines secret, and made advantage of them as nostrums. Of his works an abridged collection was made in German, which was translated into English in 1689; but they are now consigned to oblivion.

Glauber's *salt*. See Soda, *Sulphate of*. It is found native; and, according to Bergman, it contains sulphuric acid, soda, and water, in the proportions of 27.15.58; that is, when saturated with water of crystallization. When efflorescent, the native Glauber's salt contains, beside pure sulphate of soda, some oxide of iron, and portions of muriate and carbonate of soda. It is found in old salt mines, on the borders of the salt lakes in different parts of the world, and on the surface of peat-mosses in France. It is also held in solution in the Natron lakes of Egypt, and the mineral springs of Carlsbad. Glauber's salt easily dissolves in water, and shoots into long and beautiful crystals, which contain a large quantity of water; in consequence of which they undergo the aqueous fusion, when exposed to heat. This salt, on account of its efficacy as a purgative, was formerly held in the highest esteem, and was denominated sal mirabile Glauberi. It has been used in some countries as a substitute for soda, in the manufacture of white glass.

GLAUCOPIS, or the *wattle-bird*, in natural history, a genus of birds of the order Picæ. Generic character: bill incurvate and arched; lower mandible shorter than the upper, and carunculate beneath at the base; nostrils depressed, half covered with a cartilaginous membrane; tongue cartilaginous, split, and ciliated at the end; legs carinated at the back; feet formed for walking.

The G. cinerea, or cinereous wattle-bird, is about the size of a jay; it is found in every part of New Zealand: berries, and insects of almost every kind, constitute its food; it rarely perches on trees; but is often seen walking on the ground: its notes are said at different times to resemble whistlings and murmurings, and its flesh is good for the table.

GLAUX, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Calycanthemæ. Salicariæ, Jussieu. Essential character: calyx one-leafed, bell-shaped: corolla none; capsule one-celled, five-valved, five-seeded. There is only one species, *viz.* G. maritima, sea milk-wort, or black saltwort. It is common on the sea coast, and on salt marshes at a distance from the sea; it is a beautiful little plant, enlivening large tracts of the dreary situations where it is found; the whole plant is succulent, and salt to the taste. It is also a native of the United States.

GLAZING, in the arts, is the polishing or crusting over earthen ware. When earthen ware is properly baked, it is dipped into a composition called a glaze, made by mixing together in water, till it becomes as thick as cream, fifty-six parts of white lead, twelve of ground flints, and three of ground flint glass. The ware, by being baked, acquires a strong property of imbibing moisture, and in this state it is called biscuit; when dipped into the glaze, it attracts it into its pores, and the ware becomes presently dry; it is then exposed a second time to the fire, by which means the glaze it has imbibed is melted, and a thin, glassy coat is formed upon the surface. The colour is more or less yellow, according as a greater or less proproportion of lead has been used. The lead promotes also the vitrification; the flint serves to give a consistency to the lead during the time of its vitrification, and to prevent its becoming too fluid, and running down the sides of the ware, and thereby leaving them unglazed. This kind of glazing by lead is liable to be attacked by acids, and of acting in some degree as a poison; a substitute has therefore been recommended, which conconsists of equal parts of white glass and soda finely pulverized, and exposed to a strong heat till quite dry, and with this the vessels are varnished or glazed. See POTTERY.

GLEANING, in law. It hath been said, that, by the common law and custom of England, the poor are allowed to enter and glean upon another's ground, after the harvest, without being guilty of trespass; and that this humane provision seems borrowed from the Mosaical law; but it is now positively settled, by a solemn judgment of the court of Common Pleas, that a right to glean in the harvest field cannot be claimed as a general right by every person at common law; nor as a custom by the poor of a parish, legally settled.

GLEBE, or *Glebe-land*, is a portion of land, meadow, or pasture, belonging to, or parcel of, the parsonage or vicarage, over and above the tythes.

Glebe lands, in the hands of the parson, shall not pay tithes to the vicar; nor, being in the hands of the vicar, shall they pay tithes to the parson. By statute 28 Hen. VIII. c. 11, every successor, on a month's warning after induction, shall have the mansion-house, and the glebe belonging thereto, not sown at the time of the predecessor's death. He that is instituted may enter into the glebe-land before induction, and has right to have it against any strangers.

GLECHOMA, in botany, English *ground-ivy*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx five-cleft; each pair of anthers converging in form of a cross. There is but one species, *viz.* G. hederacea, ground-ivy.

GLEDITSIA, in botany, a genus of the Polygamia Dioecia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: hermaphrodite; calyx four-cleft; corolla fourpetal led; stamens six; pistil one, legume. There is only one species, with several varieties.

GLEE, in music, a vocal composition in three or more parts, generally consisting of more than one movement, the subject of which may be either gay, tender, or grave; bacchanalian, amatory, or pathetic.

GLEET, in medicine, the flux of a thin, limpid humour from the urethra.

GLINUS, in botany, a genus of the Dodecandria Pentagynia class and order. Natural order of Coryophyllei. Ficoideæ, Jussieu. Essential character: calyx five-leaved; corolla none; nectaries cloven bristles; capsule five-cornered, five-celled, five-valved, containing numerous seeds. There are three species.

GLOBBA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Scitamineæ. Cannæ, Jussieu. Essential character: calyx superior, trifid; corolla equal, trifid; capsule three-celled; seeds very many. There are four species.

GLOBE, a round or spherical body, more usually called a sphere, bounded by one uniform convex surface, every point of which is equally distant from a point within, called its centre. Euclid defines the globe or sphere, to be a solid figure described by the revolution of a semi-circle about its diameter, which remains unmoved. Also, its axis is the fixed line or diameter about which the semi-circle revolves; and its centre is the same with that of the revolving semi-circle, a diameter of it being any right line that passes through the centre, and terminated both ways by the superficies of the sphere.

Euclid, at the end of the twelfth book, shews that spheres are to one another in the triplicate ratio of their diameters, that is, their solidities are to one another as the cubes of their diameters. And Archimedes determines the real magnitudes and measures of the surfaces and solidities of spheres and their segments, in his treatise "De Sphæra et Cylindro:" *viz.* 1. That the superficies of any globe is equal to four times a great circle of it. 2. That any sphere is equal to two-thirds of its circumscribing cylinder, or of the cylinder of the same diameter and altitude. 3. That the curve surface of the segment of a globe, is equal to the circle whose radius is the line drawn from the vertex of the segment to the circumference of the base. 4. That the content of a solid sector of the globe is equal to a cone whose altitude is the radius of the globe, and its base equal to the curve superfices or the base of the sector, with many other properties. And from hence are easily deduced these practical rules for the surfaces and solidities of globes and their segments; *viz.* 1. "For the Surface of a globe," multiply the square of the diameter by 3.1416; or multiply the diameter by the circumference. 2. "For the Solidity of a Globe," multiply the cube of the diameter by .5236 (*viz.* one-sixth of 3.1416); or multiply the surface by one-sixth of the diameter. 3. "For the surface of a Segment," multiply the diameter of the globe by the altitude of the segment, and the product again by 3.1416. 4. "For the Solidity of a Segment," multiply the square of the diameter of the globe by the difference between three times that diameter and twice the altitude of the segment, and the product again by .5236, or one-sixth of 3.1416.

Hence, if d denote the diameter of the globe,
c the circumference,
a the altitude of any segment, and
$p = 3.1416$; then

	The surface.	The solidity.
In the globe	$pd^2 = cd$	$\frac{1}{6} pd^3$
In the segment	pad	$\frac{1}{6} pd^2 \times \overline{3d - 2a}$

See Mensuration.

GLOBE, in practical mathematics, an artificial spherical body, on the convex surface of which are represented the countries, seas, &c. of our earth; or the face of the heavens, the circles of the sphere, &c. That with the parts of the earth delineated upon its surface is called the terrestrial globe; and that with the constellations, &c. the celestial globe. These globes are placed in frames, with other appurtenances. Their principal use, besides serving as maps to distinguish the outward parts of the earth, and the situation of the fixed stars, is, to illustrate and explain the phenomena arising from the diurnal motion of the earth.

The globes commonly used are composed of plaister and paper in the following manner: A wooden axis is provided, somewhat less than the intended diameter of the globe, and into the extremes two iron wires are driven for poles: this axis is to be the beam or basis of the whole structure. On the axis are applied two spherical or rather hemispherical caps, formed on a kind of wooden mould or block. These caps consist of pasteboard or paper, laid one lay after another on the mould, to the thickness of a crown-piece; after which, having stood to dry and embody, making an incision along the middle, the two caps thus parted are slipped off the mould. They remain now to be applied on the poles of the axis, as before they were on those of the mould; and to fix them in their new place, the two edges are sowed together with pack-thread, &c. The rudiments of the globe thus laid, they proceed to strengthen and make it smooth and regular. In order to this, the two poles are hasped in a metalline semi-circle of the size intended, and a kind of plaster made of whiting, water, and glue, heated, melted, and incorporated together, is daubed all over the paper surface. In proportion as the plaster is applied, the ball is turned round in the semi-circle, the edge of which pares off whatever is superfluous, and beyond the due dimension, leaving the rest adhering in places that are short of it. After such application of plaster, the ball stands to dry; which done, it is put again in the semi-circle, and fresh matter applied: thus they continue alternately to apply the composition, and dry it, till the ball every where accurately touches the semi-circle; in which state it is perfectly smooth, regular, and complete. The ball thus finished, it remains to paste the map or description on it. In order to this, the map is projected in several gores or gussets, all which join accurately on the spherical surface, and cover the whole ball. To direct the application of these gores, lines are drawn by a semi-circle on the surface of the ball, dividing it into a number of equal parts, corresponding to those of the gores, and subdividing those again answerably to the lines and divisions of the gores.

The papers thus pasted on, there remains nothing but to colour and illuminate the globe, and to varnish it, the better to resist dust, moisture, &c. The globe itself thus finished, they hang it in a brass-meridian, with an hour-circle and a quadrant of altitude, and thus fit it into a wooden horizon.

There are ten principal circles represented upon globes, *viz.* six greater and four lesser ones. The greater circles are the horizon, meridian, and equinoctial, as it is called on the celestial, and equator on the terrestrial globe, the ecliptic drawn along the middle of the zodiac, and the two colures.

The lesser circles, of principal use, are the two tropics and two polar circles.

Of these circles some are fixed, and always obtain the same position; others moveable, according to the position of the observer. The fixed circles are the equator and the ecliptic, with their parallels and secondaries; which are usually delineated upon the surfaces of the globes. The moveable circles are the horizon, with its parallels and secondaries.

The horizon is that broad wooden circle surrounding the globe, and dividing it into two equal parts called the upper and lower hemispheres. It has two notches, to let the brazen meridian slip up and down, according to the different heights of the pole. On the flat side of this circle are described the twelve signs, the months of the year, the points of the compass, &c. The brazen meridian is an annulus or ring of brass, divided into degrees, *viz.* each quadrant in 90 degrees. It divides the globe into two equal parts, called the eastern and western hemispheres. The quadrant of altitude is a thin pliable plate of brass, answering exactly to a quadrant of the meridian. It is divided into 90°, and has a notch, nut, and screw, to fix to the brazen meridian in the zenith of any place; where it turns round a pivot, and supplies the room of vertical circles. The hour-circle is a flat ring of brass, divided into twenty-four equal parts, or hour-distances; and on the pole of the globe is fixed an index, that turns round with the globe, and points out the hours upon the hour-circle. Lastly, there is generally added a compass and needle upon the pediment of the frame.

The surface of the celestial globe may be esteemed a just representation of the concave expanse of the heavens, notwithstanding its convexity; for it is easy to conceive the eye placed in the centre of the globe, and viewing the stars on its surface; supposing it made of glass, as some globes are: also that if holes were made in the centre of each star, the eye in the centre of the globe, properly placed, would view through each of the holes the very stars in the heavens represented by them.

As it would be impossible to have any distinct notion of the stars, in respect to their number, order, and distances, without arranging them in certain forms, called constellations, this the first observers of the heavens took care to do; and these, like kingdoms and countries, upon the terrestrial globe, serve to distinguish the different parts of the superfices of the celestial globe.

The stars, therefore, are all disposed in constellations, under the forms of various animals, whose names and figures are represented on the celestial globe; which were first invented by the ancient astronomers and poets, and are still retained, for the better distinction of these luminaries. We shall now give some problems on both the globes, beginning with the terrestrial globe.

TERRESTRIAL GLOBE.

Prob. 1. "To find the latitude and longitude of any place." Bring the place to the graduated side of the first meridian: then the degree of the meridian it cuts is the latitude sought; and the degree of the equator then under the meridian is the longitude.

2. "To find a place, having a given latitude and longitude." Find the degree of longitude on the equator, and bring it to the brass meridian; then find the degree of latitude on the meridian, either north or south of the equator, as the given latitude is north or south; and the point of the globe just under that degree of latitude is the place required.

3. "To find all the places on the globe that have the same latitude and the same longitude, or hour, with a given place, as suppose London." Bring the given place, London, to the meridian, and observe what places are just under the edge of it, from north to south; and all those places have the same longitude and hour with it. Then turn the globe round; and all those places, which pass just under the given degree of latitude on the meridian, have the same latitude with the given place.

4. "To find the antœci, periœci, and antipodes, of any given place, suppose London." Bring the given place, London, to the meridian, then count 51½ the same degree of latitude southward, or towards the other pole, and the point thus arrived at will be the antœci, or where the hour of the day or night is always the same at both places at the same time, and where the season and lengths of days and nights are also equal, but at half a year distance from each other, because their seasons are opposite or contrary. London being still under the meridian, set the hour index to twelve at noon, or pointing towards London; then turn the globe just half round, or till the index point to the opposite hour, or twelve

at night; and the place that comes under the same degree of the meridian where London was shows where the periœci dwell, or those people that have the same seasons and at the same time as London, as also the same length of days and nights, &c. at that time, but only their time or hour is just opposite, or twelve hours distant, being day with one when night with the other, &c. Lastly, as the globe stands, count down by the meridian the same degree of latitude south, and that will give the place of the antipodes of London, being diametrically under or opposite to it; and so having all its times, both hours and seasons, opposite, being day with the one when night with the other, and summer with the one when winter with the other.

5. "To find the distance of two places on the globe." If the two places be either both on the equator, or both on the same meridian, the number of degrees in the distance between them, reduced into miles, at the rate of seventy English miles to the degree, (or more exactly sixty-nine and one-fifth,) will give the distance nearly. But in any other situations of the two places, lay the quadrant of altitude over them, and the degrees counted upon it, from the one place to the other, and turned into miles as above, will give the distance in this case.

6. "To find the difference in the time of the day at any two given places, and thence the difference of longitude." Bring one of the places to the meridian, and set the hour index to twelve at noon; then turn the globe till the other place comes to the meridian, and the index will point out the difference of time; then, by allowing fifteen degrees to every hour, or one degree to four miles of time, the difference of longitude will be known. Or the difference of longitude may be found without the time, thus:

First bring the one place to the meridian, and note the degree of longitude on the equator cut by it; then do the same by the other place; which gives the longitudes of the two places; then subtracting the one number of degrees from the other gives the difference of longitude sought.

7. "The time being known at any given place, as suppose London, to find what hour it is in any other part of the world." Bring the given place, London, to the meridian, and set the index to the given hour; then turn the globe till the other place come to the meridian, and look at what hour the index points, which will be the time sought.

8. "To find the sun's place in the ecliptic, and also on the globe, at any given time." Look into the calendar on the wooden horizon for the month and day of the month proposed, and immediately opposite stands the sign and degree which the sun is in on that day. Then, in the ecliptic drawn upon the globe, look for the same sign and degree, and that will be the place of the sun required.

9. "To find at what place on the earth the sun is vertical, at a given moment of time at another place, as suppose London." Find the sun's place on the globe by the last problem, and turn the globe about till that place come to the meridian, and note the degree of the meridian just over it. Then turn the globe till the given place, London, come to the meridian, and set the index to the given moment of time. Lastly, turn the globe till the index points to twelve at noon; then the place of the earth, or globe, which stands under the before noted degree, has the sun at that moment in the zenith.

10. "To find how long the sun shines, without setting, in any given place in the frigid zones." Subtract the degrees of latitude of the given place from ninety, which gives the complement of the latitude, and count the number of this complement upon the meridian fromthe equator towards the pole, marking that point of the meridian; then turn the globe round,and carefully observe what two degrees of the ecliptic pass exactly under the point marked on the meridian. Then look for the same degrees of the ecliptic on the wooden horizon, and just opposite to them stand the months and days of the months corresponding, and between which two days the sun never sets in that latitude.

If the beginning and end of the longest night be required, or the period of time in which the sun never rises at that place; count the same complement of latitude towards the south or farthest pole, and then the rest of the work will be the same in all respects as above.

Note, that this solution is independent of the horizontal refraction of the sun, which raises him rather more than half a degree higher, by that means making the day so much longer, and the night the shorter; therefore, in this case, set the mark on the meridian half a degree higher up towards the north pole than what the complement of latitude gives; then proceed with it as before, and the more exact time and length of the longest day and night will be found.

11. "A place being given in the torrid zone, to find on what two days of the year the sun is vertical at that place." Turn the globe about till the given place come to the meridian, and note the degree of the meridian it comes under. Next turn the globe round again, and note the two points of the ecliptic passing under that degree of the meridian. Lastly, by the wooden horizon, find on what days the sun is in those two points of the ecliptic; and on these days he will be vertical to the given place.

12. "To find those places in the torrid zone to which the sun is vertical on a given day." Having found the sun's place in the ecliptic, as in the eighth problem, turn the globe to bring the same point of the ecliptic on the globe to the meridian; then again turn the globe round, and note all the places which pass under that point of the meridian; which will be the places sought.

After the same manner may be found what people are ascii for any given day. And also to what place of the earth, the moon, or any other planet, is vertical on a given day; finding the place of the planet on the globe by means of its right ascension and declination, like finding a place from its longitude and latitude given.

13. "To rectify the globe for the latitude of any place." By sliding the brass meridian in its groove, elevate the pole as far above the horizon as is equal to the latitude of the place; so for London, raise the north pole fifty-one and a half degrees above the wooden horizon: then turn the globe on its axis till the place, as London, come to the meridian, and there set the index to twelve at noon. Then is the place exactly on the vertez, or top point of the globe, at ninety degrees every way round from the wooden horizon, which represents the horizon of the place. And if the frame of the globe be turned about till the compass needle point to twenty-two and a half degrees, or two points west of the north point (because the variation of the magnetic needle is nearly twenty-two and a half degrees west), so shall the globe then stand in the exact position of the earth, with its axis pointing to the north pole.

14. "To find the length of the day or night, or the sun's rising or setting, in any latitude; having the day of the month given." Rectify the globe for the latitude of the place; then bring the sun's place on the globe to the meridian, and set the index to twelve at noon, or the upper twelve, and then the globe is in the proper position for noon-day. Next turn the globe about towards the east till the sun's place come just to the wooden horizon, and the index will then point to the hour of sun-rise; also turn the globe as far to the west side, or till the sun's place come just to the horizon on the west side, and then the index will point to the hour of sun-set. These being now known, double the hour of setting will be the length of the day, and double the rising will be the length of the night. And thus also may the length of the longest day, or the shortest day, be found for any latitude.

15. "To find the beginning and end of twilight on any day of the year, for any latitude." It is twilight all the time from sun-set till the sun is eighteen degrees below the horizon, and the same in the morning from the time the sun is eighteen degrees below the horizon till the moment of his rise. Therefore, rectify the globe for the latitude of the place, and for noon, by setting the index to twelve, and screw on the quadrant of altitude. Then take the point of the ecliptic opposite the sun's place, and turn the globe on its axis westward, as also the quadrant of altitude, till that point cut this quadrant in the eighteenth degree below the horizon; then the index will shew the time of dawning in the morning; next turn the globe and quadrant of altitude towards the east, till the said point opposite the sun's place meet this quadrant in the same eighteenth degree, and then the index will shew the time when twilight ends in the evening.

16. "At any given day, and hour of the day, to find all those places on the globe where the sun then rises, or sets, as also where it is noon-day, where it is day-light, and where it is in darkness." Find what place the sun is vertical to, at that time; and elevate the globe according to the latitude of that place, and bring the place also to the meridian; in which state it will also be in the zenith of the globe. Then is all the upper hemisphere, above the wooden horizon, enlightened, or in day light; while all the lower one, below the horizon, is in darkness, or night: those places by the edge of the meridian, in the upper hemisphere, have noon-day, or twelve o'clock; and those by the meridian below, have it midnight: lastly, all those places by the eastern side of the horizon have the sun just setting, and those by the western horizon have him just rising.

Hence, as in the middle of a lunar eclipse, the moon is in that degree of the ecliptic opposite to the sun's place; by the present problem it may be shown what places of the earth; then see the middle of the eclipse, and what the beginning or ending, by using the moon's place instead of the sun's place in the problem.

17. "To find the bearing of one place from another, and their angle of position." Bring the one place to the zenith, by rectifying the globe for its latitude, and turning the globe till that place come to the meridian; then screw the quadrant of altitude upon the meridian at the zenith, and make it revolve till it come to the other place on the globe; then look on the wooden horizon for the point of the compass, or number of degrees from the south, where the quadrant of altitude cuts it, and that will be the bearing of the latter place from the former, or the angle of position sought.

18. "The day and hour of a solar or lunar eclipse being given, to find all those places in which the same will be visible." Find the place to which the sun is vertical at the given instant; and elevate the globe to the latitude of the place; then, in most of those places above the horizon will the sun be visible during his eclipse; and all those places below the horizon will see the moon pass through the shadow of the earth in her eclipse.

19. "The length of a degree being gigen, to find the number of miles in a great circle of the earth, and thence the diameter of the earth." Admit that one degree contains $69\frac{1}{2}$ English statute miles; then multiply 360 (the number of degrees in a great circle) by $69\frac{1}{2}$ and the product will be 25,020, the miles which measure the circumference of the earth. If this number be divided by 3.1416, the quotient will be $7{,}963\frac{86}{100}$ miles, for the diameter of the earth.

20. "The diameter of the earth being known, to find the surface in square miles, and its solidity in cubic miles." Admit the diameter be 7,964 miles; then multiply the square of the diameter by 3.1416, and the product will be 199,250,205 very near, which are the square miles in the surface of the earth. Again, multiply the cube of the diameter by 0,5236, and the product 264,466,789,170 will be the number of the cubic miles in the whole globe of the earth.

21. "To express the velocity of the diurnal motion of the earth." Since a place in the equator describes a circle of 25,020 miles in twenty-four hours, it is evident that the velocity with which it moves is at the rate of $1{,}042\frac{1}{2}$ in an hour, or $17\frac{3}{10}$ miles per minute. The velocity in any parallel of latitude decreases in the proportion of the co-sine of the latitude to the radius. Thus for the latitude of London, 51° 30′, say,

As radius - - - - - - -	10.000000
To the co-sine of lat. 51° 30′	9.794149
So is the velocity in the equator, $17\frac{3'}{10}$ - - - -	2.238046
To the velocity of the city of London, $10\frac{8'}{10}$ - -	2.032195

That is, the city of London moves about the axis of the earth at the rate of $10\frac{8}{10}$ miles every minute of time: but this is far short of the velocity of the annual motion about the sun; for that is at the rate of more than 65,000 miles per hour.

PROBLEMS ON THE CELESTIAL GLOBE.

1. "To rectify the globe." Raise or elevate the pole to the latitude of the place; screw the quadrant of altitude in the zenith; set the index of the hour-circle to the upper XII; and place the globe north and south by the compass and needle; then is it a just representation of the heavens from the given day at noon.

2. "To find the sun's place in the ecliptic." Find the day of the month in the calendar on the horizon, and right against it is the degree of the ecliptic, which the sun is in for that day.

3. "To find the sun's declination." Rectify the globe, bring the sun's place in the ecliptic to the meridian, and that degree which it cuts in the meridian is the declination required.

4. "To find the sun's right ascension." Bring the sun's place to the meridian, and the degree of the equinoctial cut by the meridian is the right ascension required.

5. "To find the sun's amplitude." Bring the sun's place to the horizon, and the arch of the horizon intercepted between it and the east or west point is the amplitude, north or south.

6. "To find the sun's altitude for any given day and hour." Bring the sun's place to the meredian; set the hour-index to the upper XII; then turn the globe till the index points to the given hour, where let it stand; then screwing the quadrant of altitude in the zenith, lay it over the sun's place, and the

arch contained between it and the horizon will give the degrees of altitude required.

7. "To find the sun's azimuth for any hour of the day." Every thing before done as in the last problem, the arch of the horizon contained between the north point and that where the quadrant of altitude cuts it, is the azimuth east or west, as required.

8. "To find the time when the sun rises or sets." Find the sun's place for the given day; bring it to the meridian, and set the hour-hand to XII; then turn the globe till the sun's place touches the east part of the horizon, the index will shew the hour of its rising; after that turn the globe to the west part of the horizon, and the index will shew the time of its setting for the given day.

9. "To find the length of any given day or night." This is easily known by taking the number of hours between the rising and setting of the sun for the length of the day; and the residue, to twenty-four, for the length of the night.

10. "To find the hour of the day, having the sun's altitude given." Bring the sun's place to the meridian, and set the hour-hand to XII; then turn the globe in such a manner, that the sun's place may move along by the quadrant of altitude (fixed in the zenith) till it touches the degree of the given altitude, where stop it, and the index will shew on the horary circle the hour required.

11. "To find the place of the moon, or any planet, for any given day." Take White's ephemeris, and against the given day of the month you will find the degree and minute of the sign which the moon or planet possesses at noon, under the title of geocentric motions. The degree thus found being marked, in the ecliptic on the globe by a small mark, or otherwise, you may then proceed to find the declination, right ascension, latitude, longitude, altitude, azimuth, rising, southing, setting, &c. in the same manner as has been shewn for the sun.

12. "To explain the phenomena of the harvest-moon." In order to this we need only consider, that when the sun is in the beginning of Aries, the full moon on that day must be in the beginning of Libra; and since when the sun sets, or moon rises, on that day, those equinoxal points will be in the horizon, and the ecliptic will then be least of all inclined thereto, the part or arch which the moon describes in one day, *viz.* 13°, will take up about an hour and a quarter ascending above the horizon; and therefore, so long will be the time after sunset, the next night, before the moon will rise. But at the opposite time of the year, when the sun is in the autumnal, and the full moon in the vernal equinox, the ecliptic will, when the sun is setting, have the greatest inclination to the horizon; and therefore, 13° will in this case soon ascend, *viz.* in about a quarter of an hour; and so long after sun-set will the moon rise the next day after the full: whence, at this time of the year, there is much more moon-light than in the spring; and hence this autumnal full moon came to be called the harvest-moon, the hunter's or shepherd's moon: all which may be clearly shewn on the globe.

13. "To represent the face of the starry firmament for any given hour of the night." Rectify the globe and turn it about, till the index points to the given hour; then will all the upper hemisphere of the globe represent the visible half of the heavens, and all the stars on the globe will be in such situations as exactly correspond to those in the heavens; which may therefore be easily found, as will be shewn in the sixteenth problem.

14. "To find the hour when any known star will rise, or come upon the meredian." Rectify the globe, and set the index to XII; then turn the globe till the star comes to the horizon or meridian, and the index will show the hour required.

15. "To find at what time of the year any given star will be on the meridian at XII at night." Bring the star to the meridian, and observe what degree of the ecliptic is on the north meridian under the horizon; then find in the calendar on the horizon the day of the year against that degree, and it will be the day required.

16. "To find any particular star."—First find its altitude in the heavens by a quadrant, and the point of the compass it bears on; then, the globe being rectified, and the index turned to the given hour, if the quadrant of altitude be fixed on the zenith, and laid towards the point of the compass on which the star was observed, the star required will be found at the same degree of altitude on the said quadrant, as it was by observation in the heavens.

The invention of globes is of great antiquity. Some allusions to the celestial globe may be found as early as Hipparchus's time, in the writings of Pliny and

Ptolemy. Strabo makes mention of the terrestrial globe; and a contemporary of his, Propertius, refers directly to depicted worlds; and Claudius, who describes Archimedes's glass sphere, evinces great knowledge of the constructions of an orrery, spheres, &c. that then existed among mathematicians.

Among the improvers and makers of globes may be subsequently ranked the following as chief: Tycho Brahe, Regiomontanus, Schonerus, Gemma Fricius, Gr. Mercator, J. Hondius, Johnsonius, Wm. Saunderson, Wm. Bleau, &c; some of whom wrote learnedly on their uses: but, in this respect, the preference is certainly due to our countryman, Mr. Robert Hues, whose Latin treatise was afterwards published by Handinus, and then by Pontanus, with figures and notes. This work was afterwads translated into English by J. Chilmead, in the year 1639.

No globes had any pretensions to accuracy, taste, or elegance, till the time of Mr John Senex, F. R. S.; who, about the year 1739, delineated and engraved sets of plates for globes of nine, twelve, seventeen, and twenty-eight inches in diameter, which he used with the globes then manufactured by himself, and making these instruments more accurate and useful than any former maker. The terms and names of places on the globes of seventeen and twenty-eight inches in diameter were in Latin.

About the year 1759, and just after the decease of Mr. Senex, Mr. Benjamin Martin, a learned optician, became possessed of Mr. Senex's plates, and continued for many years to manufacture the globes, but with additional skill, and with various improvements.

About the year 1765, the late Mr. George Adams caused new plates for eighteen and twelve inches globes to be engraved. The terms and names of these, like the larger ones of Senex, were printed in Latin. Instead of horary circles fixed on the meridian, with moveable indices for computation of time, Mr. Adams contrived circular wires, to envelop the globe about the equinoctial circles, with sliding brass points; so that, as the globes were revolved on their axes, the time by these was pointed out on the graduations of the above great circle; which consequently gave a more extensive and conspicuous scale of time, than could be had by means of the smaller horary circles. He also applied to each globe a semi-circular slip of brass, connected at the poles, having on the terrestrial a sliding compass bearing circle; and on the celestial a small sliding sun. The brass slips were graduated each way from the equinoctial, so that the positions for rhomb-lines, right ascensions, and declinations, could be better and more readily obtained.

The horary, or hour circle of the globes being usually attached to the external edge of the meridians, prevented a free and uninterrupted motion of the meridians, with their poles through the horizons of the globes, to admit of an universal position of the axis with respect to the horizon, for all latitudes of places. Mr. James Harris, of the Mint, in the year 1740, contrived a method of fixing the brass horary circles at the poles, under the meridians; *i. e.* between the surface of the globes and interior edge of the meridian, and to be occasionally moveable, independent either of the globe or meridian. In this manner the globes were rendered completely useful for the solution of problems in all latitudes.

About the year 1785, Mr. G. Wright contrived a moveable index, applicable to the poles of a globe, to act in a similar manner to the circle of Mr. Harris, which pointed to a circle of hours engraved round the poles of each globe. This he considered a method of obviating the great friction, or adherence, that sometimes inconveniently takes place between the surfaces of the circle and globe.

From the lapse of years, the numerous astronomical and geographical discoveries, and the Latin terms adopted in the larger globes of Senex and Adams, these globes became inconvenient, embarrassing, and finally obsolete. A short time before the year 1800, sets of new and accurately engraved plates were suggested, and considered as a desideratum in astronomy, by the Astronomer Royal, Dr. Maskelyne, Sir Joseph Banks, Professor Vince, and others; and conformably to this object, in the year 1800 were completed and produced a set of entirely new plates for globes of eighteen inches in diameter, and under the denomination of the "New British Globes." The graduations and lines are laid down in the most correct manner, and with much greater accuracy than in any former globe plates. The drawing from which the terrestial is engraved was an entirely new one, from the hands of Mr. Arrowsmith, an eminent geographer. The latitudes and longitudes of places are rectified from the latest and best authorities; and there are likewise inserted all the authentic discoveries to the present time. The celestial globe contains a description of a complete catalogue of stars, clusters, planetary, nebula, &c. to the amount of nearly 6,000, from the observations and communications of Dr. Maskelyne, Dr. Herschel, Rev. Mr. Wollaston, &c., and inserted from calculations made by Mr. W. Jones, optician of Holborn, in their exact positions, to the present period. To the prinicipal stars are annexed Bayer's Greek letters of reference; and the whole are circumscribed by well-designed figures of the constellations, faintly engraved.

The great circles are divided into twenty minutes of a degree, and the equinoctial in addition into two minutes of time, so that, by estimation, the solution of problems may be obtained to five minutes of a degree, or half a minute of time; a degree of accuracy sufficiently useful, not only for all the common problems, but most of the trigonometrical ones.

As the reading off of time is found to be a ready and convenient method by hour circles attached to the meridians, the horary circle has been contrived to admit of being slid away from its pole, upon the exterior edge of the meridian; this is done by making the extremity of the pole which carries the index of the horary circle moveable, by unscrewing. The horary circle being attached to the meridian barely by springs, when the index is unscrewed, the circle may consequently be slid to any part of the meridian. This contrivance is necessary only for the circle of the north pole of Messrs. W. and S. Jones's terrestrial globe, who have adopted this circle, and at the south pole of the globes have applied the interior brass index, or circles above mentioned.

Plates for the British globes of twelve inches diameter have been reduced and abridged, from the eighteen inches above mentioned. Plates for globes of nine, twelve, and twenty-one inches diameter, have been engraved by Mr. Cary, of the Strand. The stars of the celestial globe are not circumscribed with the figures of the constellations.

GLOBULAR *chart*, a name given to the representation of the surface, or of some part of the surface of the terrestrial globe upon a plane, wherein the parallels of latitude are circles nearly concentric, the meridian curves bending towards the poles, and the rhomb-lines are also curves.

GLOBULAR *sailing*. See SAILING.

GLOBULARIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Aggregatæ. Lysimachiæ, Jussieu. Essential character: calyx common, imbricate; proper tubular inferior; corollets the upper lip two-parted; lower three-parted; receptacle chaffy. There are eight species.

GLORIOSA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Sarmentaceæ Lilia, Jussieu. Essential character: corolla six-petalled, waved, reflex; style oblique. There are two species, *viz.* G. superba, superb lily, and G. simplex.

GLOSS, in matters of literature, denotes an exposition or explication of the text of any author, whether in the same language or any other; in which sense it differs little from commentary.

GLOSSOMA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rhamni, Jussieu. Essential character: calyx turbinate four-toothed, superior; corolla four-petalled; anthers almost united, with a membranaceous scale at the end; stigmas four, drupe. There is only one species, *viz.* G. guianensis, a native of Guiana, flowering in September. Votomita is the vernacular name.

GLOSSOPETALUM, in botany, a genus of the Pentandria Pentagynia class and order. Natural order of Rhamni, Jussieu. Essential character: calyx very small, five-toothed; petals five, with a strap at the tip of each berry. There are two species, both lofty trees, natives of Guiana and Cayenne.

GLOTTIS, in anatomy, the mouth or aperture of the larynx, through which the air ascends and descends in respiring. It can be dilated or contracted at pleasure, and by the various vibratory motions of which the tones of the voice are modified. The name was applied by the ancients to an additional moveable part of the flute, which they placed between their lips in performance, and which is supposed to have been similar to our reed.

GLOW *worm*. See LAMPYRIS.

GLOXINIA, in botany, so called in honour of Ben. Petr. Gloxin, of Colmar, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Campanulaceæ, Jussieu. Essential character: calyx superior, five-leaved; corolla bell-shaped, with the border oblique; filaments, with the rudiment of a fifth, inserted in the receptacle. There is only one species, *viz.* G. maculata, spotted gloxinia, a native of South America.

GLUCINA, in chemistry, an earth lately discovered by Vauquelin, while he was analyzing the beryl, to ascertain whether its constituent parts were the same as those of the emerald. See BERYL. In this experiment he found the glucina, which is so named from its sweetish kind of taste. Glucina in the form of powder, or in fragments, is almost three times as heavy as water; it is infusible in the fire; it does not contract, like alumina, by great heat, and it has no effect on vegetable colours. The oxygen, nitrogen, and hydrogen gases have no action on it; nor is it acted upon by carbon, sulphur, or phosphorus. It combines with sulphurated hydrogen. It is insoluble in water, but combines with acids, making with them soluble salts, distinguished by a sweet and slightly astringent taste.

GLUE, among artificers, a tenacious viscid matter, which serves as a cement to bind or connect things together. Glues are of different kinds, according to the various uses they are designed for, as the common glue, glove glue, parchment glue, isinglass glue, &c.

The common or strong glue is chiefly used by carpenters, joiners, cabinet-makers, &c. and the best kind is that made in England, in square pieces, of a ruddy brown colour, and next to this the Flanders glue. It is made of the skins of animals, as oxen, cows, calves, sheep, &c. and the older the creature is, the better is the glue made of its hide. Indeed, whole skins are but rarely used for this purpose, but only the shavings, parings, or scraps of them; or the feet, sinews, &c. That made of whole skins, however, is undoubtedly the best; as that made of sinews is the very worst.

In making glue of parings, they first steep them two or three days in water; then washing them well out, they boil them to the consistence of a thick jelly, which they pass, while hot, through ozier baskets, to separate the impurities from it, and then let stand some time, to purify it further: when all the filth and ordures are settled to the bottom of the vessel, they melt and boil it a second time. They next pour it into flat frames or moulds, whence it is taken out pretty hard and solid, and cut into square pieces or cakes. They afterwards dry it in the wind, in a sort of coarse net; and at last string it, to finish its drying. The glue made of sinews, feet, &c. is managed after the same manner; only with this difference, that they bone and scour the feet, and do not lay them to steep. The best glue is that which is oldest; and the surest way to try its goodness is, to lay a piece to steep three or four days, and if it swell considerably without melting, and when taken out resumes its former dryness, it is excellent. A glue that will hold against fire or water may be made thus: mix a handful of quick lime with four ounces of linseed oil, boil them to a good thickness, then spread it on tin plates in the shade, and it will become exceedingly hard, but may be dissolved over a fire, as glue, and will effect the business to admiration.

GLUE, *method of preparing and using.* Set a quart of water on the fire, then put in about half a pound of good glue, and boil them gently together till the glue be entirely dissolved, and of a due consistence. When glue is to be used, it must be made thoroughly hot; after which, with a brush dipped in it, besmear the faces of the joints as quick as possible; then clapping them together, slide or rub them lengthwise one upon another, two or three times, to settle them close; and so let them stand till they are dry and firm.

GLUE, *parchment*, is made by boiling gently shreds of parchment in water, in the proportion of one pound of the former to six quarts of the latter, till it be reduced to one quart. The fluid is then to be strained from the dregs, and afterwards boiled to the consistence of glue. Isinglass glue is made in the same way; but this is improved by dissolving the isinglass in alcohol, by means of a gentle heat. See CEMENTS.

GLUME. See BOTANY.

GLUTA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx bell-shaped, deciduous; petals five, glued at bottom to the column of the germ; filaments inserted into the tip of the column; germ sitting on an oblong column. There is only one species, *viz.* G. benghas, a native of Java.

GLUTEN. With the fecula and saccharine matter which compose the principal part of nutritive grain, is another substance, approaching more nearly in its characters to animal matter than any other product of the vegetable system. From the resemblance in its properties to the animal principle formerly called gluten, but now described under the term FIBRIN, (which see,) it has received the name of vegetable gluten. It is obtained in largest quantities from wheat, amounting to the twelfth part of the whole grain, by kneading the flower into paste, which is to be washed very cautiously, by kneading it under a jet of water, till the water carries off nothing more, but runs off colourless; what remains is gluten: it is ductile and elastic; it has some resemblance to animal tendon or membrane: it is very tenacious, and may be used as a cement for broken porcelain vessels. It has a peculiar smell, with scarcely any taste. When exposed to the air it assumes a brown colour, and becomes apparently covered with a coat of oil. When completely dry it resembles glue, and breaks like glass. It is insoluble in water, alcohol, and ether; but the acids dissolve it, and the alkalies precipitate it. It has a strong affinity for the colouring matter of vegetables, and likewise for resinous substances. When kept moist it ferments, and emits a very offensive smell; the vapour blackens silver and lead. Its constituent parts are oxygen, hydrogen, carbon, and azote. It exists, as we have observed, most abundantly in wheat, but it is found in large quantities in many other plants. It is gluten that renders wheat so useful in the art of bread making.

GLYCINE, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx two-lipped; corolla the keel turning back, the banner at the tip. There are twenty-five species. There are eleven species enumerated by Muhlenberg, as natives of the United States, and a twelfth was discovered by Dr. W. P. C. Barton, professor of botany in the University of Pennsylvania, *viz.* G. parabolica. It is described by him in his Prodromus Flora Philadelphica.

GLYCYRRHIZA, in botany, English *liquorice*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx two-lipped, upper-lip three-parted, lower undivided; legume ovate, compressed. There are four species. These are tall growing perennial, herbaceous plants, with the stalk somewhat woody at bottom. The stipules are distinct from the petiole; the flowers in a head or spike from the axils and at the ends of the branches; seed vessel a legume or pod, smooth, hairy, or prickly.

GLYPH, in sculpture and architecture, denotes any canal or cavity, used as an ornament.

GLYSTER, or CLYSTER, among physicians. See CLYSTER.

GMELINA, in botany, so called in honour of Joh. George Gmelin, professor of natural history at St. Petersburgh, afterwards of botany at Tubingen, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx slightly four-toothed; corolla four-cleft, bell-shaped; anthers two parted, two simple; drupe with a two or three-celled nut. There is but one species, *viz.* G. asiatica.

GNAPHALIUM, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, with the marginal scales rounded, scariose, coloured; down feathered; receptacle naked. There are sixty-six species: the numerous species of this genus are chiefly under shrubs or herbs; the leaves are alternately placed, generally hoary; the flowers usually terminate the stem and branches in globes or corymbs. The calyx is permanent, with yellow or white scales. There are nine American species.

GNAT. See CULEX.

GNEISS, in mineralogy, is composed principally of felspar, quartz, and mica, forming plates, laid on each other, and separated by thin layers of mica. It differs from granite by being shistose; though, like that, it sometimes contains shorl and garnet. The beds of gneiss sometimes alternate with layers of granular limestones, shistose, hornblende, and porphyry. It is rich in ores, almost every metal has been found in gneiss rocks, either in veins or beds. Mr. Jameson mentions four kinds of gneiss: 1. That which approaches to the granular structure. 2. The waved or undulated. 3. The common; and, 4. The thin slaty; and he says the order of their transition is also that of their relative antiquity, consequently the more granular the structure, the older the rock; and, on the contrary, the more slaty, the newer it is. In the last member of the series is the smallest portian of felspar, and largest of mica; hence its texture is more completely slaty than that of any of the others. The other extremity contains much felspar, and but little mica. The common contains a nearly equal quantity of felspar and quartz.

GNETUM, in botany, a genus of the Monoecia Monadelphia class and order. Natural order of Piperitæ. Urticæ, Jussieu. Essential character: male an ament with scales; corolla none; filaments one, with two anthers: female an ament with scales; corolla none; style with a bifid stigma; drupe with one seed. There is only one species, *viz.* G. gnemon, a native of the East Indies, where the leaves, male catkins and fruits, are eaten.

GNIDIA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Veprecülæ. Thymeleæ, Jussieu. Essential character: calyx funnel-form, four-cleft; petals four, inserted into the calyx; seed one, somewhat berried. There are eleven species.

GNOMON, in dialing, the style, pin, or cock of a dial; which, by its shadow, shows the hour of the day. The gnomon of every dial represents the axis of the world. See DIAL and DIALING.

GNOMON, in geometry. If, in a parallelogram (Pl. VI. Miscel. fig. 1.) the diameter A C, be drawn; also two lines, E F, H I, parallel to the sides of the parallelogram, and cutting the diameter in one and the same point, G, so that the parallelogram is, by these parallels, divided into four parallelograms, then are the two parallelograms, D G, B G, through which the diameter does not pass, called complements; those through which the diameters pass, E H, F I, are called the parallelograms about the diameter; and a gnomon consists of the two complements, and either of the parallelograms about the diameter, *viz.* G D + H E + E I, or G D + F I + G B.

GNOMON, in astronomy, a stile erected perpendicular to the horizon, in order to find the altitude of the sun. Thus in the right angled triangled A B C, fig. 2, are given A B, the length of the stile, B C, the length of its shadow, and the right angle, A B C. Hence, making C B, the radius, we have this analogy for finding the angle, A C B, the sun's altitude, *viz.* B C : A B : : radius : tangent of the angle C.

By means of a gnomon, the sun's meridian altitude, and consequently the latitude of the place, may be found more exactly than with the smaller quadrants.

By the same instrument, the height of any object, G H, may be found; for as D F, fig. 3, the distance of the observer's eye from the gnomon is to D E, the height of the stile, so is F H, the distance of the observer's eye from the object, to G H, its height.

the Gnomon may be made useful in taking the meridian altitude of the sun, and thence finding the latitude of the place. Having a meridian line drawn through the centre of the gnomon, mark the point where the shadow of the gnomon terminates when projected along the meridian line, and measure the distance of that point from the centre of the gnomon, which will be the length of its shadow; then, having the height of the gnomon, and the length of the shadow, the sun's altitude is easily found. Thus, if A B be the gnomon, and A C the length of the shadow, then in the right angled triangle, A B C, we have A B and B C given; hence the angle C is easily found, for C B : B A : : radius : tangent of the angle C; that is, as the length of the shadow is to the height of the gnomon, so is radius to the tangent of the sun's altitude above the horizon. *Ex.* We learn from Pliny, at the time of the equinoxes, that the shadow was to the gnomon as 8 : 9, therefore we say as $8 : 9 :: R : \frac{9}{8} = 1.125$, the tangent of an angle of 48° 22′, which is the height of the equator at Rome, and its complement 41° 38′ is therefore the height of the pole, or the latitude of the place. This method, however, requires correction for the sun's parallax, and for refraction.

GNOMONICS, the art of DIALING, which see. From the shadow of a rod, perpendicularly or obliquely placed on a plane, may be determined a triangle, by drawing from the top of the rod a line that shall touch the luminous body, forming with the rod the least possible angle. The sides of the triangle will be, first, the part of this line comprehended between the top of the rod and the given plane; then the rod itself; and lastly, the line drawn from the bottom of the rod till it meets the other line already mentioned. This last line will be the shadow relatively to the given plane: it will increase and decrease in proportion as the sine of the angle, whose summit coincides with the summit of the rod, shall be greater or less, that is, in proportion as the luminous body shall descend or ascend with respect to the given plane; and if that body move to the right or the left of the position first occupied by the triangle, that determines the shadow, which will move on the plane in a contrary direction; and on these principles the art of dialing consists.

GNOSTICS, in church history, a sect of Christians, so called from their pretensions to be more enlightened than others, and from their affecting to be able to bring back mankind to the knowledge of the true God. The opinions held by these people have not been completely ascertained; they were fond of speculation, and like many of the gnostics of modern times, held public worship and positive institutions in little esteem.

GOAL, or Gaol. See Gaol.

GOAT, in zoology. See Capra. These animals require scarcely any thing to keep them. Their milk is esteemed the greatest nourisher of all liquids, women's milk excepted, and very comfortable to the stomach. The young kids also are very good for the table, and may be managed in all respects like lambs.

Goat's *beard*, in botany. See Tragopogon.

Goat-*sucker*. See Caprimulgus. These birds are regarded by the American Indians as very ominous. They believe that goat-suckers were not known in their country till the English had made depredation upon it, and that they are, in fact, the departed spirits of the murdered Indians. In Carolina the lower class of people look upon them as birds of ill omen, and are gloomy, and almost melancholy, if one alights on the house or near the door, and begins its call, which they will sometimes do even on the very threshold, imagining that it is a sure prognostic of the death of one of the family.

GOBIUS, the *goby*, in natural history, a genus of fishes of the order Thoracici. Generic character: head small; eyes approximated, with two punctures between them; gill membrane, four-rayed, ventral fins united into a funnel-like oval; dorsal fins two. There are twenty-five species, of which we shall notice the following. G. niger, or the black goby, is about six inches in length. It inhabits the Mediterranean and North Seas, and often, in summer, when it deposits its spawn, enters the mouths of rivers for that purpose. It is eaten, but not highly valued. The ventral fins unite into a species of funnel, by which this fish is said often to attach itself almost inseparably to stones and rocks. It lies chiefly under stones; and its food consists of worms, insects, and the young of small fishes. For another species, the lanceolated goby, see Pisces, Plate IV. fig. 4.

GOD, *Deus*, the Supreme Being, the first cause or creator of the universe, and the only true object of religious worship, The Hebrews called him Jehovah; which name they never pronounced, but used instead of it the words Adonai, or Elohim.

God, says Sir Isaac Newton, is a relative term, and has respect to servants. It denotes, indeed, an eternal, infinite, absolutely perfect being: but such a being, without dominion, would not be God. The word God, frequently signifies lord, but every lord is not God. The dominion of a spiritual being, or lord, constitutes God; true dominion, true God. From such true dominion it follows, that the true God is living, intelligent, and powerful; and from his other perfections, that he is supreme, or supremely perfect. He is eternal and infinite; omnipotent and omniscient; that is, he endures from eternity to eternity, and is present from infinity to infinity He governs all things that exist, and knows all things that are to be known. He is not eternity or infinity, but eternal and infinite. He is not duration and space, but he endures and is present; he endures always, and is present every where; and by existing always and every where, constitutes the very things we call duration and space, eternity and infinity. He is omnipresent, not only virtually, but substantially; for power without substance cannot subsist. All things are contained and move in him, but without any mutual passion; that is, he suffers nothing from the motions of bodies, nor do they undergo any resistance from his omnipresence.

It is confessed, that God exists necessarily; and by the same necessity he exists always and every where. Hence also he must be perfectly similar; all eye, all ear, all brain, all arm, all perception, intelligence, and action; but after a manner not at all corporeal, not at all like men; after a manner altogether unknown to us. He is destitute of all body and bodily shape, and therefore cannot be seen, heard, or touched; nor ought to be worshipped under the representation of any thing corporeal. We know him only by his properties, or attributes, by the most wise and excellent structure of things, and by final causes; but we adore and worship him only on account of his dominion: for God, setting aside dominion, providence, and final causes, is nothing but fate and nature.

The plain argument, says Mr. Maclaurin, for the existence of the deity, obvious to all, and carrying irresistible conviction with it, is from the evident contrivance and fitness of things for one another, which we meet with throughout all parts of the universe. There is no need of nice or subtle reasonings in this matter; a manifest contrivance immediately suggests a contriver. It strikes us like a sensation, and artful reasonings against it may puzzle us, but without shaking our belief. No person, for example, that knows the principles of optics and the structure of the eye, can believe that it was formed without skill in that science, or that the ear was formed without the knowledge of sounds, or that the male and female, in animals, were not formed for each other, and for continuing the species. All our accounts of nature are full of instances of this kind. The admirable and beautiful structure of things for final causes exalt our idea of the contriver: the unity of design shows him to be one. The great motions in the system, performed with the same facility as the least, suggest his almighty power, which gave motion to the earth and the celestial bodies with equal ease as to the minutest particles. The subtility of the motions and actions in the internal parts of bodies, shows that his influence penetrates the inmost recesses of things, and that he is equally active and present every where. The simplicity of the laws that prevail in the world, the excellent disposition of things in order to obtain the best ends, and the beauty which adorns the works of nature, far superior to any thing in art, suggest his consummate wisdom. The usefulness of the whole scheme, so well contrived for the intelligent beings that enjoy it, with the internal disposition and moral structure of those beings themselves, show his unbounded goodness. These are the arguments which are sufficiently open to the views and capacities of the unlearned; while, at the same time, they acquire new strength and lustre from the discoveries of the learned.

The Deity's acting and interposing in the universe show that he governs, as well as formed it; and the depth of his counsels, even in conducting the material universe, of which a great part surpasses our knowledge, keep up an inward veneration and awe of this great being, and dispose us to receive what may be otherwise revealed to us concerning him. It has been justly observed, that some of the laws of nature, now known to us, must have escaped us, if we had wanted the sense of seeing. It may be in his power to bestow upon us other senses, of which we have at present no idea; without which it may be impossible for us to know all his works, or to have more adequate ideas of himself. In our present state we know enough to be satisfied of our dependency upon him, and of the duty we owe to him, the Lord and Disposer of all things. He is not the object of sense; his essence, and, indeed, that of all other substances, is beyond the reach of all our discoveries; but his attributes clearly appear in his admirable works. We know that the highest conceptions we are able to form of them are still beneath his real perfections; but his power and dominion over us, and our duty towards him, are manifest.

"Though God has given us no innate ideas of himself," says Mr. Locke, "yet, having furnished us with those faculties our minds are endowed with, he hath not left himself without a witness; since we have sense, perception, and reason, and cannot want a clear proof of him as long as we carry ourselves about us. To show, therefore, that we are capable of knowing, that is, being certain, that there is a God, and how we may come by this certainty, I think we need go no farther than ourselves, and that undoubted knowledge we have of our own existence. I think it is beyond question, that man has a clear perception of his own being; he knows certainly that he exists, and that he is something. In the next place, man knows, by an intuitive certainty, that bare nothing can no more produce any real being than it can be equal to two right angles. If, therefore, we know there is some real being, it is an evident demonstration, that from eternity there has been something: since what was not from eternity had a beginning, and what had a beginning must be produced by something else. Next, it is evident, that what has its being from another, must also have all that which is in and belongs to its being from another too: all the powers it has must be owing to and received from the same source. This eternal source, then, of all beings must be also the source and original of all power; and so this eternal being must be also the most powerful.

"Again, man finds in himself perception and knowledge: we are certain then that there is not only some being, but some knowing intelligent being, in the world. There was a time, then, when there was no knowing being, or else there has been a knowing being from eternity. If it be said, there was a time when that eternal being had no knowledge; I reply, that then it is impossible there should have ever been any knowledge; it being as impossible that things wholly void of knowledge, and operating blindly, and without any perception, should produce a knowing being, as it is impossible that a triangle should make itself three angles greater than two right ones. Thus, from the consideration of ourselves, and what we infallibly find in our own constitutions, our reason leads us to the knowledge of this certain and evident truth, that there is an eternal, most powerful, and knowing Being, which whether any one will call God, it matters not. The thing is evident; and from this idea, duly considered, will easily be reduced all those other attributes we ought to ascribe to this eternal Being.

"From what has been said, it is plain to me, that we have a more certain knowledge of the existence of a God, than of any thing our senses have not immediately discovered to us. Nay, I presume I may say, that we more certainly know that there is a God, than that there is any thing else without us. When I say we know, I mean, there is such a knowledge within our reach, which we cannot miss, if we will but apply our minds to that as we do to several other inquiries.

"It being then unavoidable for all rational creatures to conclude that something has existed from eternity, let us next see what kind of a thing that must be. There are but two sorts of beings in the world, that man knows or conceives; such as are purely material, without sense or perception; and sensible perceiving beings, such as we find ourselves to be. These two sorts we shall call cogitative and incogitative beings; which, to our present purpose, are better than material and immaterial.

"If then there must be something eternal, it is very obvious to reason that it must necessarily be a cogitative being; because it is as impossible to conceive that bare incogitative matter should ever produce a thinking intelligent being, as that nothing of itself should produce matter. Let us suppose any parcel of matter eternal, we shall find it in itself unable to produce any thing. Let us suppose its parts firmly at rest together; if there were no other being in the world, must it not eternally remain so, a dead inactive lump? is it possible to conceive that it can add motion to itself, or produce any thing? Matter then, by its own strength, cannot produce in itself so much as motion. The motion it has must also be from eternity, or else added to matter by some other being more powerful than matter. But let us suppose motion eternal too; but yet matter, incogitative matter, and motion, could never produce thought. Knowledge will still be as far beyond the power of nothing to produce. Divide matter into as minute parts as you will, vary its figure and motion as much as you please, it will operate no otherwise upon other bodies of proportionable bulk, than it did before this division. The minutest particles of matter repel and resist one another just as the greater do, and that is all they can do; so that if we suppose nothing eternal, matter can never begin to be; if we suppose bare matter without motion eternal, motion can never begin to be; if we suppose only matter and motion eternal, thought can never begin to be; for it is impossible to conceive that matter, either with or without motion, could have, originally, in and from itself, sense, perception, and knowledge, as is evident from hence, that then sense, perception, and knowledge, must be a property eternally inseparable from matter, and every particle of it. Since, therefore, whatsoever is the first eternal being must necessarily be cogitative; and whatsoever is first of all things must necessarily contain in it, and actually have, at least, all the perfections that can ever after exist, it necessarily follows, that the first eternal being cannot be matter. If, therefore, it be evident that something must necessarily exist from eternity, it is also as evident, that that something must be a cogitative being. For it is as impossible that incogitative matter should produce a cogitative being, as that nothing, or the negation of all being, should produce a positive being or matter.

"This discovery of the necessary existence of an eternal mind sufficiently leads us to the knowledge of God; for it will hence follow, that all other knowing beings that have a beginning must depend on him, and have no other ways of knowledge or extent of power, than what he gives them; and therefore, if he made those, he made also the less excellent pieces of this universe, all inanimate bodies, whereby his omniscience, power, and providence, will be established; and from thence all his other attributes necessarily follow."

With respect to Christians, it need only be just mentioned, that they were very early divided in opinion as to the nature and essence of the Supreme Being; a great part worshipping three persons in the unity of the godhead, whilst others absolutely rejected a trinity of persons, and asserted the unity of the divine nature, both as to person and substance.

With respect to the theology of the

Pagans, it is thought by most learned men that they acknowledged but one God; and that the many different divinities worshipped by them were but attributes and actions of one and the same God. This may probably be true of the wiser Heathens; and, indeed, there are many strong and beautiful passages in Pagan authors, to prove that these acknowledged but one God. Thus Pythagoras taught the unity of God, and defined him to be a mind penetrating and diffusing itself through all the parts of the universe, from which all animals receive life; and Plato called God the being which is; and whenever he mentions the Deity, it is always in the singular number.

GOGGLES, in surgery, instruments used for the cure of squinting, or that distortion of the eyes which occasions this disorder. They are short conical tubes, composed of ivory stained black, with a thin plate of the same ivory fixed in the tubes; through the centre of the plates is a small circular hole, about the size of the pupil of the eye, for the transmission of the rays of light. These goggles must be worn regularly and constantly, till the muscles of the eye are brought to act properly and uniformly, so as to direct the pupil straight forward.

GOLD is a yellow metal, of much greater specific gravity than any other body in nature, except platina. It is soft, very tough, ductile, and malleable; unalterable and fixed, whether exposed to the atmosphere, or to the strongest heat of furnaces. The most powerful burning mirrors are said to have volatilized it; and it has been driven up in fumes, in the metallic state, by flame urged upon it by a stream of oxygen gas. The electric shock converts it into a purple oxide, as may be seen by transmitting that commotion through gold leaf between two plates of glass; or by causing the explosive spark of three or more square feet of coated glass to fall upon a gilded surface. A strong heat is required to melt it, which does not happen till after ignition. Its colour, when melted, is of a bluish green; and the same colour is exhibited by light transmitted through gold-leaf.

The limits of the ductility and malleability of gold are not known, and its tenacity exceeds that of any other metal. A gold wire of one tenth of an inch diameter requires 500lb. weight to break it.

The method of extending gold, used by the gold-beaters, consists in hammering a number of thin-rolled plates between skins or animal membranes. By the weight and measure of the best wrought gold leaf, it is found, that one grain is made to cover 56¾ square inches; and from the specific gravity of the metal, together with this admeasurement, it follows, that the leaf itself is $\frac{1}{282000}$ parts of an inch thick. This, however, is not the limit of the malleability of gold; for the gold-beaters find it necessary to add three grains of copper in the ounce to harden the gold, which otherwise would pass round the irregularities of the newest skins, and not over them; and in using the old skins, which are not so perfect and smooth, they proceed so far as to add twelve grains. The wire which is used by the lace-makers is drawn from an ingot of silver, previously gilded. In this way, from the known diameter of the wire, or breadth when flattened, and its length, together with the quantity of gold used, it is found, by computation, that the covering of gold is only one-twelfth part of the thickness of gold-leaf, though it still is so perfect as to exhibit no cracks when viewed by a microscope.

No acid acts readily upon gold but the nitro-muriatic acid, called aqua-regia, and the oxygenized-muriatic acid. The sulphuric acid, distilled from manganese, has some action upon it: as have likewise the pale nitric acid, and the phosporic acid when boiling. Chromic acid added to the muriatic enables it to dissolve gold.

The small degree of concentration of which the oxygenized-muriatic acid is susceptible, and the imperfect action of the latter acids, render aqua-regia the most convenient solvent for this metal.

When gold is immersed in aqua-regia, an effervescence takes place with the escape of gas; the solution tinges animal matters of a deep purple, and corrodes them. By careful evaporation, fine crystals of a topaz colour are obtained. The gold is precipitated from its solvent by a great number of substances. Lime and magnesia precipitate it in the form of a yellowish powder. Alkalies exhibit the same appearance; but an excess of alkali redissolves the precipitate. The precipitate of gold obtained from aqua-regia by the addition of a fixed alkali appears to be a true oxide, and is soluble in the sulphuric, nitric, and muriatic acids; from which, however, it separates by standing, or by evaporation of the acids. Gallic acid precipitates gold of a reddish colour, very soluble in the nitric acid, to which it communicates a fine blue colour.

Ammonia precipitates the solution of gold much more readily than fixed alkalies. This precipitate, which is of a brown, yellow, or orange colour, possesses the property of detonating with a very considerable noise, when gently heated. It is known by the name of fulminating gold. The presence of ammonia is necessary to give the fulminating property to the precipitate of gold; and it will be produced by precipitating it with fixed alkali from an aqua-regia previously made, by adding sal ammoniac to nitric acid; or by precipitating the gold from pure aqua-regia, by means of sal ammonia, instead of the ammonia alone. The fulminating gold weighs one-fourth more than the gold made use of. A considerable degree of precaution is necessary in preparing this substance. It ought not to be dried but in the open air, at a distance from a fire, because a very gentle heat may cause it to explode. Several fatal accidents have arisen from its explosion, in consequence of the friction of ground stoppers in bottles containing this substance, of which a small portion remained in the neck.

Fulminating gold, when exposed by Berthollet to a very gentle heat in a copper tube, with the pneumatical apparatus of mercury, was deprived of its fulminating quality, and converted into an oxide, at the same time that ammoniacal gas was disengaged. From this dangerous experiment it is ascertained, that fulminating gold consists of oxide of gold combined with ammonia. The same eminent philosopher caused fulminating gold to explode in copper vessels. Nitrogen gas was disengaged, a few drops of water appeared, and the gold was reduced to the metallic form. In this experiment he infers, that the ammonia was decomposed; that the nitrogen, suddenly assuming the elastic state, caused the explosion, while the oxygen of the oxide united with the hydrogen of the alkali, and formed the water.

This satisfactory theory was still farther confirmed by the decomposition of fulminating gold, which takes place in consequence of the action of the concentrated sulphuric acid, of melted sulphur, fat oils, and ether; all of which deprived it of its fulminating quality, by combining with its ammonia.

Sulphurets precipitate gold from its solvent, the alkali uniting with the acid, and the gold falling down combined with the sulphur; of which, however, it may be deprived by moderate heat.

Most metallic substances precipitate gold from aqua-regia: lead, iron, and silver, precipitate it of a deep and dull purple colour; copper and iron throw it down in its metallic state; bismuth, zinc, and mercury, likewise precipitate it. A plate of tin, immersed in a solution of gold, affords a purple powder, called the purple powder of Cassius, which is used to paint in enamel. There are various methods of managing this process. That described by Macquer consists in dissolving tin by very small portions at a time, without heat, in an aqua-regia composed of two parts of nitric and one of muriatic acid, previously weakened with water equal in weight to both the acids. The first small portion of tin must be suffered to be entirely dissolved before a second is added. This addition must be continued till the acid has acquired a yellow colour, and scarcely acts at all upon the tin last added.

On the other hand, the purest gold must be dissolved in an aqua-regia composed of three parts of nitric and one of muriatic acid. This solution may be made, as expeditiously as the operator chooses, by the assistance of the heat of a sand bath.

The solution of tin must then be largely diluted, as, for example, with one hundred parts of distilled water; and a small quantity of this may then be assayed, by separating it in two parts, and diluting one of the parts still farther. Upon trial of both, by letting fall a drop of the solution of gold into each, it will be seen which affords the most beautiful purple precipitate. The whole of the solution of tin must accordingly be altered, if necessary, by adding more water. Pour into this solution, in a large glass or earthen vessel, nearly half as much of the solution of gold as it contains of solution of tin, stirring the mixture with a glass stick. In a short time the liquor will become of a beautiful red colour, which will gradually disappear on the subsidence of the precipitate. By adding a small quantity of the solution of tin, it will be seen whether the whole of the gold is precipitated. The clear liqour must then be decanted, and the precipitate washed. It consists of metallic gold and oxide of tin, at a maximum in combination, and is the only known substance which has the property of communicating a purple colour to glass. This purple powder is perfectly soluble in ammonia. Nitric acid boiled on it brightens it to a tint approaching that of cinnabar.

The difficulties attending the preparation of this article appear to depend on the state of the tin. If the solution of this metal be made with heat and rapidity, it becomes too much oxyded to adhere to the acid, or to precipitate the gold; and the combination of the two metals, which falls down, varies in colour according as this term is approached: these are the chief circumstances; but there is no doubt that a complete examination of the process would indicate others worthy of notice.

Ether, naphtha, and the essential oils, take gold from its solvent, and form liquors which have been called potable gold. The gold which is precipitated by evaporation of these fluids, or by the addition of sulphate of iron to the solution of gold, is of the utmost purity.

In the dry way, gold resists the action of neutral salts, more especially nitre, which deflagrates with the imperfect metals. Nitre, however, does not afford an expeditious way of purifying gold, because this metal in some measure protects and covers the alloys from its action. It is remarked that borax, used as a flux with gold, renders it paler; and that this alteration of colour disappears by the addition of nitre or commou salt. As the acid of borax forms a compound with gold, which falls to the bottom when this acid is added to the metal in solution, it is probable that the paleness produced by borax may arise from the combination of a small portion of its acid with the gold, which might be driven off by a continuance of the heat, and united by stronger affinity with the alkali of the nitre, or of the common salt, in proportion as their acids are dissipated by heat.

Earth and alkalies do not act on gold in the dry way. Sulphur, which combines with most metals, has no effect on this. A process, called dry-parting, is grounded on this property; and is more especially used in separating silver from gold, when the quantity of the latter metal is too small to answer the expense of dissolving the larger mass of silver in nitric acid. For this purpose the mixed metal is fused, and flowers of sulphur thrown on its surface. These combine with the silver in the form of a black scoria, while the gold remains at the bottom in its metallic state. The operation of dry-parting does not leave the gold in a state of purity; because the last portions of silver are defended from the action of the sulphur. But when the quantity of silver is thus diminished, the operation of parting with aqua-fortis, or nitric acid, may be advantageously used.

Sulphuret of potash dissolves gold in the dry way. Equal parts of sulphur and potash are hastily fused with one-fourth of a part of gold leaf. This combination is soluble in water, with which it forms a yellowish green solution. By the addition of an acid, the gold is thrown down in combination with the sulphur, of which it may be deprived by heat.

Most metals unite with gold by fusion. With silver it forms a compound, which is paler, in proportion to the quantity of silver added. It is remarkable that a certain proportion, for example, a fifth part, renders it greenish. From this circumstance, as well as from that of a considerable proportion of these metals separating from each other by fusion, in consequence of their different specific gravities, when their proportions do not greatly differ, it should seem that their union is little more than a mere mixture without combination; for, as gold-leaf transmits the green rays of light, it will easily follow that particles of silver, enveloped in particles of gold, will reflect a green instead of a white light.

A strong heat is necessary to combine platina with gold: it greatly alters the colour of the gold if its weight exceed the forty-seventh part of the mass. Mr. Francillon, however, informs us, that six parts of gold and one of malleable platina produce a metal of a beautiful colour, great malleability, susceptible of a fine polish, and more unalterable than gold itself. It does not much affect the ductility. The Spanish ministry has prohibited the exportation of platina from America, lest it should be used in adulterating gold; but this does not appear to be a danger which need be feared, as chemistry has long been in possession of several simple and expeditious methods of detecting this fraud, which besides is evident to the sight when the quantity of debasement is considerable. It may be questioned, likewise, whether the value of platina would not soon equal that of gold, if its properties and uses were better known in society. Gold made standard by platina, and hammered, is tolerably elastic.

Mercury is strongly disposed to unite with gold, in all proportions with which it forms an amalgam: this, like other amalgams, is softer, the larger the proportion of mercury. It softens and liquifies by heat, and crystallizes by cooling.

Lead unites with gold, and considerably impairs its ductility, one-fourth of a grain to an ounce rendering it completely brittle. Copper renders gold less ductile, harder, more fusible, and of a deeper colour. This is the usual addition in coin, and other articles used in society.—Tin renders it brittle in proportion to its quantity; but it is a common error of chemical writers, to say that the slightest addition is sufficient for this purpose.—When alloyed with tin, however, it will not bear a red heat. With iron it forms a grey mixture, which obeys the magnet. This metal is very hard, and is said to be much superior to steel for the fabrication of cutting instruments. Bismuth renders gold white and brittle; as do likewise nickel, manganese, arsenic, and antimony. Zinc produces the same effect; and, when equal in weight to the gold, a metal of a fine grain is produced, which is said to be well adapted to form the mirrors of reflecting telescopes, on account of the fine polish it is susceptible of, and its not being subject to tarnish. The alloys of gold with molybdena are not known. It could not be mixed with tungsten on account of the infusibility of this last substance. Mr. Hatchett gives the following order of different metals, arranged as they diminish the ductility of gold: bismuth, lead, antimony, arsenic, zinc, cobalt, manganese, nickel, tin, iron platina, copper, silver. The first three were nearly equal in effect; and the platina was not quite pure.

For the purpose of coin, Mr. Hatchett considers an alloy of equal parts of silver and copper as to be preferred, and copper alone is preferable to silver alone.

Gold is found mostly in the metallic state, though generally alloyed with silver, copper, iron, or all three. It is found either in separate lumps, or visible grains, among the sands of rivers, in many parts of Europe and elsewhere. The quantity is, for the most part, insufficient to pay the cost of separating it; but it is thought to be more universally diffused in sands and earths than any other metal, except iron. The greatest quantity of gold is imported into Europe from South America. Some is brought from the East Indian islands and China, and some from the coast of Africa. The principal gold mines in Europe are those of Hungary.—Some sands afford gold by simple washing; the heavy metallic particles subsiding soonest: but when it is bedded in earths, or stones, these substances are pounded, and boiled with one-tenth of their weight of mercury together with water. The mercury, after a certain time, absorbs the gold, and may be separated by pressure through leathern bags, and subsequent distillation. Or, otherwise, if the sand be heated red hot, and quenched in water several times, for the purpose of cracking and dividing it, and the whole be then melted into glass, with twice its weight of the oxide of lead, called litharge, and charcoal powder be then added, the lead will be revived in the metallic state, and will carry the gold along with it. By exposure to a proper degree of heat, with access of air, the lead may again be converted into litharge, and the gold will be left pure. This last operation is, in fact, a method of assaying sands which contain gold, rather than of obtaining it from them in the large way.

Gold is also found in certain martial pyrites in Sweden and elsewhere; from which it may be extracted by torrefaction, or burning of the sulphur, and subsequent digestion in aqua-regia.

To obtain gold in a state of purity, or to ascertain the quantity of alloy it may contain, it is exposed to a strong heat, together with lead, in a porous crucible. This operation is called cupellation.

After gold has passed the cupel, it may still contain either of the other perfect metals, platina or silver. The former is seldom suspected; the latter is separated by the operations called quartation and parting. For all these operations, see Assaying.

The quantity of alloy is never considered as part of the value of metals which contain either gold or silver. In estimating or expressing the fineness of gold, the whole mass spoken of is supposed to weigh 24 carats of 12 grains each, either real or merely proportional, like the assayer's weights; and the pure gold is called fine. Thus, if gold be said to be 23 carats fine, it is to be understood that, in a mass weighing 24 carats, the quantity of pure gold amounts to 23 carats.

In such small works as cannot be assayed by scraping off a part, and cupelling it, the assayers endeavour to ascertain its quality or fineness by the touch. This is a method of comparing the colour and other properties of a minute portion of the metal with those of certain small bars whose composition is known. These bars are called touch-needles; and they are rubbed upon the black basaltes, which, for that reason, is called the touch-stone. Black flint, or pottery, will serve the same purpose. Sets of golden needles may consist of pure gold; pure gold twenty-three and a half carats with half a carat silver; twenty-three carats gold with one carat silver; twenty-two and a half carats gold with one and a half carat silver, and so forth, till the silver amounts to four carats, after which the additions may proceed by whole carats. Other needles may be made in the same manner, with copper instead of silver; and other sets may have the addition, consisting either of equal parts of silver and copper, or such proportions as the occasions of business require.

In foreign countries, where trinkets and small works are required to be submitted to the assay of the touch, a variety of needles are necessary; but they are not much used in England. They afford, however, a degree of information, which is more considerable than might at first be expected. The attentive assayer not only compares the colour of the stroke made upon the touchstone by the metal under examination with that produced by his needle, but will likewise attend to the sensation of roughness, dryness, smoothness, or greasiness, which the texture of the rubbed metal excites when abraded by the stone. When two strokes, perfectly alike in colour, are made upon the stone, he may then wet them with aquafortis, which will affect them very differently if they be not similar compositions; or the stone itself may be made red hot by the fire, or by the blowpipe, if thin black pottery be used, in which case the phenomena of oxydation will differ according to the nature and quantity of the alloy.

Gold ores may be assayed in the moist way by pounding them very fine, weighing a determinate portion, and attempting their solution in nitric acid, which will dissolve the matrix if it consist of calcareous earth; or if it be sulphate of lime, the powder may be digested in aqua-regia as long as any metallic substance is taken up; after which the gold may be precipitated by an addition of sulphate of iron, which will cause it to fall down in the metallic state.

The principal use of gold is as the medium of exchange in coin, for which it has been chosen to occupy the first place, on account of its scarcity, its great weight, and its not being subject to tarnish. The gold coins of Great Britain contain eleven parts of gold and one of copper. See Coin.

Gold is likewise used in gilding. See Gilding.

The other uses of gold, in laces, &c. are sufficiently known.

Gold *beating*. See Gold.

Gold *wire*, a cylindrical ingot of silver, superficially gilt, or covered with gold at the fire, and afterwards drawn successively through a great number of little round holes of a wire-drawing iron, each less than the other, till it be sometimes no bigger than a hair of the head. It may be observed, that before the wire be reduced to this excessive fineness, it is drawn through above an hundred and forty different holes, and that each time they draw it, it is rubbed afresh over with new wax, both to facilitate its passage, and to prevent the silver's appearing through it.

Gold *wire flatted*, is the former wire flatted between two rollers of polished steel, to fit it to be spun on a stick, or to be used flat, as it is, without spinning, in certain stuffs, laces, embroideries, &c.

Gold *thread*, or *spun gold*, is a flatted gold, wrapped or laid over a thread of silk, by twisting it with a wheel and iron bobbins.

Manner of forming gold wire and gold thread, both round and flat. First, an ingot of silver, of 24 pounds, is forged into a cylinder of about an inch in diameter: then it is drawn through eight or ten holes, of a large, coarse, wire-drawing iron, both to finish the roundness, and to reduce it to about three-fourths of its former diameter. This done, they file it very carefully all over, to take off any filth remaining on the forge; then they cut it in the middle; and thus make two equal ingots thereof, each about 26 inches long, which they draw through several new holes, to take off any inequalities the file may have left, and to render it as smooth and equable as possible.

The ingot thus far prepared, they heat it in a charcoal fire; then taking some gold leaves, each about four inches square, and weighing twelve grains, they join four, eight, twelve, or sixteen of these, as the wire is intended to be more or less gilt, and when they are so joined as only to form a single leaf, they rub the ingots reeking hot with a burnisher. These leaves, being thus prepared, they apply over the whole surface of the ingot, to the number of six, over each other, burnishing or rubbing them well down. When gilt, the ingots are laid anew in a coal fire; and when raised to a certain degree of heat, they go over them a second time, both to solder the gold more perfectly, and to finish the polishing. The gilding finished, it remains to draw the ingot into wire.

In order to this, they pass it through 20 holes of a moderate drawing-iron, by which it is brought to the thickness of the tag of a lace: from this time the ingot loses its name, and commences gold wire. Twenty holes more of a lesser iron leaves it small enough for the least iron; the finest holes of which last scarcely exceeding the hair of the head, finish the work.

To dispose the wire to be spun on silk, they pass it between two rollers of a little mill: these rollers are of nicely polished steel, and about three inches in diameter. They are set very close to each other, and turned by means of a handle fastened to one of them, which gives motion to the other. The gold wire, in passing between the two, is rendered quite flat, but without losing any thing of its gilding, and is rendered so exceedingly thin and flexible, that it is easily spun on silk thread, by means of a hand wheel, and so wound on a spool or bobin.

GOLDFINCH. See FRINGILLA.

GOLD *size*. See SIZE.

GOLDSMITH, or as some choose to express it, *silver-smith*, an artist who makes vessels, utensils, and ornaments in gold and silver.

The goldsmith's work is either performed in the mould, or beat out with the hammer, or other engine. All works that have raised figures are cast in a mould, and afterwards polished and finished: plates, or dishes, of silver or gold are beat out from thin flat plates; and tankards, and other vessels of that kind, are formed of plates soldered together, and their mouldings are beat, not cast. The business of the goldsmiths formerly required much more labour than it does at present; for they were obliged to hammer the metal from the ingot to the thinness they wanted: but there are now invented flatting-mills, which reduce metals to the thinness that is required, at a very small expence. The goldsmith is to make his own moulds, and for that reason ought to be a good designer, and have a taste in sculpture: he also ought to know enough of metallurgy, to be able to assay mixed metals, and to mix the alloy. The goldsmiths in London employ several hands under them, for the various articles of their trade: such are, the jeweller, the snuff-box and toy-maker, the silver turner, the gilder, the burnisher, the chaser, the refiner, and the gold-beater.

GOLD, *mosaic*, that applied in pannels, on proper ground, distributed into squares, lozenges, and other compartments, part whereof is shadowed, to heighten or raise the rest.

GOLD, *shell*, that used by the illuminers to write gold letters. It is made with the parings of leaf-gold, and even of the leaves themselves, reduced into an impalpable powder, by grinding on a marble with honey. After leaving it to infuse some time in aqua-fortis, they put it in shells, where it sticks. To use it they dilute it with gum-water, or soap-water.

GOLD, *pure*, that purged by fire of all its impurities, and all alloy. The moderns frequently call it gold of 24 carats, but in reality there is no such thing as gold so very pure, and there is always wanting at least a quarter of a carat. Gold of 22 carats has one part of silver, and another of copper; that of 23 carats has half a part, *i. e.* half a twenty-fourth of each. See CARAT.

GOLDEN *number*, in chronology, a number shewing what year of the moon's cycle any given year is. See CHRONOLOGY.

The rule for finding the golden number is this; add one to the given year, and divide by 19, the quotient is 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: the golden number for $1809 = \frac{1809+1}{19} = 95$ for the number of cycles, and 5 the remainder will be the golden number: when there is no remainder the golden number is 19.

GOLDEN *rod*. See SOLIDAGO.

GOLDEN *rule*, in arithmetic, is also called the rule of three, and the rule of proportion. See PROPORTION, and RULE OF THREE.

GOMPHIA, in botany, a genus of the Decandria Monogynia class and order. Essential character: calyx five-leaved; corolla five petalled; berries two, on a large receptacle; seed solitary. There are three species.

GOMPHRENA, in botany, *globe amaranth*, a genus of the Pentandria Digynia class and order. Natural order of Amaranthi, Jussieu. Essential character: calyx coloured, outer three-leaved; leaflets two, converging, keeled; petals rude, villose; nectary cylindric, five-toothed; style cloven half way; capsule one-seeded. There are nine species.

GONATOCARPUS, in botany, a genus of the Tetrandria Monogynia class and order. Essential character; corolla four-cleft; drupe eight cornered, one-seeded. There is only one species; *viz.* G. micranthus.

GONDOLA, in naval architecture, a flat kind of boat, very long and narrow, chiefly used on the canals at Venice.

GONG, in music, an instrument used in China, is made of a metal composed of silver, lead, and copper, and its shape is a sort of circular concave. The tone is loud, harsh, and clanging. It is never introduced, except on occasion of giving a national cast to the music in which it is employed, or to awaken surprise, and rouse the attention of the company.

GENIOMETRY, a method of measuring angles with a pair of compasses, and that without any scale whatever, except an undivided semicircle. Thus, having any angle drawn upon paper to be measured, produce one of the sides of the angle backwards behind the angular point; then with a pair of fine compasses describe a pretty large semicircle from the angular point as a centre, cutting the sides of the proposed angle, which will intercept a part of the semicircle. Take then this intercepted part very exactly between the points of the compasses, and turn them successively over upon the arc of the semicircle, to find how often it is contained in it, after which there is commonly some remainder: then take this remainder in the compasses, and in like manner find how often it is contained in the last of the integral parts of the first arc, with again some remainder: find in like manner how often this last remainder is contained in the former; and so on continually, till the remainder become too small to be taken and applied as a measure. By this means is obtained a series of quotients, or fractional parts, one of another, which, being properly reduced into one fraction, give the ratio of the first arc to the semicircle, or of the proposed angle to two right angles, or 180 degrees, and consequently that angle itself in degrees and minutes. Thus, suppose the angle B A C (plate VI. Miscellany, fig. 4.) be proposed to be measured. Produce B A out towards *f*, and from the centre, A, describe the semicircle *a b e f*, in which *a b* is the measure of the proposed angle. Take *a b* in the compasses, and apply it four times on the semicircle, as at *b*, *c*, *d*, and *e*; then take the remainder *f e*, and apply it back upon *e d*, which is but once, *viz.* at *g*; again, take the remainder *g d*, and apply it five times on *g e*, as at *h*, *i*, *k*, *l*, and *m*; lastly, take the remainder *m e*, and it is contained just two times in *m l*. Hence the series of quotients is 4, 1, 5, 2; consequently the fourth, or last arc, *e m*, is $\frac{1}{2}$ the third, *m l* of *g d*; and therefore the third arc *g d*, is $\frac{1}{5\frac{1}{2}}$, or $\frac{2}{11}$ths of the second arc, *e f*; and therefore, again, this second arc, *e f*, is $\frac{1}{1\frac{2}{11}}$, or $\frac{11}{13}$ of the first arc, *a b*; and consequently this first arc, *a b*, is $\frac{1}{4\frac{11}{13}}$, or $\frac{13}{36}$ds of the whole semicircle *a f*. But $\frac{13}{63}$ds of 180° are $37\frac{1}{7}$°, or 37° 8′ $34\frac{2}{7}$″, which therefore is the measure of the angle sought.

GONIUM, in natural history, a genus of the Vermes Infusoria. Worm very simple, flat, angular, invisible to the naked eye. There are five species, of which G. pectorale is quadrangular, pellucid, with sixteen spherical molecules. It is found in pure water: molecules oval, nearly equal in size, set in a quadrangular membrane, like diamonds in a ring, the lower ones larger than the rest.

GONORRHŒA. See MEDICINE.

GOODENIA, in botany, so called in honour of the Rev. Samuel Goodenough, F. R. S. a genus of the Pentandria Monogynia class and order. Natural order of Campanulaceæ, Jussieu. Essential character: corolla longitudinally cloven on the upper side, exposing the organs of fructification; border five-cleft, leaning one way; anther linear; stigma cup-shaped, ciliated; capsule two-celled, two-valved, with a parallel partition; seeds many, imbricated. There are nine species. These plants are all natives of New South Wales, about Port Jackson.

GOOD *behaviour*, in law. Surety for good behaviour, is the bail for any person's good conduct for a certain time; as surety for the peace is a recognizance taken by a competent judge of record for keeping the King's peace.

Justices of the peace may also bind persons of evil fame to their good behaviour, &c. 34 Edward III. c. 1. This statute being penned in such general words, seems to empower justices, not only to bind over those who seem to be notoriously troublesome, and likely to break the peace, as eves-droppers, &c. but also those who are publicly scandalous, or contumers of justice, &c. as haunters of bawdy houses, or keepers of lewd-women in their own houses, common drunkards, or those who sleep in the day, and go abroad in the night, or such as keep suspicious company, or such are generally suspected as robbers, such as speak contemptuous words of inferior magistrates, as justices of the peace, mayors, &c. not being in the actual execution of their offices; or of inferior officers of justice, as constables, &c. being in the actual execution of their office; but it seems that rash, quarrelsome, or unmannerly words, spoken by one private person to another, unless they directly tend to a breach of the peace, are not sufficient cause to bind a man to his good behaviour.

GOOGINGS, in naval affairs, certain clamps of iron or other metal, bolted on the stern post, on which to hang the rudder; for this purpose there is a hole in each of them to receive a correspondent spindle, bolted on the back of the rudder, which turns thereby as on hinges. There are several googings on a ship's posts and rudder, according to her size, and on these the rudder is supported and traverses.

GOOLE, in law books, signifies a breach in a sea-bank, or wall.

GOOSE. See ANAS.

GOOSE *berry*. See RIBES.

GOOSE *neck*, in a ship, a piece of iron fixed on the end of the tiller, to which the laniard of the whip-staff, or the wheel rope, comes, for steering the ship.

GOOSE *wing*, in the sea language. When a ship sails before, or with a quarter wind on a fresh gale, to make the more haste, they launch out a boom, and sail on the lee-side; and a sail so fitted is called a goose-wing.

GORDIUS, in natural history, *hair-worm*, a genus of the Vermes Intestina class and order. Body round, filiform, equal, smooth. There are five species. G. aquaticus is from four to six inches long, of a pale brown colour, bnt darker at the extremities: it is found in stagnant waters, and twists itself into various contortions and knots, and it is said that, if it is handled without caution, it will inflict a bite that occasions the whitlow. A worm analagous to this species is often found in many parts of the United States, and from its great resemblance to a hair plucked from the tail of a horse, many ignorant persons have entertained the absurd notion of its being no other than a horse hair, reorganized and animated into a complete and separate animal. G filum is found in the bark of old wooden water-pipes. G. lacteus is white and opaque; found in stagnant waters; when touched it contracts itself in a moment, and afterwards expands as suddenly.

GORDONIA, in botany, *loblolly bay*, so called from Mr. James Gordon, an eminent nursery man, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx five-leaved; petals five, united at the base by means of the nectary; filament inserted into the nectary; capsule superior, five-celled; seeds winged. There are three species. There are two American species.

GORE, in heraldry, one of the abatements, which, according to Guillim, denotes a coward. It is a figure consisting of two arch lines drawn one from the sinister chief, and the other from the sinister base, both meeting in an acute angle in the middle of the fess point.

GOREING, in the sea-language, sloping. A sail is cut goreing, when it is cut sloping by degrees, and is broader at the clue than at the earing, as all top-sails and top-gallant sails are.

GORGE, in fortification, the entrance of the platform of any work.

GORGED, in heraldry, the bearing of a crown, coronet, or the like, about the neck of a lion, a swan, &c. and in that case it is said, the lion or cygnet is gorged with a ducal coronet, &c. Gorged is also used when the gorge, or neck of a peacock, swan, or the like bird, is of a different colour or metal from the rest.

GORGONIA, in natural history, a genus of the Vermes Zoophyta class and order. Animal growing in the form of a plant; stem coriaceous, corky, woody, horny, or bony, composed of glassy fibres, or, like stone, striate, tapering, dilated at the base, covered with a vascular or cellular flesh or bark, and becoming spongy and friable when dry; mouths or florets covering the surface of the stem and polype bearing. There are about forty species, of which the following are found in the Eurupean seas, *viz.* G. placomus; branching both ways, with flexuous, rarely anastomosing branches, covered with conic florets. The stem is erect, the branches flattish, bending towards each other: florets surrounded at the top with small spines. G. Anceps; slightly branched, with compressed stem and branches, each with rows of florets along both margins. It inhabits the American and British coasts; nearly two feet high; flesh calcareous; bone of horny leathery texture; when recent, of a fine violet colour, but when dry, yellowish or white. G. flabellum, Venus's fan; reticulate, with the branches compressed on the inner side; bark yellow or purplish; bone black and horny. It inhabits most seas, and is often several feet high, and expanded into a large surface; trunk and branches pinnate, and by means of the smaller branches blending together, forming an elegant kind of network; polype with eight claws. See ZOOPHYTES.

GORTERIA, in botany, so named in honour of David de Gorter, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Compositæ Capitatæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, with spiny scales; corolla of the ray ligulate; down woolly; receptacle naked.—There are thirteen species, mostly shrubby plants from the Cape of Good Hope.

GOSHAWK, the English name of the yellow-legged falcon, with a brown back, and a white variegated breast. See FALCO.

GOSSAMER is the name of a fine filmy substance, like cob-web, which is seen to float in the air in clear days in autumn, and is more observable in stubble-fields, and upon furze and other low bushes. This is probably formed by the flying-spider, which, in traversing the air for food, shoots out these threads from its anus, which are borne down by the dew, &c.

GOSSIPIUM, in botany, English *cotton*, a genus of the Monodelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx double, outer trifid; capsule four-celled; seeds wrapped in cotton. There are six species. See MANUFACTURE *of cotton.*

GOTHIC *style*, in architecture. The characteristics of this mannner of building are pointed arches, greater height than breadth in the proportions, and profuse ornament, chiefly derived from an imitation of the leaves and flowers of plants. The word gothic, by which it has long been distinguished in England, has lately been considered by its admirers as a term of reproach, applied by architects who were at a loss how to imitate its excellence, in order to bring it into disrepute; the former therefore now call it the pointed style. If we were to judge wholly from the complete oblivion which involves the origin of gothic architecture, it must follow, that architects were held in as little estimation about the time of Henry III. as common masons are at present; but this inference is doubtful, and the cause that the names of the most eminent have not reached us may be more correctly attributed to the then and subsequent neglect of literature. Writing was almost exclusively confined to the cloister, yet the monks, who could best inform us of their architects and the changes in their styles, were unaccountably silent on the subject; an instance may be cited from Malcolm's "Londinium Redivivum," in which that author introduces a legend of the building of the priory of St. Bartholomew, Smithfield, written immediately after the death of Rahere, the founder, by a monk resident there. This person describes the manner in which the money was raised, and many miracles performed, but not a word occurs relating to the architect: Rahere died in 1174, and the monk adds, "and with moor ampliant buildings were the skynnys of our tabernaculys dylatid;" we may therefore suppose that the arches under the tower, which are partly circular in the Saxon style, and partly pointed, were some of the first essays in the new mode of building, and erected about 1200.

Westminster Abbey was begun by Henry III. in 1245; this beautiful edifice is a complete and regular specimen of the purest pointed style; it is consequently perfectly fair to suppose, that the interval between the above dates was the period when gothic architecture superceded its heavy and tasteless predecessor. That it soon became the favourite mode may be concluded, from its adoption in all the additions made to old churches at that time, which is discoverable in an instant by the total disagreement of the proportions and ornaments. There is every probability that the first principles of the style in question were derived from the eastern nations, now partially under the dominion of the East India Company, where there are many buildings dedicated to their mode of worship that might almost be called gothic, and those are certainly very ancient. The Romans had explored the coasts of those countries, and their remote descendants may have been representations of the structures alluded to, left by their ancestors, and adopted them with alterations in some few of the earliest specimens of Christian churches. When a people of so much importance in the history of the world, as the successors of its conquerors, introduced any peculiarity in their manners or buildings, it is reasonable to suppose that they were eagerly imitated throughout Europe; hence we find that a few centuries produced a vast number of churches, in the pointed style, in the Italian states, Germany, France, Spain, &c. &c. though it must be admitted that the latter country being conquered by the Moors may have, in some measure, operated to introduce an imitation of their mosques, which are very like gothic architecture.

Such are the conjectures which naturally follow the consideration of this subject, and yet they may be altogether erroneous, as much might be said to induce a supposition, that the pointed style was gradually invented by the abberration of the pencil and compasses, or similar instruments of ingenious architects, who, having observed intersected arches in some very ancient Roman buildings, of Grecian architecture, admired their effect, and followed them as fundamental principles in new designs. This speculation may be supported by referring to an engraving by Marco Sadeler, representing the ruins of the Terme di Diocletiano, which shows the perspective of a long passage, very similar to the aisle of a church, where the roof is made completely and decidedly gothic by the intersection of arches throughout.

Some enquirers as to the origin of the style have thought that the first idea of high pointed ailes was taken from avenues of lofty trees, the branches of which interweaving, suggested the rich ribs and tracery of the later specimens of the art, but this is mere conjecture and fancied resemblance.

One of the most plausible reasons for supposing the invention gradual is, the finding of interlaced arcades on the sides of Saxon buildings, intimating an inclination to deviate from the semicircle of that style. (See plate Gothic Architecture, fig. 1.) The pointed arch, as has been mentioned, intermingled with the circular in the ribs or groins of the roof, and lastly occurred the plain and positive pointed manner, the earliest instances of which have very little decoration, compared with the more modern; indeed the rapid increase of ornament may be traced in our numerous and magnificent cathedrals, till their introduction operated to render the gothic style too expensive for continuance.

That this taste was imported into England from the continent will not admit of a doubt, but it is absurd to suppose that architects and masons were imported with it, as certain authors have imagined.

It is impossible to treat this subject methodically, as the principles of the gothic are simply those mentioned at the commencement of the article; indeed the varieties and caprices often obervable in the same building set all rules at defiance, and yet there are numbers of regular structures, the parts of which correspond exactly.

One of the arcades in the choir of Gloucester cathedral is seventeen feet wide, the columns on its sides are fifty-seven feet high, and the arch from the capitals to the point twenty-one feet; a circular arch, aperture, or window into another part of the church, in the same arcade, has the following proportions, width twelve feet, and the height fifteen feet. The west front of the same church has a great central window, and two lateral; those certainly should be of the same dimensions, to preserve the necessary uniformity, but that is not the fact, one being sixteen feet wide and thirty-one high, and the other twenty-nine feet high and twelve wide.

Two segments of a circle meeting at the tops make the pointed arch, (see fig. 2.) To improve the nakedness of this figure, the inventors introduced the section of a quatrefoil, or figure formed of four leaves, within the arch, (see fig. 3.) and ribs or borders, sometimes raised, and at others excavated; each of those were afterwards enriched by pierced tracery, see fig. 4.

The windows were bounded by numerous pillars with beautiful capitals of foliage, and intersected by perpendicular and horizontal bars or mullions, the former of which turned into delicate ramifications and filled the arch, (see fig. 5.); painted glass rendered those extremely grand when viewed within the structure, mouldings or cornices almost universally divided the different ranges of windows, the doors of the casement nearly reached the lower, and the angles above the arch are adorned with tracery, see fig. 6.

The windows are separated by buttresses, which vary in breadth, depth, and solidity, according to the fancy of the architect, and are frequently very magnificent, as they admit of being pierced into an arch, (as in fig. 7.) in order that they may contribute to the support of two walls on different lines, and are decorated with niches under fretted canopies, statues and pinnacles, see fig. 8.

Battlements extend along the summits of the walls, those are of different kinds, see fig. 9, 10.

The interior generally exhibits three ranges of arches in each arcade, the lowest are bounded by a strong pillar, with others more slender filleted round it; from the capitals of those arise the first arch, three of the small pillars ascend to the spring of the roof; the second range of arches open into a gallery, and the upper are windows (see fig. 11.) which exhibit the tracery or ribs from the pillars on the roof. Fig. 12, 13, 14, 15, 16, 17, shew a variety of ornaments peculiar to the gothic or pointed style of architecture.

GOUANIA, in botany, so called in honour of Antoine Gouan, M. D. a genus of the Polygamia Monoecia class and order. Natural order of Rhamni, Jussieu. Essential character: hermaphrodite, calyx five-cleft; corolla none; anthers five, under a veil; style three-cleft; fruit inferior, tripartite: male, similar, but without germ and stigma. There is only one species, *viz.* G. domingensis, chavstick, a native of St. Domingo in the woods.

GOVERNMENT, in general, is the polity of a state, or an orderly power constituted for the public good.

Civil government was instituted for the preservation and advancement of men's civil interests, and for the better security of their lives, liberties, and properties. The use and necessity of government is such, that there never was an age or country without some sort of civil authority; but as men are seldom unanimous in the means of attaining their ends, so their difference in opinion, in relation to government, has produced a variety of forms of it. To enumerate them would be to recapitulate the history of the whole earth. But they may, in general, be reduced to one of these heads; either the civil authority is delegated to one, or more, or else it is still reserved to the whole body of the people; whence arises the known distinction of government into monarchy, aristrocacy, and democracy. See Aristocracy, Constitution, Democracy, &c.

A mixed government is composed by the combination of the simple forms of government, which have already been, or will hereafter be, described; and, in whatever proportion each form enters into the constitution of a government, in the same proportion may both the advantages and evils, which have been attributed to that form, be expected. The government of England is unquestionably a mixed government, though by some writers it is denominated a limited monarchy. It is formed by a combination of the three regular species of government; the monarchy residing in the King, the aristocracy in the House of Peers, and the republic being represented by the House of Commons. The perfection intended, and, with regard to the United Kingdoms, in a considerable degree effected, is, to unite the advantages of the several simple forms, and to exclude the inconveniences. "For, as with us," says Sir William Blackstone, "the executive power of the laws is lodged in a single person, they have all the advantages of strength and dispatch that are to be found in the most absolute monarchy; and as the legislature of the kingdom is entrusted to three distinct powers, entirely independent of each other: first, the King; secondly, the Lords, spiritual and temporal, which is an aristocratical assembly of persons selected for their piety, their birth, their wisdom, their valour, or their property; and, thirdly, the House of Commons, freely chosen by the people from among themselves, which makes it a kind of democracy; as this aggregate body, actuated by different springs, and attentive to different interests, composes the British Parliament, and has the supreme disposal of every thing, there can be no inconvenience attempted by either of the three branches, but will be withstood by one of the other two; each branch being armed with a negative power, sufficient to repel any innovation which it shall think inexpedient or dangerous." See Monarchy.

GOUGE, an instrument or tool used by divers artificers, being a sort of round hollow chisel for cutting holes, channels, grooves, &c. either in wood or stone.

GOUST, or Gout, signifies taste or skill in poetry, painting, &c.

GOUT. See Medicine.

GRACE, in music, either in vocal or instrumental performances, consists not only in giving due place to the decorative additions, but in that easy, smooth, and natural expression of the passages, which best conveys the beauties of the composition, and forms one of the principal attributes of a good performer.

GRADUATE, a person who has taken a degree in the university. See Degree.

GRADUATION, in mathematics, the act of graduating or dividing any thing into degrees, or equal parts.

GRAFT, or Graff, in gardening, a

scion or shoot of a tree inserted into another, so as to make it yield fruit of the same nature with that of the tree from whence the graft was taken. See GARDENING, BUDDING, &c.

GRACULA, the *grakle*, in natural history, a genus of birds of the order Picæ. Generic character: the bill convex, thick, sharp-edged, somewhat naked at the base; nostrils small, near the base of the bill; tongue entire, rather sharp at the end; claws hooked and sharp. No species of this bird is found in Europe. There are thirteen species, of which we shall notice the following: G. kelegiosa, or the minor grakle, is of the size of a blackbird, is found in various districts of the East Indies, and almost in every island beyond the Ganges. It is rendered familiar with the greatest ease, and taught to speak with greater facility than even the parrot, and also enounces its words with more distinctness. It feeds on berries and fruits, and is particularly partial to cherries. When refused its wishes, it is stated to express sounds of disappointment and vexation extremely like the crying of a child.

The paradisœa tristis is rather larger than the former, and inhabits the Philippine Islands. It is exceedingly voracious, and has been known to swallow a young rat nearly two inches long, after beating it against the wires of its cage to soften it. It alights on the backs of oxen in its unconfined state, and devours the vermin which annoy them. These birds are particularly fond of grasshoppers, and are stated to have been imported into the Isle of Bourbon purposely to extirpate those consuming insects, which they have effectually accomplished. Being as they are, however, highly prolific birds, devouring every species of fruits and grain, and occasionally entering pigeon-houses and destroying the young, the inhabitants of the island have often found their depredations greater than those of the enemy which they were called in to extirpate.

G. quiscula, or the purple grakle, inhabits North America, and also the Island of Jamaica. It is a very considerable nuisance to the farmers of those countries, by scratching up the maize seed almost as soon as it is put into the ground. When the leaf appears, these purple daws, as they are called, will often tear up the plant by the roots; and when the maize is ripe they commit their depredations upon it in immense flocks, insomuch that premiums have been occasionally given for the destruction of them. They are, however, extremely serviceable by devouring insects. They pass the greatest part of the winter in swamps, overhung with woods; from which, on days of fine weather, they make their appearance abroad. Their flesh is far from being excellent, but their notes are melodious.

GRAIN, the name of a small weight, the twentieth part of a scruple in apothecaries weight, and the twenty-fourth of a penny-weight troy. See WEIGHT.

A grain-weight of gold bullion is worth about two-pence, and that of silver half a farthing.

GRAIN also denotes the component particles of stones and metals, the veins of wood, &c. Hence cross-grained, or against the grain, is contrary to the fibres of wood, &c.

GRAINING *board*, among curriers, an instrument called also a pummel, used to give a grain to their leather. See CURRYING.

GRAMMAR. 1. The grammar of any language is a set of rules and observations, directing to the proper use of the sorts of words composing that language. These rules are founded upon the general usage of good writers; and after this is ascertained, it is customary for those, who are desirous of speaking and writing correctly, to be uniformly guided by it. Grammarians, then, do not make a language; but they are formed by an enlightened view of the language, and afterwards direct the employment of it.

2. The art of grammar is sometimes divided into four parts: Orthography, Etymology, Syntax, and Prosody. The first and last of these have nothing to do with grammar, except so far as they relate to the grammatical changes made on different sorts of words. Etymology refers to the arrangements of the sorts of words, and to the various changes which are made upon them. Syntax directs the employment of those changes, and the situation of the different sorts of words in a sentence.

3. Hitherto grammar has been spoken of as an art, but it is in no way our intention to enlarge upon it in this view. Those who wish to study it, in order to guide their use of the English language, we refer to Mr. Murray's "Grammar," and Dr. Crombie's work on "Etymology and Syntax;" and in the latter, many valuable remarks will be found respecting scientific grammar. Considered as a science, grammar has for its object those

principles on which its rules are founded. Scientific grammar discusses the grounds of the calassification of words, and investigates the reasons of those procedures which the art of grammar lays down for our observance.

4. Grammar, as an art, refers only to particular languages: because it would be impossible to lay down any system of rules which would apply to two languages. We may point out in what respects the grammars of two languages agree; but we cannot form a common grammar for both. To a certain extent, the principles of scientific grammar are general, and some of them may be said to be universal. The laws of the human mind are the same in all ages, and in all nations; and of those causes which have called forth its energies, many have operated universally. Whatever have been the variety of terms, and of the modification and arrangement of them, the grand objects of men, in the formation and extension of language, have been the same, —to communicate their sensations, their judgments, their reasonings; to express the objects of their thoughts, and the changes and connections observed among them,—and to do this with dispatch. This has produced great uniformity in the general principles of language. But the connection between words and thoughts is arbitrary, as well as the mode of connecting words themselves. Hence, with much uniformity, we meet with much variety: and hence, universal, or even general grammar must be confined within very narrow limits, till the phenomena of a variety of languages have been examined, and their correspondence with each other, as well as their diversities, ascertained. For some of those more general principles, which may be regarded as the foundation of language in general, we refer our readers to the articles LANGUAGE, and *the Origin of Alphabetical* WRITING; we shall here content ourselves with making the philosophy of our own language our principal object, though we may occasionally be led to state the more general principles of grammar, and derive our illustrations from other languages. Such a mode of procedure may contribute to render the practical use of our own language more clear and certain.

Of the Arrangement of Words.

5. The first object of scientific grammar is, to form an arrangement of the sorts of words composing a language. In languages which admit of various changes in the form of words to denote changes of meaning, the arrangement, in a great degree, is pointed out for the grammarian; and a technical classification will, in such cases, have a decided superiority over one founded purely upon scientific principles. In languages like our own, we are less shackled by the contrivances of art; yet our arrangements ought to have in view the advantage of practice.

6. The true principle of classification seems to be, not essential differences in the origin or signification of words, but the mode in which they are employed. It should, however, be steadily kept in view, that all distinctions among the sorts of words have gradually arisen out of the circumstances in which language has been formed, and proceeded towards maturity; and that such distinctions are by no means to be extended beyond the present employment of words. It is necessary, for convenience and dispatch, that we arrange; but arrangement must not supersede further examination. The fact is, that originally there could have been but one sort of words, the *names* of the objects of our sensations and ideas. From these all others must have sprung; but, without words expressing *affirmation*, language must have moved very slowly, and often have been very ambiguous; and therefore we may reasonably suppose, that the ever active principle of association would soon transform *nouns* into *verbs*, by making them in certain situations expressive of affirmation. From these two classes all the rest have sprung, and though it is desirable, and even necessary, for the grammarian to arrange, it should ever be carefully borne in mind, that his arrangements respect the present contrivances of language; and that he, who would look into the causes of these contrivances, must retrace the steps which have been trodden, and see what were the procedures of those periods, when language was merely the child of necessity, not the organ of long-established and intricate associations. The philosophy of language is one branch of the philosophy of mind, and neither will be fully understood till both are.

7. The objects of sense and intellect are, in reality, nothing more than properties, or collections of properties. The mind, however, resorts to a support for those properties; something by which they are connected, in which they exist; and this we call *substance*. As far, however, as this word has any meaning,

it signifies nothing more than *a collection of properties existing, or capable of existing, independently of other properties.* These properties may be considered *collectively;* or they may be thought and spoken of, though they cannot exist, *separately.* We can think of no material substance which does not possess, at least, two properties; no visible object, for instance, can be without colour and extension; but we can think of extension and of colour separately; that is, we can direct the attention of the mind to each of them, exclusively of the other properties with which it may be connected. This separate or exclusive attention of the mind is called *abstraction.* It is a very simple, though a very difficult, operation of the mind. It is often confounded with *generalization;* but though exercised in every act of generalization, it may be exercised altogether independently of it.

8. The *names* of substances are called *substantives;* the *names* of properties, without reference to the substances of which they form a part, are called *abstract nouns.* To every name comprehended under these two classes, the term NOUN is applied. A noun is said to be increased or diminished in *comprehension,* when the *number of ideas* denoted by it is increased or diminished; and in *extension,* when the *number of objects,* to which it can be applied, is increased or diminished. Those single words, which are added to nouns to vary their comprehension, or to vary or determine their extension, are called ADNOUNS. From these similar, yet generally distinct objects, of different adnouns arise two grand classes, *adjectives* and *restrictives:* the former varying the comprehension of the conjoined nouns; the latter varying, sometimes determining, the extension of them. In one mode of the application of the term, adjectives are nouns; for they are the names of properties; and, as will be seen in LANGUAGE, originally they were nouns; but since they are not employed alone, like substantives and abstract nouns, to denote the objects of thought or discourse, it is preferable to class them with words whose use and employment is similar. Founding our arrangement on the use and mode of employment of words, we include, under the head of nouns, those words only which denote substances and properties, without being connected with other words. This, of course, includes substantives and abstract nouns; but excludes adjectives.

9. We constantly find it necessary to speak of ourselves, to address others, or to speak of others. If we wish to speak of ourselves, or to address others, we immediately find, that we must either mention the names of the individuals concerned, or use some words not belonging to ourselves or them, as individuals, but as the persons speaking, or spoken to. How much to be preferred the latter method is, a slight attention to the subject will show: George might say to James, "George hopes that James is well, and that James will come and see George very soon:" but there is nothing in this which shews that George is the person speaking, or that James is the person spoken to; and besides, it often happens, that the names of the parties in conversation are mutually unknown. It is the mode adopted by children, and persons speaking to them; and probably was so universally in the early periods of language; but we feel that we want more. Suppose George to say, "The person speaking hopes the person spoken to is well," &c.; it would be perfectly intelligible, and answer every purpose but that of dispatch. That would be effected by using some short words of equivalent signification; such are *I* and *thou.* *I* has the same force as *the person speaking, thou* as *the person spoken to;* except that *I* and *thou* are limited to the individuals actually speaking or addressed, or supposed to be so speaking or addressed. These words are then, strictly speaking, *nouns;* but as they are used *for names* of persons, they are called PRONOUNS, that is, *for-nouns.* Again, suppose we wish to speak of some person or thing, which we have before mentioned, in such a manner as will denote, that we have before mentioned that person or thing, instead of merely repeating the word, as "James is gone, and James will come back;" in which case it is left to an inference, which, in many cases, would be a doubtful one, that the latter referred to the same person as the former,—we might say, "James is gone, and the *said* James (or the *said* person) will come back," or, "and *he* will come back." Here it is obvious, that *he* not only supplies the place of the name, on which account it might be called a pronoun, but has a distinct reference to the person having been before mentioned. In a similar manner, *she* means the female person spoken of; and *it,* the thing spoken of. These words, with their plurals, are all called pronouns, and though they obviously either come under other sorts of words, or are abbreviations for one or more of them, yet they are at present so distinct and important in their use, that

they require a separate class. PRONOUNS, then, are words used for the names of persons or things, connected with the idea, that they are either speaking, spoken to, or before spoken of.

10. We cannot advance one step in language, without leading our hearers or readers to the inference,that certain ideas are connected in our minds, or that we believe certain objects, properties, or events, to be connected. The connecting link in language need not always be stated ; in the infancy of language it could not exist, and in the language of childhood it does not exist. Words are joined together, and it is easily understood, that the corresponding ideas are connected in the mind. " Mamma, milk good," would surely be understood by any one ; and, in similar cases, depending upon the ease of inference, the ancient writers left it to the mind of the reader to form it for himself. But how slowly and how ambiguously communication would proceed, without some appropriated link of connection, any one may be convinced, by leaving out of a few sentences those words, which, in our language, serve that purpose, and which, in all languages, are necessary to render an affirmation complete. The intelligent reader, to whatever other account of such words he may have been accustomed, will perceive that we refer to verbs. The essential quality of a VERB is, to express affirmation, when joined with the subject of the affirmation. Whenever a word expresses it, that word is a verb : if in any case it does not express it, it ceases to be a verb. That it does express affirmation is, doubtless, by an inference of the mind ; in itself considered, it can only be the name of some quality or circumstance of its subject ; but by being frequently employed with such inference, and, in the later periods of language, being invested with peculiarities of flexion, it acquires a character different, in appearance at least, from that of the noun, and, in many instances, is *appropriated* to convey the inference, that something is affirmed of its subject.

11. From verbs, or rather from the *noun-state* of verbs, in which they do not express affirmation, a new class of words is formed, partaking of the characteristics of the noun and adjective, and agreeing with verbs in the accidental circumstance of requiring after them a peculiar form of pronouns. These words are called PARTICIPLES.

12. In the same manner as it is found needful, for the purpose of accurate and expeditions communication, to employ words to modify or restrict the signification of nouns, it is found at least convenient to appropriate other words to modify or restrict the signification of adnouns and verbs. These are called ADVERBS, which are to be regarded as a class of words formed from nouns or adnouns, and used to express some quality or circumstance respecting the action, quality, or circumstance, denoted by verbs or adnouns. They are, therefore, convenient abbreviations, which may be supplied by the other sorts of words.

13. From nouns, adnouns, and verbs, another class of words have arisen, which from the long disuse of the original forms of them, have lost their peculiar characteristics, and are now regarded as independent of them. They are now used to connect words or sentences, or words and sentences; and, in general, point out some particular kind of connection. From the employment of them, they may be termed CONNECTIVES ; and under this class, we comprehend those words which are usually denominated Prepositions and Conjunctions. The distinction between these two sorts of Connectives is merely technical ; the latter requiring after them a peculiar form of the pronoun, and of the noun, in languages in which the noun admits of flexion.

14. We feel obliged, very much against our inclination, to admit, as an eighth class of words, some of those which are usually denominated INTERJECTIONS. Words of this sort are of very little importance, and by many are thought undeserving of the name of words. Some are *involuntary* expressions of grief, or joy, or surprize, or some other strong emotion ; and some may be used with the *intention* of informing others what emotions are in the mind of the speaker or writer. The former set have no more right to be called words, than the sigh of sorrow, the groan of pain, the laugh of mirth, &c. which no one calls words ; for words are voluntary vocal sounds, employed to express our ideas to others. The latter set are generally found to be parts of sentences, or single words of the before-mentioned sorts. Our great philosophical etymologist, Mr. Horne Tooke, has traced the origin of the greater part of them ; and the few that remain will probably be hereafter traced by some of those grammarians who are treading in his steps.

We now proceed to a few remarks on each of these sorts of words : our limits will allow of very little amplification, and will enable us only to present an outline to our readers. Those who wish for further information, we beg to refer to the article GRAMMAR, in Dr. Rees's "Cyclopedia."

1. *Of the Noun.*

15. Those words which are *names* of things, and which can stand alone, as the subject of an affirmation, are called *Nouns*: this class of words has two grand divisions: *substantives* and *abstract nouns* (8). *Substantives* are the names for substances. All names must originally have been names of individuals; the extension of the application of them must, however, have been immediate. The difficulty of producing a great number of distinguishable articulate sounds, and the operation of the associative power, first led to generalization; convenience, perhaps we may justly say necessity, led to its extension and completion. When a number of things resemble each other in some striking particulars, we class them together in one species, and give to the species a name which is applicable to every individual included in it. When several species agree in some common properties, we refer them to a higher class, which we call a genus, and to the genus give a name which is applicable to every species and every individual included in it; and this classification we extend to the limits of human knowledge; and it is one of those admirable contrivances which are the result of necessity or of casual circumstances, but which, being extended and perfected by science, contribute essentially to the progress and diffusion of knowledge. But though it is necessary, for the purposes of communication, that many names should be applicable to classes of individuals, it is also necessary, that there should be others capable of denoting individuals, without the circuitous plan of naming the general term, and the distinguishing qualities of the individual; and, accordingly, we find in all languages numerous words, which apply to an individual only, or, at least, are at once referred, both by speaker and hearer, to an individual. Those names which, when alone, apply to a number of individuals, are called *general terms, appellatives*, or *common nouns*; and those which, when alone, are used to denote particular individuals, are called *proper nouns*. Sometimes proper nouns are so applied, as to become common nouns, as when we say, the Cæsars, or the Ptolemies. These are instances of the commencement of generalization; but there is another mode of the use of proper nouns, which is more illustrative of the processes actually adopted, in employing terms originally denoting an individual, to denote classes of individuals, who resemble him in some striking characteristics: thus, we say, "the Bacons, the Newtons, and the Lockes, of modern times," meaning, by these terms, all those individuals who have resembled Bacon, Newton, or Locke, respectively, in the mode and success of their investigation.

16. Though it seems to be a very simple procedure, to form and appropriate names to denote properties separate from the other properties with which we see them connected in nature, the origin and appropriation of such names must have been very gradual; and the contrivances which, in the natural progress of language, have been adopted to designate separate properties, are among the most curious procedures of the art of mutual communication. Mr. H Tooke, who has indisputably conducted us further towards an acquaintance with the causes of language than any other author on grammar, considers abstract terms as (generally speaking) "participles or adjectives used without any substantive to which they can be joined," "Such words," he observes, (Epea Pteroenta, vol. ii. p. 17.) "compose the bulk of every language. In English, those which are borrowed from the Latin, French, and Italian, are easily recognized, because those languages are sufficiently familiar to us, and not so familiar as our own: those from the Greek are more striking, because more unusual; but those which are original in our own language have been almost wholly overlooked, and are quite unsuspected." A large proportion of the nouns which he thus traces are certainly not to be considered as abstract terms, according to what appears to be the customary meaning of that appellation, (such as *view* the past part of *voir*, something *seen*; *tent*, the past participle from *tendo*, something *stretched*:) and others certainly require more explanation than he has thought right to give (for instance *providence, prudence, innocence*, and all the rest of the tribe of qualities in *ence* and *ance*, which he considers as the neuter plurals of the present participles of *videre, nocere*, &c. without shewing us why *things foreseeing*, or *things not hurting*, have acquired the force of the above words:) but a considerable number of his derivations are very satisfactory, and give great insight into the procedures of language. A few may be adduced as a specimen of his etymologies. *Skill* is the past participle of the Anglo-Saxon

verb ꞅcẏlan, *to divide, to make a difference, to discern*; and it signifies that faculty by which things are properly *divided* or *separated* one from another. *Sorrow* is the past participle of ꞅẏꞃꞃan, to *vex*, to *cause mischief to*, and is the general name for any thing by which one is *vexed, grieved*, or *mischieved*. *Wrath* is the past participle of ƿꞃıðan, *to writhe*. *Heat* is the past participle of hætan, *to make hot*. *Doom* is the past participle of ꝺeman, *to judge, to decree*.

17. Another class of abstract nouns, viz. those ending in *th*, have been traced to a very probable origin by Mr. H. Tooke: he considers them as the third persons singular of verbs. For instance: *truth*, (anciently written *troweth, trowth, trouth*, and *troth*,) means, what one *troweth, i. e.* thinketh, or firmly believeth; *warmth* means that which *warmeth*; *strength* is that which *stringeth*, or maketh one *strong*. While, however, we agree so far with Mr. Tooke, we cannot go with him when he limits our acception of words to that in which they were first employed; and supposes that all the complicated, yet often definable, associations, which the gradual progress of language and intellect has connected with words, are to be reduced to the standard of our forefathers. We cannot avoid expressing our belief, that he has either totally overlooked, or greatly neglected, the influence of the principle of association, both in the formation of ideas, and in the connecting of them with words. It does not follow that, because the ideas connected with abstract terms are not what Mr. Locke supposed, that there are no ideas connected with them, but that they are merely contrivances of language. Several classes of abstract nouns are altogether passed over by Mr. H. Tooke; and we regret it, because he is eminently qualified to trace the origin of those terminations by which are formed the names of qualities, considered as separate from those substances in which they exist. One class is formed by the addition of *ness* to the adjective, such as *whiteness, goodness*, &c. *Ness* is the Anglo-Saxon neaꞅ, or neꞅe, signifying *nose*. It is also used for *promontory:* as in *Sheer-ness, Orford-ness*, the *Naze*, &c. Joined to the name of a quality, it denotes that the quality is a distinguishing feature of an object; it consequently holds it up as an object of separate attention.

18. We now proceed to those changes which are made in the form of nouns to express a change of signification; and first we shall attend to *number*. In speaking of the objects of thought, we have constant occasion to speak of one or more of a kind; in every language therefore we may expect to find a variation in the form of adjuncts of nouns, to denote unity or plurality. To avoid the necessity of using such adjuncts, or rather in consequence of the coalescence of them with the nouns, owing to the frequent use of them in connection with the nouns, a change of form has taken place in most cultivated languages. The Hebrew plurals are generally formed by the addition of ם, *mem*, to the noun, probably because ם was the symbol of water, and denoted collection and pluralty; and in that language the coalescence has actually taken place, and occasionally undergone some corruption. Among the Chinese the plural adjunct has not yet coalesced with the noun; and they generally denote the plural by the addition of *min* to the singular. Supposing the coalescence of plural adjuncts to have been the origin of the changes on nouns to denote plurality of meaning, it does not necessarily follow that all plural changes were thus formed. The change of form produced by such coalescence in some cases might suggest a corresponding change in others, though the change might not be exactly similar. Hence, could we trace some of the plural changes to art, as their earliest origin, it would weigh little against the general principle. We shall, however, almost universally find, that the extension of old procedures, rather than the invention of new ones, has been the cause of almost all even of the artificial changes in language. The reason is obvious: besides the greater ease to the innovator, it would be much more intelligible to those who are to adopt his innovation. Even the philosopher judges it more proper to follow the analogies of his language, than to deviate from them, where he knows such deviation would be an improvement. Except as far as is dictated by custom, and that convenience on which the custom has been founded, there is no reason why the same word unchanged should not be applicable both where *one* and where *more* are meant: why, for instance, we should not say *two man*, as well as *one man*. The plural form may be applied to two, or two hundred, or any indefinite number; now is there in the nature of the thing a more marked distinction between one and two, than between two and two hundred? In fact, were we always able to join to the noun a numeral, or some other adnoun denoting number, a plural form would be unnecessary; but it is frequently desirable to denote plurality, where the number is

indeterminate or unnecessary to be specified. The Chinese drop their plural adjunct, when there is another word of plurality attached to the noun. We do not go upon the same principle; but there are cases in which we make no changes to denote plurality, as twenty *pound* of flour, thirty *sail* of ships, four *thousand*, &c. These instances, though contrary to the prevailing analogy of our language, certainly do not oppose the general principles of language; and though the neglect of the plural termination in such cases is ungrammatical, it probably savours less of vulgarity to go thus far with the multitude, than of pedantry to quit the beaten track. There are other instances, however, in which the use of the same word, both in a singular and plural acceptation, is perfectly legitimate; we say one, or twenty, *deer*, *sheep*, or *swine*. If there must be a form for unity as distinguished from plurality, why not forms to denote two things, three things, &c.? There is no reason, but in their inferior utility some languages have a form for duality; and by the Greeks this form was carried through their nouns, adnouns, pronouns, verbs, and participles. They had, however, no scruple in using the plural form for two things, and in making their duals agree with plurals. The fact is, the distinction between one and more than one is more useful than any farther distinction. The indefinite denotement of plurality is continually serviceable; and if we wish to specify the exact number, the addition of a numeral is a much more simple procedure, than the burdening of language with a number of distinctions, which would seldom be useful, and never necessary.

19. In every department of knowledge we are concerned with individuals; and though for the purposes of communication general terms are not only convenient, but absolutely necessary, some contrivances are requisite to designate individuals, or less general classes of individuals. This is done by means of adnouns, or by stating some connection between what is denoted by the noun and some other substance or quality. The latter is accomplished by juxtaposition, by prepositions, or by equivalent changes in the word connected. The last is called inflection, and the word so changed is called a *case* of the noun. In English we have only one inflection of the noun, and two of the pronoun. Persons who think that the procedures of every language must be accommodated to the grammar of the Greek and Latin, strenuously contend for an equal number of cases with theirs. If *case* mean a change in the word, to denote connection with other words, then the plan of our language cannot be accommodated to that of the Latin: If *of a man*, *to a man*, &c. be considered as cases, there is certainly no reason why the same appellation should not be given to every noun to which a preposition is prefixed, and then we shall have above thirty cases. It is fortunate for the speculator, that, in this and other instances, language will not bend to the contrivances of the technical grammarian: for his wish to reduce every process to an agreement with a standard, which prejudice only can deem perfect, would, if successful, materially increase the difficulties of grammatical investigation. The variation of our nouns is confined to the denotement of one relation, that of *property* or *possession*; and it is therefore with great propriety called the *possessive case*. The appellation *genitive case* is sometimes applied to it; but the force of the Greek and Latin genitive is to denote relation in general, though capable of specific application, and is exactly equivalent to a noun preceded by *of*. The possessive case of a noun is not equivalent to the noun preceded by *of*, except where the latter has the specific force of belonging to. It may in all cases be represented by *of*, with the noun following; but the latter mode of expression cannot in many instances be represented by the possessive case. The French, Spanish, and Italian languages have no cases of nouns: the German has changes, to express what we denote by *of* and *to*; but these changes are not carried through all the nouns. The Latin and Greek languages have still more variations, which they carry through all their variable parts of speech, except the verbs. The arrangement of these variations is the work of art; and the appellations of *case*, or *fallen*, and *declension*, or *bending from*, appear to have gone upon this principle: the word from which the cases are formed was represented by a perpendicular line, and the cases by lines declining or falling from it. For the sake of convenience, the nominative and vocative are denominated cases; and from the above contrivance the nominative was termed the *upright* case, and the other cases were termed oblique. The *nominative* is the name itself, The *vocative*, or case of calling, has its origin in those changes in the pronunciation, which arise from the mode of utterance in calling to a person: it is a corruption, or an abbreviation of the nominative. We have already spoken of the force of the *genitive*; we shall only add here, that

we have in English one procedure exactly corresponding to it in force, though not so universally applied, *viz*. juxtaposition. This is a very simple and intelligible procedure. To connect the terms, is a satisfactory expression of the connection of the things signified: and in this procedure, as in the genitive, the kind of connection is left to be inferred; as in the expressions iron ore, iron chain, iron heat, China orange, house door, &c. The theoretical distinction between the *dative* and *accusative* does not appear to be clearly marked; but the general force of the former is to denote *acquisition*, and of the latter to designate the word, as the *object* of the action of verbs and their derivatives. As to the *ablative*, there is scarcely room for doubt that it is merely a variation of the dative form, where indeed it has a form distinct from it. Probably in consequence of the elipsis of a preposition, this form has by degrees become the denotement of the cause, manner, or instrument of an action; and this is now the primary force of the case when unattended by prepositions. The changes which are made to denote connection have been formed by prefixing or affixing letters to the words themselves; and they might have been arbitrary, or gradually produced by the coalescence of words or abbreviations of words. The latter hypothesis is in every respect so very probable, that nothing seems requisite to prove it to have been the general procedure of language, but to show that it has actually occurred in some instances. It has been for some time the prevailing opinion among philosophical philologists, and it has acquired great support from the discoveries of Mr. H. Tooke. He states it without any limit, in the following manner: "All those *common* terminations, in any language, of which all nouns or verbs in that language equally partake (under the notion of *declension* or *conjugation*) are themselves separate words, with distinct meanings; which are therefore added to the different nouns, or verbs, because those additional meanings are intended to be added occasionally to all those nouns or verbs. These terminations are all explicable, and ought to be explained." In fact, the progress of the coalescence has been detected in some of the most refined instances of it; and in many cases to which system has not reached, the coalescence is universally allowed. In the two principal cases of the Greek noun, in some at least of its forms of inflection, the origin of the change has been traced; and all the cases of the Hebrew noun are obviously formed by prefixing (instead of affixing, as in the Greek) significant words. The grammarian does not indeed allow that the changes of the Hebrew noun are cases: but such arbitrary distinctions serve only to render obscurity more obscure. In the French, *au* and *du* are indisputably abbreviations of *à le* and *de le*: we can trace their corruption, and we are not obliged to suppose greater corruptions in more disputable instances. What is the origin of the possessive termination of our nouns is very uncertain. It is obviously the corresponding Anglo Saxon termination; but what is the origin of that? We may hope to receive light upon this point, when the third part of "Epea Pteroenta" is laid before the public.

20. *Gender* is a distinction of substantives as denoting males or females, or neither. The names of males are said to be of the masculine gender; the names of females of the feminine gender; and all other names are said to be of the neuter, that is, of neither gender. The purposes even of accurate communication do not in all cases require any denotement of gender, and accordingly we find many words which are common to both sexes. The English and the pure Persian appear to be the only languages which observe the natural distinction in the division of nouns. We denote difference of sex, either by a change of appellation, or by a change on the word itself, or by a significant adjunct. In addition to its greater philosophical accuracy, the procedure of our language enables us to mark with greater perspicuity and force the personification of inanimate substances or abstract qualities. In the earliest languages there is no distinction of gender further than into masculine and feminine, and the reason is obvious; for the principle of animation appears to the uncultivated mind to pervade all nature. In the more cultivated languages, in which a third class is admitted, the arrangement seems to have been the work of art. The foundation was laid in the natural distinction of sex; by degrees those terminations which most frequently occurred in the respective divisions were made the characteristics of those divisions, and nouns of similar terminations were arranged under them, without respect to the original ground of distinction. We must not be surprised to find that languages, derived from those in which the distinctions of nature had given way to the divisions of art, should leave nature altogether: and

we accordingly find, that in those modern European languages which are derived from the Latin, gender is little more than a mere grammatical distinction of nouns into two classes, called masculine and feminine.

II. *Of the Adnoun.*

21. We apply the term *adnoun* to those single words which are added to nouns, to vary their comprehension, or to vary or determine their extension. Those which affect the former object are called *adjectives;* those which affect the latter we call *restrictives.* It is not, perhaps, in all cases, easy to say, to which of these classes an adnoun should be referred, because the two objects are not always distinguishable; but in general, those which denote *qualities* are adjectives, and those which denote *situation, possession* or *number,* are restrictives.

22. The adjective is exactly equivalent to a noun connected with another noun by means of juxtaposition, or of a preposition, or of corresponding flexion. *E. g.* A *golden* cup is the same with a *gold* cup, or a cup *of gold;* a *prudent* man is the same as a man *of prudence,* or vir *prudentiæ.* It has been already observed, that the Greek and Latin genitive, our preposition *of,* and juxtaposition, are all equivalent procedures, though custom has produced a variety in the mode of their application: we now add, that the adjective is another equivalent; and further, that the connection denoted by the adjective is equally indefinite with the others. *E. g.* A *healthy* colour, is a colour *caused by* health; a *healthy* exercise, is exercise *causing* health. And the use of all these procedures is the same, to particularize the general term, by connecting with the qualities which are included under it some quality which the general term does not include. In many instances, to denote that the name of a quality is used thus in connection with some other name, that is, in fact, that it is used as an adjective, certain terminations are employed, significant of such connection; and Mr. H. Tooke informs us, that those by which the simple adjectives are formed, *viz. en, ed,* and *ig* (our modern *y*) convey, all three, the designation that the names to which they are annexed are to be joined to some other names; and this by their own intrinsic meaning, for they signify *give, add, join.* "So the adjectives *wooden* and *woollen,*" he continues, "convey precisely the same ideas, are the names of the same things, denote the same substances, as the substantives *wood* and *wool*: and the termination *en* only puts them in a condition to be joined to some other substances, or rather gives us notice to expect some other substances to which they are to be joined."

23. Most languages which admit of inflection carry it through their adjectives as well as nouns. In some the adjective is varied, to express difference in the gender, number, and case of the connected noun. Where great liberty of inversion is desirable, these variations are convenient, because they point out with what noun the adjective is connected: where juxtaposition ascertains this, they are unnecessary, since they make no change in the signification of the adjective. The signification of the adjective *wise, e. g.* is unchanged, whether it be applied to one man or woman, or to twenty men or women: whether its substantive be stated singly, or conjoined with others, as the names of the parents, place of abode, &c. of those to whom it is applied. The French always place the adjective close to its noun, yet they make changes on it to denote the gender of the connected noun. This is always unnecessary; but sometimes it contributes to elegance, by preventing an awkward circumlocution.

24. The qualities denoted by adjectives may, in general, vary in degree: some, as dimensions and weight, may be measured with accuracy; and the comparative degree of some qualities, at least of heat and cold, can be ascertained with precision. Many, however, are incapable of exact measurement; and the cases in which the exact degree of the quality cannot be ascertained are few, in comparison with those in which it is unnecessary. When we use terms to express a greater or less degree of a quality, we may either make a direct and particular reference to the degree in which it is possessed by other objects, or use them without such reference. In the former case, we are said to compare the qualities; and variations of the adjective, to express this comparison, are called *degrees of comparison.* The difference between the comparative and superlative, in our language, consists in the manner of construction merely, and not in the degree of the quality: thus, Solomon was *wiser* than any other king of Israel, is the same as, "Solomon was the *wisest* of the

kings of Israel." The comparative is used, when we speak of an object as distinct from those with which we compare it; the superlative, when it is spoken of as one of those with which we compare it. Man is the noblest of animals, but not the noblest of the brute creation, otherwise he must be one of the brute creation: he is nobler than the brutes, but not than all animals, or he must be nobler than himself. The custom of our language makes one distinction between the comparative and superlative, which does not coincide with this grand distinction. We use the comparative with the force of the superlative when we speak of two; as, he is the *wiser* of the two, and the *wisest* of any great number. This is not an unjustifiable usage; but it has no particular foundation in the force of the comparative and superlative.

Few of the modern European languages vary the words themselves to express comparison. The French, *e. g.* express by *plus* and *le plus*, what we express by *more* and *most*; or (what is obviously equivalent, though custom limits their use to particular cases) by the terminations *er* and *est*. What is the meaning of these terminations? is a natural question: the answer is not so easy. It appears, however, very probable, that *er* is nothing more or less than the word which we still use in the form *ere*, signifying *before;* and that *wiser* signifies *wise before*. Now, as has been well remarked by Mr. Dalton, *then* and *than* are the same in origin and signification: hence, *wiser than I*, is exactly represented by, *wise before then I*, *i. e.* wise before, then (that is, next in order) *I*. This derivation, if correct, explains the ground of the peculiarity above stated, in the use of the comparative: he is the *wiser* of the two, means, simply, he is wise before (the other) of the two.—It might be conjectured, that the superlative termination *est*, is an abbreviation of *most* annexed to an adjective, in the same manner as in *topmost*, *undermost*, &c.; but Mr. H. Tooke has shewn, that *more* is merely *mo-er*, and *most mo-est*, which leaves the origin of the terminations *er* and *est* as it was found.

25. Those adnouns, which, without expressing qualities, vary or determine the extent of the signification of the nouns to which they belong we call *restrictives*. Some restrictives are, by the custom of our language, applicable to singular nouns only; as *one*, *a* or *an*, *another*, *this*, *that*, *each*, *every*, &c.: others to plural nouns only; as *two*, *three*, *these*, *those*, *other*, *few*, *all*, &c.; but most restrictives, like all adjectives, are applicable to both singular and plural nouns. Of the restrictives, two are called *articles*, *the* and *an*, which last is abbreviated into *a* before consonants, *h* when pronounced, *u* long as in *use*, and *one*. *An* is simply another form of the numeral *one*, still used in North Britain under the form *ane*; and in the French, the numeral and the article corresponding to one are the same. But though *an* and *one* have the same origin and primary signification, there is occasionally an obvious difference in the mode of their employment. This difference is well expressed by Dr. Crombie: "If, instead of saying, 'A horse, a horse, a kingdom for a horse,' I should say, 'One horse, one horse, one kingdom for one horse,' the sentiment, I conceive, would not be strictly the same. In both expressions, the species is named, and in both, one of that species is demanded; but with this difference, that, in the former, the name of the species is the emphatic word, and it opposes that species to every other; in the latter, unity of object seems the leading idea." *An* is called the *indefinite* article, because it leaves undetermined what one individual is meant; *the* determines the application of the noun to some particular individual, and hence it is termed the *definite* article. It has the same primary signification with *that;* but they vary in the mode of their employment, the former never being employed without a noun, the latter having its noun frequently understood; and farther, *that* is more emphatic than *the:* these, however, are the refinements of language, and have no foundation in the origin of words. Mr. H. Tooke considers *that* as the past particle, and *the* as the imperative mood of the verb DEAN, *to get*, *to take*, *to assume:* and *the*, he observes, may very well supply the place of the corresponding Anglo-Saxon article ſe, which is the imperative of ſeon, *to see;* for it answers the same purpose in discourse to say *see* man, or *take* man. We really like the import of our forefathers' article so much better than that of our own, that we shall cheerfully give up *the* for *se*, unless it should appear, that *the* and *that* have their origin in some verb signifying *to point at*. Of that large class of restrictives called *numerals*, the origin of some may be traced; and as we wish to give our readers some insight into the labours of Mr. H. Tooke, we shall mention his derivation of words in this class. It is in the highest degree probable, that all numeration was originally performed by the fingers, the actual re-

sort of the ignorant; for the number of the fingers is still the utmost extent of numeration. The hands doubled, closed, or shut in, may therefore well be denominated *ten* (the past particle of ꞇyann to enclose, to shut in) for therein you have closed all numeration; and if you want more, you must begin again, *ten* and one, *ten* and two, &c. to *twaintens*, when you must begin again as before. *Score* is the past particle of ꞅcipan to shear, to separate; and means *separated* parcels or talleys. The ordinal numbers, as they are called, are formed like the abstract nouns in *eth : fifth, sixth, tenth*, &c. is the unit which *five-eth, six-eth, ten-eth, i. e.* makes up the number *five, six, ten*, &c. The ordinal numerals are obviously abbreviations of expression, for one, and one, and one, &c.; and we need not be surprised, as they are continually used, and were so originally, without any noun following them, to find them occasionally receiving the variations of the noun.

III. *Of the Pronoun.*

26. So much has already been said respecting the force of the pronoun, that it is unnecessary to enlarge upon it here. Mr. H. Tooke's derivation of *it* must however be stated, as it shows what have been the actual procedures of language in the formation of one of our pronouns, and gives an insight into the probable origin of the rest. *It*, formerly written *hit* and *het*, is the past participle of the verb 𐌷𐌰𐌹𐍄𐌰𐌽 *to name*, and therefore means the person or persons, thing or things *named*, or afore *said :* and accordingly was applied by all our old writers indifferently to plural and to singular nouns. We do not know whether a similar opinion, as to the origin of pronouns, has been before laid before the public, but the philosophical Greek professor of Glasgow, (whose prelections have often anticipated Mr. H. Tooke) long ago delivered it as his opinion, that some, at least, of the pronouns are participles; and, if we mistake not, traced the origin of εγω, and *ipse*, as follows. Εγω, in the more ancient dialect of Greece, was εγων. which is an obvious abbreviation or corruption of λεγων; so that εγω (whence the Latin and other languages have their first person) signifies the *speaking* person. *Ipse* is the Latin past participle from επω; and though this verb is not to be found in Latin writers, those who know how much the Latin is a dialect of the Greek, will not feel this a material difficulty: on this derivation, *ipse* signifies the *said* person, &c. These speculations might be advantageously extended, would our limits permit; but sufficient has been said to show, that these words are not of that unintelligible nature which has been usually supposed.

27. Respecting the inflection of pronouns, the same general principles are applicable, as respecting that of nouns. *His* is obviously *he's*; and whatever be the origin of the possessive termination of the noun, it has the same origin here. *Mine, thine*, and *hern* and *theirn*, still retained in some of our dialects, have apparently the same origin as *wooden, woollen*, &c. The objective form is merely a grammatical appropriation of one of the forms of the pronouns to a particular purpose; and we still find that *her*, among the vulgar, is commonly employed, as the subject of verbs, instead of *she*.

28. Though we see no reason to give the appellation *pronoun* to those words which are called *adjective pronouns*, (and accordingly we class them as restrictives,) yet there is one word of peculiar importance, which seems properly a pronoun, and to which some attention is necessary, *viz.* the *relative*. We have already observed several of the contrivances of language to particularize general terms; another is, to restrict or explain the general term by means of a dependant sentence connected with it by a relative.—We will first consider what the relative performs, and then how it performs it. Take the following examples; every man, who loves truth, abhors falsehood; and John, who loves truth, hates falsehood. If the relative clause had been omitted in the former sentence, the remaining assertion would have been false; here then it is restrictive: in the second it is merely explanatory, and in such cases, so far from being necessary, may even destroy the unity and force of the sentence. To explain the subject of discourse, and to restrict its signification, are the two offices of the relative. If the custom of language allowed it, precisely the same purpose might be answered by an adjective or participle connected with the term, as, every man loving truth, &c. and it might seem useless to introduce a new procedure; but the utility of the present plan is obvious, when we consider the immense number of new words which must be introduced to supply the place of the relative; and further, that it ena-

bles us to state a greater variety of circumstances in connection with the antecedent, and occasionally to state them more forcibly. The relative is equivalent to a personal pronoun with a connective of general signification. We do not mean to affirm, that in the original signification that connective will be found; but that such is the present force. The dependent clause may be joined to the principal, either by simple juxtaposition, or by means of a connecting particle, or lastly by a word including the force of a connective particle. Instances of the first are. The ship he commanded was wrecked, and, The man that (i. e. that man) loves wisdom shall find her: in both of which the dependent clause is connected in that natural manner, which is frequently adopted in our simple language to express connection in ideas; and in the same manner the early Greek writers employ their definite article for their relative. As an instance of the second kind we may adduce this mode of expression; A man if he do not love truth cannot be virtuous; in which the dependent clause is joined by a connective, though of a less general kind than what is implied in the relative. This last mode is the most general, and on the whole the most useful, because most general and least ambiguous. Without venturing to assert that *who* essentially differs in its original signification from *that*, it certainly does now include more signification; and that additional signification we think to be what is expressed by *and*, so that, Every man who loves truth hates falsehood, means, Every man *and he* loves truth, hates falsehood, *i. e.* as Mr. H. Tooke has shewn us, Every man *and* (this circumstance) *he* loves truth, &c.

IV. *Of the Verb.*

29. As we do not profess to consider the theory of grammar in general, we have not much occasion to enlarge respecting this important sort of words; for our language, simple in most of its procedures, is here almost at the verge of simplicity. Some languages have a great variety of changes in the form of the verb, to denote the subject of affirmation, and the mode and time in which the affirmation is to be taken: we have only four, and of those three are, to say the least, is no way necessary. We have already said enough respecting the nature of the verb (§ 10.) to render it unnecessary to recur again to that point, and we shall here direct the attention of our readers to the modes of signification assumed by the English verb; only repeating, that the *verb* is a word, which, when preceded by a noun or pronoun, or by what may be represented by it, expresses affirmation. In English and in other languages, words appropriated to express affirmation are often used without any such force: in such cases it might in some respects be more scientific to cease to give them the appellation of verbs, but it would be inconvenient in practice, and we prefer speaking of them as in the *noun-state* of the verb; so in the expressions, Eat this, and He dares not eat it, *eat* is in the noun-state.

30. To denote that a name was appropriated to be used as a verb, our ancestors added a distinguishing termination, like all other common terminations, almost certainly significant in its original state. Why that was dropped does not appear: but since it was dropped, the verb in many instances ceases to have any thing in its form to distinguish it from the noun, and in a great variety of instances it is used exactly as a noun. It is true, it is generally, when in the noun-state, preceded by the particle *to*; but in most instances *to* is used in its most customary sense, and in the few instances in which it seems to have merely the force of the Anglo-Saxon termination, it has a sense equally accordant with the original force of the word. Mr. H. Tooke has shewn that *to* (as well as *do*, which is certainly the same word,) is a particle of a Gothic substantive, signifying *act*, *effect*, and we presume *object*; now when we say, I am going to walk, *to* shows that *walk* (which is still the *name* of an action) is the object of my going: but when we say, To walk is healthful, *to* designates the word following as the name of an action, and the expression means the *act* (*viz.*) *walk* is healthful. We must, however, admit, that the *use* of *to* before the noun-state of verbs does not seem to be in every case consistent with its meaning; but such cases may fairly be referred to the general tendency there is to lose sight of the original force of words, in the stress laid on them in particular cases, or in the mode of their employment in particular cases; and hence by degrees to extend the employment of them to similar cases, without reference to their primary signification.

31. The *infinitive* mood, as it is commonly called, is the verb, divested of its peculiar force, *viz.* of affirmation, and uncompounded with those words which render it expressive of person, number, &c.

and in the modern languages of time; but is seems erroneous to consider this as the fundamental form of the verb, where it has any distinguishing termination: it is then the noun-state of the word with a termination added to it, to show that it is to be employed as a verb. Thus in the Anglo-Saxon ꝺean, ꝺe is the fundamental form of the verb, and an is the verbalising adjunct. Now as the *imperative* form of the verb is nothing more or less than the simple verbal name, unattended with the inference of affirmation, this may be considered as the fundamental form: and in the Latin, in particular, the variations of flexion are traced with the greatest advantage from this source. But without enlarging on this point, with which our language in the present state of it has no concern, we must repeat, that the imperative form of the verb is merely the noun-state, or verbal name; and that command, entreaty, &c. supposed to be conveyed by it, are merely the inference of custom. If I say to a servant, Bread, it is understood that I wish him to bring me bread, but it is not said: if I say, Bring some bread, in like manner it is understood, that I wish him to bring me bread, but all that is expressed is the name of the action, and the object of the action. It has, indeed, been supposed, that an affirmation is understood, as, I desire you to bring some bread; but this supposition is rather to show, that *bring*, &c. in such situations, are verbs, than to show the actual procedure. The fact is, full as much is done by inference, as by actual expression, in every branch of language, and even as it is, thought is too quick for words. Admitting the justness of this account of the imperative mood, we need not be surprised at the plan adopted by the Greek writers, of using the infinitive instead of it; nor need we resort to a sub-auditor, in order to show the ground of this use, or to complete the grammatical construction. And it may be considered as confirmatory of it, that the Hebrew imperative is the same with the radical form of the verb in its several conjugations, excepting Niphal, where it is the same as the infinitive.

32. When the verbal energy is referred to past time, a change is made in the form of nearly all our English verbs: the greater proportion of them add *ed* to the noun-state. Whether this alteration was originally intended to refer the meaning of the verb to past time, or that the change had a different object, and the reference has been gradually formed in consequence of an appropriation similar to what we spoke of, respecting the objective form of pronouns, we have yet to learn; but there seems little room to doubt but that all the common changes which have taken place in the verbs of all languages, whether to denote time, person, number, or mode of signification, have been formed in consequence of the coalescence of words of appropriate signification; and though the gradual refinements of language may have greatly varied the associations of words from what they originally possessed, yet that these changes were originally found sufficient to answer their respective purposes. In some cases, the contrivances adopted can be traced even yet; and from the new turn which has lately been given to etymological investigation, we may expect other discoveries respecting the causes or origin of particular flexions: the future of the French verb is nothing more than the infinitive of the verb, with the present tense of *avoir* following it: thus, *blâmer-ai* is *ai blâmer*, and *je blâmerai* means *I have to blame*, which mode of expression is in our own language used with a future force; the leading distinction between the past and future tense of the Hebrew verb is, that in the former the verb is placed before the fragment of the pronoun forming the person, and in the latter after it, as one would suppose to indicate that the verbal denotement is in one case past, in the other case future.

33. Similar observations may be made respecting the persons of verbs. In the Hebrew they are formed, as one would expect, by the coalescence of syllables, which are still acknowledged as pronouns: the same plan has doubtless been adopted in the Latin and Greek verbs, and in some few cases it can be traced with mush probability. In our own language there are additions made to the verb, in both the past and present form, when *thou* is the subject of affirmation, and in the present, when any singular word, excepting *I* and *thou*, is the subject. We are not aware of any advantage derived from these changes (and the same remark may be applied to the French verb;) for they do not supersede the necessity of expressing the subject of affirmation, as in the case of Latin and Greek verbs; but probably in their original import they contained in them the subject of affirmation, unless indeed they were different dialects of the verb, which by degrees were appropriated to particular subjects.

34. The variations in the Greek and Latin verbs, which denote time and man-

ner of signification, are supplied in English by other verbs, which, from their employment, are called auxiliary, or helping verbs: these are, *be, do, have, shall, will, may,* and *can,* which admit of the variations of other verbs, and *must* and *let,* which are unvaried. *Do* in its present use is merely emphatic; and assists in producing a discrimination which cannot be denoted in other languages; but from its general resemblance to the other auxiliaries, we have mentioned it among them. It is obviously the same word, both in appearance and in force, with the word, *do,* when not employed as an auxiliary. *Shall* signifies *owe*, and was formerly used as a simple verb. *Will* we use at present as a simple verb. These two words are employed as the principal denotements of future time; and though their original signification has in some degree yielded to that with which custom has invested them, the former is usually to be traced. *May* signifies to be *able.* *Can* signifies to *know,* to *ken,* and thence to be *able.* These words are all employed as auxiliaries, in their past as well as present tenses. *Must* signifies to be *obliged.* *Let* is the noun-state imperative of to *let,* signifying to *permit.* *Have,* as an auxiliary, has the same force with the simple verb; it means to possess. How this meaning is preserved in the complex expression, *I have loved,* or similar cases, we shall see in what will be said respecting the participle.

35. We have an abbreviated mode of expression in English, which has given some trouble to the grammarian, but is now pretty well understood, the *subjunctive mode,* or *future contingent form.* This arises from the omission of the future auxiliary *shall* or *will,* after words which render the affirmation contingent: thus, instead of saying, *If thou shalt or shouldst love,* we may say, *If thou love.* In all other cases in which affirmation is made, we say the verb is in the *indicative* mood. On this mood we have only to make one remark, respecting the interrogative employment of it. In interrogations we may simply state the thing, or the assertion respecting which we require information, leaving our wishes to be inferred by the reader from the connection, or some word or mark of interrogation, or by the hearer, from a variation of our tone; or, which is certainly preferable, we may make such a change in the order of the words as may leave our meaning out of doubt. This is effected in our own language by putting the subject after the verb; but this is not to be considered as making any change on the mode of its signification, but merely as indicating to the eye or ear the wish of the speaker to gain information respecting the affirmation.

V. *Of the Participle.*

36. Participles are formed from verbs, generally by the addition of terminations, originally without doubt expressive, but now ceasing to have in themselves considered any force. What their original force was will probably be shewn us in future conversations at Purley; their present force is all into which we can as yet enter. Those participles which are formed by the addition of *ing* to the noun-state of the verb express a *continued state* of the verbal denotement; and as it is frequently implied that what is meant by the verb is being continued at some time referred to, they are called *present* participles. Those which are formed by the addition of *ed* or *en* to the noun-state, or by some change in the characteristic letters of the verb, usually denote the *completed state* of what is meant by the verb: hence they are called *perfect* participles, or sometimes, with less propriety, *past* or *passive* participles. There does not seem to be any material difficulty attending the employment of these words, except in the case where a perfect participle is employed after the verb *have,* as I *have learned* my lesson. It has been supposed that this means, *I possess the finished act of learning my lesson:* we think it more probable that it means, I possess my lesson in that state which is called learned; in which case it is exactly equivalent to the Latin *habere,* followed by a participle in agreement with a noun. We readily admit that by, I have learned it, there is an inference brought into view, which is not by, I have it learned; but it seems to be merely the inference of custom, not resulting from any essential difference in the mode of expression.

VI. *Of the Adverb.*

37. We have already given a general account of the class of words called adverbs. Those to which our definition will apply, and to which alone the term should be appropriated, are principally adnouns, with or without nouns connected with them; others are prepositions with nouns following them; and the remainder are participles. The chief class of adverbs are those which end in *ly*; which termi-

nation is an abbreviation of the adnoun now spelt *like*, which is still frequently used by our northern neighbours as we use *ly*; thus, for *wisely*, they say *wiselike*. Of this class, a large proportion are formed by adding *ly* to *adnouns;* another set by adding the termination to *nouns*, as *manly*, *early*, (from aeɲ, morning) &c.: and these last are also used as adnouns. *Abed*, *aboard*, *ashore*, &c.; and *perchance*, *perhaps*, are prepositions with nouns; *a* signifying *on*, *in*, or *at*, and *per* being the Latin preposition. *Why*, *how*, &c. seem to be restrictives, their nouns being understood; as, *why* signifying *what*, *cause* or *reason* being understood; *how* signifying *which*, *way* or *manner* being understood. Several adverbs, besides those before mentioned ending in *ly*, are used either as adnouns or adverbs; such as *well*, *ill*, *much*, *worse*, *better*, &c.; in all such cases it must be remembered, that not the manner of signification, but merely the manner of employment, is changed. On the origin of most of those adverbs, which are less obviously formed from other sorts of words, Mr. H. Tooke has thrown great light; some of his derivations we may briefly state, but our limits will not allow of our doing more. The following are past participles of Anglo-Saxon verbs: *ago* signifying *gone* (time;) *adrift* signifies *driven; asunder* means *separated; fain*, *rejoiced; lief*, *beloved; astray*, *strayed* or *scattered. Needs* is *need-is*, used parenthetically. *Belike* is *by lykke*, *by chance*. *Aloft* is *on* or *in lyft*, *i. e.* the air, clouds, &c. *Much* is from *mo*, a heap; and is merely the diminutive of this word; passing through the gradual changes of *mokel*, *mykel*, *mochil*, *muchel* (still used in Scotland,) *moche*, *much*. *Rather* is the comparative of *rath*, *swift*. *Quickly* is *quicklike*, cpic, a past participle signifying *enlivened*; and it means in a *lifelike* or *lively* manner. *Very* is merely the French adjective *vrai*, anciently written *veray*, from the Latin *verus*. Some words, usually classed with adverbs, seem to have no common link of union with the genuine adverb; such are *yes*, *aye*, *yea*, and *no*: indeed Mr. H. Tooke speaks of this class of words as the common sink and repository of all heterogeneous, unknown corruptions. *Aye*, or *yea*, is the imperative of a verb of northern extraction, and means *have it*; and *yes* is *ay-es*, *have that*. *Not*)a genuine adverb) and *no*, its derivative, have their origin in the word from which arise the Dutch *noode*, *node*, *no*, meaning *averse*, *unwilling*.

VII. *Of the Connective.*

39. The precise nature of the words usually denominated conjunctions and prepositions was very little known, and not generally even suspected, till the publication of the "Diversions of Purley:" since that time, though philologists do not seem willing to admit, in all cases, the correctness of Mr. H. Tooke's derivations, yet his general principle is, we suppose, universally considered as completely established. Before his discoveries, it was the common opinion respecting the conjunction, that it is "a part of speech void of signification itself, but so formed as to help signification, by making two or more significant sentences to be one significant sentence;" and respecting the preposition, that it is "a part of speech, devoid itself of signification, but so formed as to unite two words that are significant, and that refuse to coalesce or unite of themselves." Our limits will not allow us to enter here into the arguments against these definitions, and the doctrine on which they are founded, nor indeed is it necessary; for, like the doctrine of instincts in mental philosophy, it solely depends on an appeal to ignorance, and falls to the ground, when a probable account is given of those procedures which it is supposed to explain. The distinction between prepositions and conjunctions we consider as merely technical, referring to the grammatical usage of employing the objective form of pronouns after the former, and not after the latter, unless there be some word understood which requires it: for it will be obvious to any one, that some conjunctions are still used "to unite words" as well as sentences, and that some prepositions are still used to unite sentences. The general principle before referred to is, "that all those words, which are usually termed conjunctions or prepositions, are the abbreviations or corruptions of nouns or verbs, and are still employed with a sense (directly) referable to that which they bore when in the acknowledged form of nouns or verbs." We believe this to be a correct statement of Mr. Tooke's theory; to adapt it to our own arrangements, we must include our adjectives under the term nouns, and our participles under the term verbs: and in addition to this remark, which is merely verbal, we must add, that in some instances this great philologist appears to have too much overlooked a procedure which meets us in various stages of lan-

guage, viz. that among the ideas connected with a word, that which was originally of primary importance becomes, by accidental circumstances in the mode of application, secondary only, and sometimes by degrees is altogether lost from the view of the mind, giving place to others, with which, from some cause or other, the word has been associated.

40. We now proceed to lay before our readers some specimens of the derivations and explanations given by Mr. H. Tooke. *That* is frequently termed a conjunction; it is sometimes termed a pronoun; we class it with the restrictives: but under whatever name it is known, its use and signification is the same. The differences supposed to be perceived in them arise simply from unnoticed ellipses or abbreviations of construction. If it be remembered that *that* was originally applicable to nouns of both numbers, no difficulty will be found by any intelligent reader in analysing sentences in which it occurs as a pronoun: in cases where it is used as a conjunction, the following analyses will serve as a sufficient clue. "I wish you to believe that I would not hurt a fly." Resolution; I would not hurt a fly, I wish you to believe that (assertion.) "Thieves rise by night that they may cut men's throats." Resolution: Thieves may cut men's throats, (for) that (purpose) they rise by night. *If* (formerly written *gif*) is merely the imperative of the Gothic and Anglo-Saxon verb *gifan*, to give In Scotland and the northern counties of England *gin* is used in place of *if;* and *gin* is merely the past participle *given* abbreviated. Hence, "I will read *if* (or *gin*) you will listen, means, *give* (or this *given*) that you will listen, I will read: and it cannot be unknown to the classical reader, that the imperative *da* is used in exactly the same manner. *An*, now nearly obsolete, is the imp. of *anan*, to grant. *Useless* (formerly sometimes written *onles*) is the imp. of *onlesan*, to send away. From *alesan* comes the imperative *else*; and from *lesan* the past participle *lest*; both verbs meaning the same with *onlesan*. From the same source come *less* and *least*, the privative termination *less*, the verbs *loosen*, *loose*, *lessen*, &c. *Yet* is the imperative of *getan*, to get; and *still*, of *stillan*, to put. *Though* (in some counties still pronounced *thaf*, *thof*,) is the imperative of *thafian*, to allow or grant. *But* is now corruptly employed for two words, *bot* and *but; bot* is the imperative for *botan*, to *boot*, to add, in order to supply a deficiency; *but*, of *been-utan*, to be-out, and has the same signification as *without*. But properly requires a negative in construction with it, as I saw none but him; but it is often omitted, as, I saw but two plants. *Without* is the imp. of *wyrthan-utan*, to be-out. And as the imp. of *anan-ad*, to heap, or add. Formerly four different sets of words were used where now *since* is used, and it is now taken four ways: 1. For *siththan*, *sithence*, or *seen and thenceforwards;* as, It has not been done since the reign of John. 2. For *syne*, *sene*, *or seen;* as, Did George II. live before or since that example? 3. For *seand*, *seeing*, *seeing as*, or *seeing that;* as, I should labour for truth, since no effort is lost. 4. For *siththe*, *sith*, *seen-as*, or *seen-that*; as, Since death in the end takes from all. *Sithence* and *sith* were in good use till the time of the Stuarts. *So* and *as* are articles meaning the same as, *it*, *that*, or *which*. *As* he sows, *so* he will reap, with the ellipses supplied, is, (In) what (manner) he sows, (in) that he will reap, or even without supplying them, What he sows, that he will reap.

41. Prepositions, to use the ideas of Mr. Tooke, are necessary in language, because it is impossible to have a distinct complex term for each different collection of ideas which we have occasion to put together in discourse. By the aid of prepositions, complex terms are prevented from being indefinitely numerous, and are used only for those collections of ideas which we have most occasion to use. This end is thus answered; we either take that complex term which includes the greatest number, though not *all* of the ideas we would communicate, or else that which includes *all* and the fewest *more*; and then by the help of the preposition we either make up the deficiency in the one case, or retrench the superfluity in the other: so, a house *with* a party wall; a house *without* a roof. Other relations are declared by prepositions; but they have all meanings of their own, and are constantly used according to those meanings. *With* is the imperative of *withan*, to join: sometimes of *wyrthan*, to be; in which case it is exactly the same with *by*. *Through* or *thorough* is the Gothic substantive *dauro*, or the Teutonic *thuruh*, and like them means door, gate, passage; so, *through* the air, is, *passage* the air, or the air being the *passage* or *medium*. *From* is the Anglo-Saxon noun *frum*, beginning, source, author. Of this word Harris produces three examples, which he considers as proving that it is used in three different relations, *viz.* detached relation, quiescence, and motion, the last

two being contradictory: these figs came *from* Turkey; the lamp hangs *from* the ceiling; the lamp falls *from* the ceiling. Now *came* is a complex term for one species of motion; *falls* for another; *hangs* for a species of attachment. Have we occasion to mention the *beginning* or *commencement* of these notions and this attachment, and the place where they begin or commence? What more natural or more simple than to add the signs of these ideas, *viz.* the word *beginning* (which always remains the same,) and the name of the place (which will perpetually vary.) Figs came *beginning* Turkey; lamp {hangs / falls} *beginning* ceiling: *i. e.* Turkey the *place* of *beginning* to come; ceiling the *place* of *beginning* to {hang. / fall.} *To* is the Gothic substantive *taui*, act, effect, end, or result, which is itself the past participle of *taugan*, to do. *While* is an Anglo-Saxon substantive, signifying *time*; *till*, is *to-while*, to the time; *until*, is on to the time. *Of* is probably a fragment of the Anglo-Saxon substantive *afora*, offspring, &c. and always means consequence, offspring, succession, follower, &c. In all the instances produced in the dictionaries, *cause* may be substituted for *for*, without injury to the sense, though sometimes awkwardly. It is probably the Gothic substantive *fairina*, cause. *By* is the imperative of *be on*, to be; frequently, but not always, used with an abbreviation of construction, *instrument*, *cause*, *action*, &c. being understood. *Among* is the past participle of *gamængan*, to mingle. *After* is the comparative of *aft*. *About* is from *boda*, the first outward boundary or extremity of any thing; hence *onboda*, *onbuta*, *abuta*, *about*. *In*, *out*, *on*, *off*, and *at*, Mr. Tooke does not profess to trace to an origin; we feel little doubt that *on* is simply one of the several forms of the numeral *one*; and the same process of thought has occurred in the Greek, where *εις* and *εν* (and perhaps also *συν*) are almost indisputably the corresponding numeral. We should have thought it probable that the English *in* has the same origin as *on*, if Mr. H. Tooke had not produced the Gothic substantive *innd*, the interior part of the body (used also for cave or cell.) *Out* he thinks not improbably originally meant skin.

VIII. *Of the Interjection.*

42. We have very little to say in addition to what we have said respecting this small and insignificant class of words. *Oh*, or *O*, is almost the only word for which it is necessary. A few other words may be mentioned as being usually classed with it. *Farewell* is the imperative of *faran*, to go, and the adverb *well*. *Halt* is the imperative of *healdan*, to hold. *Lo* is the imperative of look. *Fie* is the imperative of *fian*, to hate. *Welcome* means, it is *well* that you are come. *Adieu*, used so often without a moment's thought as to its serious import, is the French *à Dieu*, *to God*, meaning, I commend you *to God*.

GRAMME, in French weights. The unit weight, called a gramme, is the weight of the cube of the hundredth part of the metre of distilled water, taken at its maximum density. It answers to 15.444 grains. The kilogramme, or the weight of a thousand grammes, is equal to 32 1-6 Troy ounces.

GRANARY, a building to lay or store corn in, especially that designed to be kept a considerable time.

GRANATITE, *cross stone*, a mineral found in Spain, and in some parts of France and Switzerland. It is crystallized in a very peculiar form; two six-sided prisms intersect each other at right angles, or obliquely. Hence its name, cross stone. It is of a reddish brown colour: specific gravity 3.3, nearly. It is fusible before the blow-pipe. It consists of

Silica - - - - - - -	33
Alumina - - - - - -	44
Lime - - - - - - -	3.84
Oxide of iron - - -	13
Oxide of manganese -	1
	94.84
Loss - - -	5.15
	100

GRAND *jury*. The sheriff of every county is bound to return, to every commission of oyer and terminer, and to gaol delivery, and to every session of the peace, twenty-four good and lawful men of the county, some out of every hundred, to enquire, present, do, and execute all those things which shall then and there be commanded them. They ought to be freeholders; but to what amount is not limited by law. Upon their appearance they are sworn upon the grand jury, to the amount of twelve at the least, and not more than twenty-three, that twelve may be a majority. They are only to hear evidence on the part of the prosecution; for the finding of an indictment is only in the nature of an inquiry on accusation, which is afterwards to be tried; and they are only to enquire, upon their oaths, whether there is sufficient cause to call upon the party to answer it. If twelve agree to find the bill, it must be pronounced a true bill, but it cannot be found by a smaller number. The mode of finding a bill is by indorsing it a true bill; when it is rejected it is indorsed "ignoramus," or not found; and no one can be tried by indictment without the finding by a grand jury.

GRAND *larceny*. See LARCENY.

GRANITE, in mineralogy, is a particular mountain rock, composed of felspar, quartz, and mica. In general the felspar is the predominating substance, and mica the least considerable. In some varieties the quartz is wanting, and in others the mica. The constituent parts differ likewise considerably in their magnitude: they alternate from large to small, and even very fine granular. The large and coarse usually belong to the oldest, and the small and fine granular to the newer granite formation. It differs also in colour, and this difference depends chiefly on the felspar, the quartz and mica being usually of a grey colour. The felspar passes from the white to the red. The felspar in granite has usually a vitreous lustre, and perfectly foliated fracture; in some varieties it passes into the earthy, with the loss of its lustre and hardness, even into porcelain earth. This is owing to decomposition, effected, according to Mr. Davy, by eletro-chemical agencies. Sometimes the constituent parts of granite are regularly chrystallized, but principally the felspar and quartz. The mica sometimes occurs in nests unmixed with the other parts. Sometimes the constituent parts are so arranged, that when a specimen is cut, its surface has a kind of resemblance to written characters. Hence it has been denominated GRAPHIC stone.

Besides felspar, quartz, and mica, the essential constituent parts of granite, other fossils occur in it: of these, schorl is the most frequent, and next is garnet and tin-stone. There are three formations of granite; the first, or oldest, serves as the basis for all the other classes of rocks. The second occurs only in the first; and the third, or newest, appear to be among the newest of the primitive rocks. In the oldest granite formation, when it rises to a height above the surface of the earth, and is surrounded by other primitive rocks, these are always wrapped around it, or the strata are mantle-shaped. This is one of the most widely-extended and abundant formations with which we are acquainted. The second granite formation occurs only in veins which traverse the oldest formation, but never reaches any of the newer rock. The newest granite formation always rests on some of the older primitive rocks, and usually in an overlying position. It never occurs in globular distinct concretions: its structure is very irregular, sometimes contains grains of precious garnet, and has a deep red colour. It often occurs in veins that shoot from the rock, or in veins that are not connected with any rock beyond the strata which they traverse.

When granite is exposed, it frequently occurs in high and steep cliffs, which form vast mural precipices: often also in lofty summits, denominated peaks. It is found in almost every country, and in many places the stones are of an immense size. The largest, as an unconnected stone, has been described in the sixty-eighth volume of the Philosophical Transactions. It is found near the Cape of Good Hope. Granite rocks are frequently traversed by rents, which widen by the action of the elements: the mass separates into fragments of greater or lesser magnitude, and they remain long piled on each other, in the most fanciful manner, appearing like vast artificial tumuli, or masses brought together by an immense flood. The hard white granite, with black spots, is a very valuable kind: it consists of congeries of variously constructed and differently coloured particles, not diffused among nor running into one another, but each pure and distinct, though firmly adhering to which ever of the others it comes in contact with, and forming a very firm mass. It is much used in London for the steps of public buildings, and in other situations where great strength and hardness are required. The hard red granite, variegated with black and white, is common in Egypt and Arabia. The stones used in paving the streets are another species of granite. Granite, though not abounding in metal, contains occasionally some of the most important. Iron and tin occur most frequently.

GRANT, in law, a gift, in writing, of such a thing as cannot be passed or conveyed by a word only, as a grant is the regular method, by the common law, of transferring the property of incorporeal hereditaments, on such things whereof no livery of seisin can be had. For which reason, all corporeal hereditaments, as lands and houses, are said to be in livery, and the others, as advowsons, commons, services, rents, reversions, and the like, lie in grant. He that granteth is termed the grantor: and he to whom the grant is made is termed the grantee. A grant differs from a gift in this, that gifts are always gratuitous; grants are upon some consideration or equivalent. The operative words in grants are, *dedi et concessi*, "I have given and granted." Grants may be void by uncertainty, impossibility, being against law, or a wrong title, to defraud creditors, &c. Grants of the King are by letters patent, and are void when obtained by mistake or deceit apparent, or for an estate which cannot be granted, such as an estate to a man and his heirs male, without saying of his body; because it is neither an estate in fee nor in tail.

GRANULATION, in chemistry, the process by which a metal is reduced into grains, which is effected by melting the metal, and then pouring it in a very slender stream into cold water. As soon as the metal comes in contact with water, it divides into drops, which have a tendency to a spherical shape, and are more or less perfect, according to the thinness of the stream, the height from which it falls, and the temperature of the metal. Some of the more fusible metals may be reduced to much finer grains, by pouring it in its melted state into a wooden box, rubbed over with chalk, and shaking it violently before it has time to become solid.

GRAPE. See VITIS. Grapes have been repeatedly examined by the best informed chemists and most accurate tests, but without that success which might have been expected. They are found to contain much sugar, a portion of mucilage and jelly, some albumen and colouring matter. Tartrate of potash, tartaric acid, the citric and malic acids, have likewise been discovered in them.

GRAPHIC *gold*. See TELLURIUM.

GRAPHIC *stone*. See GRANITE.

GRAPHITES, a mineral, principally of carbon, with a small portion of iron and silica. When pure it burns with a reddish flame, emitting beautiful sparks, and a smell of sulphur. Its specific gravity is about 2: it feels somewhat greasy, stains the fingers, and marks strongly. It is a true carburet of iron, of which there are several species: one is plumbago, or black-lead, so useful in the form of pencils. It consists of

Carbon	90
Iron	10
	100

GRAPHOMETER, a mathematical instrument, otherwise called a semi-circle, the use of which is to observe any angle whose vertex is at the centre of the instrument in any plane (though it is most commonly horizontal, or nearly so) and to find how many degrees it contains.

The graphometer is a graduated semicircle, ABC, (see plate VI. Miscel. fig. 5, 6, 7,) made of wood, brass, or the like, and so fixed on a fulcrum, GH, by means of a brass ball and socket, that it easily turns about, and retains any situation. It has two sights fixed on its diameter, AC, and at the centre there is commonly a magnetical needle and compass in a box. There is likely a moveable ruler or index, ED, with two sights, P, P, which turns round the centre, and retains any situation given it.

To measure by this instrument an angle, ABC, in any plane, and comprehended between the right limes, AC and BC, drawn from two points, A and B, to the place of station, C. Let the graphometer be placed at C, supported by its fulcrum; and let the immoveable sights on the diameter of the instrument, DE, be directed towards the point A; and likewise, while the instrument remains immoveable, let the sights of the ruler FG, which is moveable about the centre, C, be directed to the point B. Now it is evident, that the moveable ruler cuts off an arch, DH, which is the measure of the angle, ABC, sought. Moreover, by the same method, the inclination of DE, or of FG, may be observed with the meridian line, which is pointed out by the magnetic needle inclosed in the box, and moveable about the centre of the instrument.

GRAPNELS, a sort of anchors with four flukes, serving for boats to ride by.

There is also a kind called fire and chain-grapnels, made with four barbed claws, instead of flukes, and used to catch hold of the enemy's rigging, or any other part, in order for boarding them.

A fire-grapnel, in some respects, resembles the former, but differing in the construction of its flukes, which are furnished with strong barbs on its points. Fire grapnels are usually fixed by a chain on the yard-arm of a ship, to grapple any adversary whom she intends to board, and are particularly requisite in fire ships.

GRASS, in botany. The tribe of grasses in one of the seven natural families into which all vegetables are distributed by Linnæus, in his "Philosophia Botanica." They are defined to be plants which have very simple leaves, a jointed stem, a husky calyx, named a glume, and a single seed. This description includes corn as well as the grasses.

Most of these plants are annual or perennial herbs; some of them are erect, others creep upon the ground. The roots, in the greatest number creep, and emit fibres from each knot or joint; in others, they are simply branched and fibrous. The stems and branches are round: the leaves are simple, alternate, entire, very long; and commonly narrow; they are generally placed immediately upon the stem, except in the bamboo, and a few others, which have a foot stalk at the origin of the leaves. The leaves form below a sort of sheath, which embraces the stem, and is generally cleft on one side through its whole length. The top of the sheath is sometimes crowned with a membrane, that is either cleft or entire, and is frequently accompanied with two appendages or ears, as in rice, pharus, darnel, wheat, rye, and barley. In others, the sheath is crowned with hairs, as in millet, panic-grass, and andropogon, and in some species of panic-grass it is naked, that is, has neither membrane nor hairs. There are three sections. The flowers are hermaphrodite in plants of the first section; male and female upon the same root in those of the second; hermaphrodite and male on the same root in those of the third. They proceed either singly from the sheath of the leaves, as in lygeum; form a single spike, as in nardus and darnel; or are formed into a panicle, that is, loose spike, as in poa, agrestis, and oats. The calyx and corolla in this order are not sufficiently ascertained. In some a single scale or husk, in others two, as in nardus, supply the place of both covers; some grasses, as canary-grass, and phleum, have four husky scales, two of which serve for the calyx, and the other two for the corolla; some have five, as anthoxanthum; others six, as rice, four of which are supposed to constitute the calyx, and the other two are termed, improperly enough, the husky petals. The corolla is sometimes composed of one petal with two divisions, as in fox-tail grass. The stamina are generally three in number, and placed irregularly with respect to the situation of the calyx and corolla. One stamen is commonly placed betwixt the seed bud and the two small scales or external husk of the corolla; and two betwixt the seed bud and the inner husk. Rice, zizania, and pharus, have six stamina. The anthers are long, furnished with two cells, and slightly attached to the filaments. The seed bud is placed upon the same receptacle as the calyx, corolla, and stamina. In bobartia it is said to be placed under the receptacle of the flower. The style is generally double, and crowned with a hairy stigma or summit. The seed vessel in this order is wanting. The seeds are single, oval, and attached below to the bottom of the flower.

GRATIOLA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx seven-leaved, the two outer leaves petalous; corolla irregular, reversed; stamens two, barren; capsule two celled. There are twelve species.

GRAVE, in music, is applied to a sound which is of a low or deep tone. The thicker the cord or string, the more grave is the note or tone; and smaller, the more acute. The gravity of sounds depends on the slowness of the vibratory motions of the chord; and their acuteness on its quick vibrations. Grave, in the Italian music, denotes a very grave and slow motion, somewhat faster than adagio, and slower than largo.

Grave *accent*, in grammar, shews that the voice is to be lowered; its mark stands thus \`. See Accent.

Grave *digging beetle*. See Silpha.

GRAVEL, in natural history and gardening, a congeries of pebbles, which, mixed with a stiff loam, makes lasting and elegant gravel walks, an ornament peculiar to our gardens, and which gives them the advantage over those of other nations.

GRAVER, in the art of engraving, a tool by which all the lines, scratches, and shades, are cut in copper, &c. Gravers are of three sorts, round-pointed, square-pointed, and lozenge. The round are the best for scratching; the square-pointed are for cutting the largest strokes, and the lozenge-pointed-ones for the most fine and delicate strokes; but a graver of a middle form, between the square and lozenge-pointed, will make the strokes or scratches appear with more life and vigour. See Engraving.

GRAVIMETER, the name given by M. Guyton to an instrument for measuring specific gravities: he adopts this name rather than either acrometer or hydrometer, because these latter terms are grounded upon the supposition that a fluid is always the thing weighed; whereas with regard to solids, the liquid is the known term of comparison to which the unknown weight is referred. Guyton's gravimeter is executed in glass, and is of a cylindric form, being that which requires the smallest quantity of fluid, and is on that account preferable, except so far as it is necessary to deviate for the security of a vertical position. It carries two basins, one of them superior, at the extremity of a thin stem, towards the middle of which the fixed point of immersion is marked. The other or lower basin terminates in a point; it contains the balls, and is attached to the cylinder by two branches. The moveable suspension by means of a hook has the inconvenience of shortening the lever which is to secure the vertical position. The cylinder is three fourths of an inch in diameter, and 6.85 inches in length. It carries in the upper basin an additional constant weight of five grammes, or one hundred and fifteen grains. These dimensions might be increased so as to render it capable of receiving a much more considerable weight; but this is unnecessary. M. Guyton has added a piece which he calls the plonguer, because, in fact, it is placed in the lower basin when used, and is consequently entirely immersed in the fluid. It is a bulb of glass loaded with a sufficient quantity of mercury, in order that its total weight may be equal to the constant additional weight added to the weight of the volume of water displaced by this piece. It will be readily understood, that, the weight being determined at the same temperature at which the instrument was originally adjusted, it will sink to the same mark on the stem, whether it is loaded with a constant additional weight in the upper basin, or whether the effect of this weight be produced by the additional piece in the lower dish. From this explanation there will be no difficulty in seeing how this instrument may be adapted to every case in practice. It may be used, 1. For solids. The only condition will be, that the absolute weight of the body to be examined shall be rather less that the constant additional weight, which in this instrument is about 115 grains. 2. For liquids of less specific gravity than water, the instrument, without the additional weight above mentioned, weighs about four hundred and fifty-nine-grains, in the dimensions before laid down. It would be easy to limit its weight to the utmost accuracy. We have therefore the range of one-fifth of buoyancy, and consequently the means of ascertaining all the intermediate densities from water to the most highly rectified spirit of wine, which is known to bear in this respect the ratio of eight to ten with regard to water. 3. When liquids of greater specific gravity than water are to be tried, the constant weight being applied below by means of the additional piece, which weighs about one hundred and thirty-eight grains, the instrument can receive in the upper basin more than four times the usual additional weight, without losing the equilibrium of its vertical position. In this state it is capable of shewing the specific gravity of the most concentrated acids. 4. It possesses another property, namely, that it may be used as a balance to determine the absolute weight of such bodies as do not exceed its additional load. 5. Lastly, the purity of the water being known, it will indicate the degrees of rarefaction and condensation in proportion to its own bulk. To find the specific gravity of any solid by the gravimeter, observe this rule: "From the weight in the upper dish, when the instrument is properly immersed in the unknown fluid, take the weight which is placed with the body in the same scale at the like adjustment. The remainder is the absolute weight of the solid. Multiply this by the specific gravity of the fluid, and reserve the product. From the additional weight, when the body is placed in the lower basin, take the weight when it was placed in the upper. The remainder will be the loss of weight by immersion. Divide the reserved product by the loss by immersion, and the quotient will be the specific gravity of the solid with regard to distilled water at the standard temperature and pressure." To find the specific gravity of a fluid, proceed thus: "To the weight of the gravimeter add the weight required in the upper basin to sink it in the unknown fluid." Again, "To the weight of the gravimeter add the weight required in the same manner to sink it in distilled water. Divide the first sum by the latter, and the quotient will be the specific gravity of the fluid in question." See Specific Gravity, Hydrostatics, and Hydrometer.

GRAVING. See Engraving. In sea affairs the word graving is used for the act of cleaning a ship's bottom, when she is laid aground during the recess of the tide. See Breaming and Careening.

GRAVITY.

GRAVITY, a term used by physical writers to denote the cause by which all bodies move toward each other, unless prevented by some other force or obstacle. The most familiar effect, and that which continually obtrudes itself on our notice, is the weight of bodies, or their tendency toward the centre of the earth. It has not been ascertained, or rendered probable, that gravity is a secondary property of matter; that is to say, that it flows from any of the other known original properties. Sir Isaac Newton, however, was of opinion, that our reasonings on the subject might be simplified, by supposing it to depend on a prodigiously elastic and rare fluid, by him called ether, and assumed to possess an increasing degree of condensation, in parts of space more and more remote from the various masses of matter. According to this doctrine, a falling body moves, because it is pressed toward the rarer parts of this extended fluid. We shall leave this theory to its merits, as being neither very perspicuous, nor much related to our subject. Bergman, and others, have considered the chemical and cohesive attractions to be one and the same with the attraction of gravity, but modified in its laws, by variations in the masses, densities, and distances of the particles of bodies. Many difficulties appear at first sight to offer themselves against this supposition. But in truth it cannot be examined at first sight; and requires to be submitted to the rigour of mathematical investigation, which has not yet been done.

The phenomena of particular gravity, or that which respects the earth, or by which bodies descend or tend towards the centre of the earth, are as follow:

1. All circumterrestrial bodies do hereby tend towards a point, which is either accurately, or very nearly, the centre of the magnitude of the terraqueous globe. Not that it is meant that there is any virtue or charm in the point called the centre, by which it attracts bodies; but because this is the result of the gravitation of bodies towards all parts of which the earth consists.

2. In all places equidistant from the centre of the earth, the force of gravity is nearly equal. Indeed, all parts at the earth's surface are not at equal distances from the earth's centre, because the equatorial parts are higher than the polar parts by about seventeen miles; as has been proved by the necessity of making the pendulum shorter in those places, before it will swing seconds. In the new "Petersburg Transactions," vol. 6 and 7. M. Krafft gives a formula for the proportion of gravity in different latitudes on the earth's surface, which is this:

$$y = (1+0.0052848 \text{ sine } {}^2\lambda)g;$$

where g denotes the gravity at the equator, and y the gravity under the other latitude λ.

3. Gravity equally affects all bodies, without regard either to their bulk, figure, or matter: so that, abstracting from the resistance of the medium the most compact and the most loose, the greatest and the smallest bodies would all descend through an equal space in the same time, as appears from the quick descent of every light body in an exhausted receiver. The space which bodies do actually fall in vacuo, is $16\frac{1}{12}$ feet in the first second of time, in the latitude of London; and for other times, either greater or less than that, the spaces descended from rest are directly proportional to the squares of the times, while the falling body is not far from the earth's surface.

4. This power is the greatest at the earth's surface, from whence it decreases both upwards and downwards; but not both ways in the same proportion; for, upwards, the force of gravity is less, or decreases as the square of the distance from the centre increases; so that at a double distance from the centre above the surface, the force would be only one-fourth of what it is at the surface; but below the surface, the power decreases in such sort, that its intensity is in the direct ratio of the distance from the centre; so that at the distance of half a semi-diameter from the centre, the force would be but half what it is at the surface; at one-third of a semi-diameter the force would be but one-third, and so on.

5. As all bodies gravitate towards the earth, so does the earth gravitate towards all bodies; as well as all bodies towards particular parts of the earth, as hills, &c. which has been proved by the attraction a hill has upon a plumb line, insensibly drawing it aside. Hence the gravitating force of entire bodies consists of those of all their parts; for, by adding or taking away any part of the matter of a body, its gravity is increased or decreased, in the proportion of the quantity of such portions to the whole mass. Hence, also, the gravitating powers of bodies at the same distance from the centre are proportional to the quantities of matter in the bodies.

General or universal gravity, is that by which all the planets tend towards one another; and, indeed, by which all bodies or particles of matter in the universe tend towards one another.

The existence of the same principles of gravitation in the superior regions of the heavens as on the earth is one of the great discoveries of Newton, who made the proof of it as easy as that on the earth. This was at first only a conjecture in his mind; he observed, that all bodies near the earth, and in its atmosphere, had the property of tending directly towards it; he soon conjectured, that it probably extended much higher than to any distance to which we could reach to make experiments; and so on, from one distance to another, till he at length saw no reason why it might not extend to the moon, by means of which she might be retained in her orbit, as a stone in a sling is retained by the hand; and if so, he next inferred, why might not a similar principle exist in the other great bodies in the universe, the sun, and all the other planets, both primary and secondary, which might all be retained in their orbits, and perform their revolutions by means of the same universal principle of gravitation.

He soon realized and verified these by mathematical proofs. Kepler had found out, by contemplating the motions of the planets about the sun, that the area described by a line connecting the sun and planet, as this revolved in its orbit, was always proportional to the time of its description, or that it described equal areas in equal times, in whatever part of its orbit the planet might be, moving always as much the quicker as its distance from the sun was less. And it is also found, that the satellites, or secondary planets, respect the same law in revolving about their primaries. But it was soon proved, by Newton, that all bodies moving in any curve line described on a plane, and which, by radii drawn to any certain point, describes areas about the point proportional to the times, are impelled or acted on by some power tending towards that point. Consequently, the power by which all these planets revolve, and are retained in their orbits, is directed to the centre about which they move, viz. the primary planets to the sun, and the satellites to their several primaries.

Again, Newton demonstrates, that if several bodies revolve with an equal motion in several circles about the same centre, and that if the squares of their periodical times be in the same proportion as the cubes of their distances from the common centre, then the centripetal forces of the revolving bodies, by which they tend to their central body, will be in the reciprocal or inverse ratio of the squares of the distances. But it had been agreed on by the astronomers, and particularly Kepler, that both these cases obtain in all the planets; and therefore he inferred, that the centripetal forces of all the planets were reciprocally proportional to squares of the distances from the centres of their orbits.

Upon the whole, it appears that the planets are retained in their orbits by some power which is continually acting upon them: that this power is directed towards the centre of their orbits: that the intensity or efficacy of this power increases upon an approach towards the centre, and diminishes on receding from the same, and that in the reciprocal duplicate ratio of the distances; and that by comparing this centripetal force with the force of gravity on the earth, they are found to be perfectly alike, as may easily be shown in various instances. For example, in the case of the moon, the nearest of all the planets, the rectilinear spaces described in any given time, by a body urged by any power, reckoning from the beginning of its descent, are porportionate to those powers. Consequently, the centripetal force of the moon, revolving in its orbit, will be to the force of gravity on the surface of the earth as the space which the moon would describe in falling, during any small time, by her centripetal force towards the earth, if she had no motion at all, to the space a body near the earth would describe in falling by its gravity towards the same.

Now, by an easy calculation of these two spaces, it appears that the former force is to the latter as the square of the semi-diameter of the earth is to the square of that of the moon's orbit. The moon's centripetal force, therefore, is equal to the force of gravity; and consequently these forces are not different, but they are one and the same; for if they were different bodies, acted on by the two powers conjointly, they would fall towards the earth with a velocity double to that arising from the sole power of gravity.

It is evident, therefore, that the moon's centripetal force, by which she is retained in her orbit, and prevented from running off in tangents, is the very power of gravity of the earth extended thither. See "Newton's Principia," lib. i. prop. 45, cor. 2. and lib. iii. prop. 3; where the numeral calculation may be seen at full length.

The moon, therefore, gravitates towards the earth, and reciprocally the earth towards the moon, and this is also farther confirmed by the phenomena of the tides.

The like reasoning may also be applied to the other planets. For as the revolutions of the primary planets round the sun, and those of the satellites of Jupiter and Saturn round their primaries, are phenomena of the same kind with the revolution of the moon about the earth; and as the centripetal powers of the primary are directed towards the centre of the sun, and those of the satellites towards the centres of their primaries; and, lastly, as all these powers are reciprocally as the squares of the distances from the centres, it may safely be concluded that the power and causes are the same in all. Therefore, as the moon gravitates towards the earth, and the earth towards the moon, so do all the secondaries to their primaries, and these to the secondaries; and so also do the primaries to the sun, and the sun to the primaries. Newton's Princip. lib. iii, prop. 4, 5, 6; Greg. Astron. lib. i. sect. 7, prop. 46 and 47.

The laws of universal gravity are the same as those of bodies gravitating towards the earth, before laid down. See Astronomy, Attraction, Geography.

Gravity, *specific.* Boyle is among the first of our philosophers, who suggested the advantage that chemistry and mineralogy might derive from an attention to the specific gravities of bodies. Much advantage may indeed be derived from this property in the general determination of the classes of minerals, and the purity of some metallic bodies; and it is very probable, that an attention to the specific gravities, capacities for heat, fusibilities, volatilities, laws of crystallization, elasticity, hardness, tenacity, malleability, and some other obvious specific properties of bodies, may produce a more intimate acquaintance with the mutual actions of their particles, than any we have hitherto acquired.

Annexed to this article is a table of specific gravities, from various authors. It appeared useless to carry it to more than four places of figures, as the temperatures are not noted; and the various specimens of the same substance often differ in the third figure. Besides this, it is remarked by Nicholson, in his "Chemical Dictionary," that the fifth figure changes in water at every three degrees of Fahrenheit's thermometer; that lead, tin, and probably all other metals, though cast out of the same fusion, will vary in their specific gravities in the third figure, from circumstances not yet determined, but most likely from the cooling, as is seen in the hardening of steel; that salts, and other artificial preparations, retain more or less of the solvent they were separated from, according to the temperature at which the crystallization was effected; and that all parts of organized substances not only differ, according to the place of their production, their age, and other circumstances, but likewise from their dryness, moisture, and manner of preservation.

The specific gravity of solids is determined by weighing them, first in air, and then in water. The loss of weight, arising from the action of the water, is equal to that of a mass of the fluid possessing the same dimensions as the solid itself. Whence it is easy to construct a general table of specific gravities, by reducing the proportion of the absolute weight to the loss sustained by immersion, into terms of which that expressing water shall be unity. If the solid be so light as to float upon water, it is convenient to attach to it a heavier body sufficient to cause it to sink, but the weight of which in water must be added in computing the loss. The specific gravity of fluids is ascertained by weighing a known body immersed in them. For the loss by immersion will accurately show the weight of the same bulk of the fluid; and, consequently, the proportion of these several quantities to the loss the same solid sustained in water being reduced, as in the other case, to the common standard of unity, will exhibit the specific gravity. Other methods are likewise used in experiments with fluids. Thus equal bulks of different fluids may be weighed by filling a small bottle with a ground stopper with each respectively, and from their several weights the weight of the bottle and stopper must be deducted. Or, otherwise, the instrument called the hydrometer may be used. See Hydrometer. This possesses the advantage of portability, speed, and a degree of accuracy, not easily obtained by the use of ordinary balances.

GRAVITY.

A TABLE,

Shewing the Specific Gravity of Metals and other bodies to Rain Water, and the Weight of a Cubic Inch of each in parts of a Pound Avoirdupoise. The Number in the Column, Specific Gravity, shows the Ounces Avoirdupoise in the Cubic Foot of each body.

Bodies.	Sp. Grav.	W. lb. Av.
Pure gold cast - - - -	19258	0.71036
——— hammered	19362	0.70030
Standard gold cast -	17486	0.63250
——— hammered	17589	0.63618
Pure silver cast - - -	10474	0.37769
——— hammered	10511	0.38017
Standard silver in coin	10391	0.87580
Crude platina in grains	15602	0.56431
Platina purified and fused - - - - - -	19500	0.70530
—— hammered - - -	20377	0.73557
—— drawn into wire	21042	0.76107
—— laminated - - -	22069	0.79821
Mercury - - - - - - -	13568	0.49074
Lead fused - - - - -	11352	0.40965
Copper fused - - - -	7788	0.28168
—— drawn into wire	8878	0.32111
Brass cast - - - - - -	8396	0.30367
—— in wire - - - -	8544	0.30903
Iron cast - - - - - -	7207	0.26067
—— bar - - - - - -	7788	0.28168
Steel soft, and not hammered - - -	7840	0.28356
—— hardened - - -	7816	0.28270
Tin, English, fused -	7291	0.26381
—— hammered - - -	7299	0.26400
Malacca tin fused - -	7296	0.26382
——— hammered	7306	0.26486
Bismuth - - - - - - -	9823	0.35529
Nickel - - - - - - -	8660	0.31323
Arsenic, the metal -	5763	0.20844
Cobalt - - - - - - -	7812	0.28255
Zinc - - - - - - - -	7191	0.26009
Antimony - - - - - -	6702	0.24240
Manganese - - - - -	6850	0.24776
Wolfran - - - - - - -	17600	0.63657
Diamond - - - - - -	3251	0.11759
Ruby - - - - - - - -	4283	0.15491
—— Spinell - - - -	3760	0.13600
Topaz, Oriental - - -	4011	0.13507
——— Brazilian - -	3536	0.11718
——— Saxon - - - -	3564	0.12891
Sapphire, Oriental -	3994	0.14446
Emerald - - - - - -	2775	0.10037
Adamantine Spar - -	4180	0.15118
Rock crystal from Madagascar - - -	2653	0.09596
Quartz - - - - - - -	2654	0.09599
Agate - - - - - - - -	2590	0.09368
Onyx - - - - - - - -	2376	0.09537

Bodies.	Sp. Grav.	W. lb. Av.
Muscovy talc - - - -	279	0.10098
Common slate - - -	2672	0.09664
Calcareous spar - - -	2715	0.09820
Alabaster - - - - - -	2730	0.09874
White marble - - - -	2716	0.09823
Limestones, from - -	1386	0.05113
———, to - - -	2390	0.08644
Ponderous spar - - -	4474	0.16182
Fluor spar - - - - -	3180	0.11502
Pumice-stone - - - -	914	0.03306
Green glass - - - - -	2620	0.09476
English crown glass	2520	0.09115
White Flint glass, English - - - -	3290	0.11900
Another piece - - -	3216	0.11632
White flint glass for achromatic uses	3437	0.12431
White glass, French	2892	0.10460
Glass of S. Gobin - -	2488	0.09000
Brimstone - - - - -	1990	0.07198
Phosphorus - - - - -	1714	0.06199
Yellow amber - - - -	1078	0.3899
Distilled water - - -	1000	0.03617
Sea water - - - - - -	1026	0.03711
Common spirit of wine	837	0.03027
Spirit of wine, the purest that can be had by mere distillation - - -	820	0.2960
Sulphuric ether - -	739	0.02673
Nitrous - - - - - - -	909	0.03288
Marine - - - - - - -	730	0.02640
Acetous - - - - - - -	866	0.03132
Concentrated sulph. acid - - - - - -	2125	0.07686
——— nitric acid -	1580	0.05714
——— muriatic acid	1194	0.04319
Fluor acid - - - - -	1500	0.05425
Oil of olives - - - - -	915	0.03309
—— of sweet almonds	917	0.03316
Linseed oil - - - - -	940	0.03400
Naptha - - - - - - -	708	0.02561
Gum elastic - - - - -	393	0.03375
Camphor - - - - - -	989	0.03577
Yellow wax - - - - -	965	0.03490
White ditto - - - - -	969	0.03505
Spermaceti - - - - -	943	0.03411
Tallow - - - - - - -	942	0.03407
Heart of oak - - - -	1170	0.04232
Cork - - - - - - - -	240	0.01868

For the Specific Gravities of different kinds of elastic fluids, see the Table at the end of the article Gas.

GRAVITY, in music, is the modification of any sound, by which it becomes deep or low in respect of some other sound. The gravity of sounds depends on the thickness and distension of the chords, or the length and diameter of the pipes, and in general on the mass, extent, and tension of the sonorous bodies. The larger and more lax the bodies, the slower will be the vibrations and the graver the sounds.

GREASE. See FARRIERY.

GREAT *circle sailing*, the manner of conducting a ship in, or rather pretty near the arch of a great circle, that passes through the zenith of the two places, *viz.* from whence she came, and to which she is bound.

GREEK *church*. In the eighth century there arose a difference between the eastern and western churches, which, in the course of about two centuries and a half, ended in a total separation. The Greek, or Eastern, or, as it is sometimes called, the Russian Church, spread itself over the eastern parts of Europe. It bears a considerable resemblance to the church of Rome, but denies the infallibility and supremacy of the Pope: it rejects also the worship of images, and the doctrine of consubstantiation, or the union of the body of Christ with the sacramental elements. The administration of baptism is performed by immersing the whole body. The Greek church has the same division of clergy, and the same distinction of ranks and offices, with the church of Rome.

GREEN, one of the original colours excited by the rays of light. See CHROMATICS, COLOURS, and OPTICS. The green colour of plants has been shown, by the French chemists, to depend upon the absorption of carbonic acid, and it is supposed that the leaves of plants have the power of decomposing the carbonic acid, and water also; the oxygen they emit, while the carbon and hydrogen enter into the composition of the inflammable parts of the plant.

GREEN *Brunswick*, a pigment used by German artists, and known in our shops under that name. It is made by saturating cold water with muriated ammonia, and adding three times as much copper clipping as ammonia. The moisture is to be evaporated, taking care that no dust be allowed to get to it. The muriate of ammonia is decomposed by the copper, which is itself corroded and converted into a green oxide. It is then to be digested in successive portions of alcohol, as long as any green oxide is taken up; the solutions are now to be added together, and the liquor to be driven off by a moderate heat; the residue is the pigment required.

GREEN *cloth*, a board or court of justice, held in the counting-house of the king's household, composed of the lord-steward, and officers under him, who sit daily. To this court is committed the charge and over-sight of the king's household in matters of justice and government, with a power to correct all offenders, and to maintain the peace of the verge, or jurisdiction of the court-royal; which is every way about two hundred yards from the last gate of the palace where his Majesty resides. It takes its name, board of green-cloth, from a green cloth spread over the board where they sit. Without a warrant first obtained from this court, none of the king's servants can be arrested for debt.

GREEN *finch*. See FRINGILLA.

GREENHOUSE, or conservatory, a house in a garden contrived for sheltering and preserving the most tender and curious exotic plants, which, in our climate, will not bear to be exposed to the open air during the winter season. These are generally large and beautiful structures, equally ornamental and useful.

GREGORIAN *calendar*, that which shows the new full moon, with the time of Easter, and the moveable feasts depending thereon, by means of epacts, disposed through the several months of the Gregorian year.

GREGORIAN *epoch*, the epocha, or time whence the Gregorian calendar or computation took place. The year 1808 is the 226th year of that epocha.

GREGORIAN *year*, the Julian year corrected, or modelled in such a manner, as that three secular years, which in the Julian account are bissextile, are here common years, and only every fourth secular year is made a bissextile year.

The Julian computation is more than the solar year by eleven minutes, which in one hundred and thirty-one years amounts to a whole day. By this calculation, the vernal equinox was anticipated ten days from the time of the general council of Nice, held in the year 325 of the Christian æra, to the time of Pope Gregory XIII. who therefore caused ten days to be taken out of the month of October, in 1582, to make the equinox fall on the twenty-first of March, as it did at the time of that council; and to prevent the like variation for the future, he ordered that three days should be abated in every four hundred years, by reducing the leap year at the close of each century, for three successive centuries, to common years, and retaining the leap year at the close of each fourth century only.

This was at that time esteemed as exactly conformable to the true solar year, but it is found not to be strictly just, because that in four hundred years it gets one hour and twenty minutes, and consequently in 7200 years a whole day.

The greatest part of Europe have long used the Gregorian style: but great Britain retained the Julian till the year 1752, when, by act of parliament, this style was adjusted to the Gregorian; since which time Sweden, Denmark, and other European states, who computed time by the Julian account, have followed this example.

GREGORY (James), professor of mathematics, first in the university of St. Andrews, and afterwards in that of Edinburgh, was one of the most eminent mathematicians of the seventeenth century. He was a son of the Rev. John Gregory, minister of Drumoak, in the county of Aberdeen, and was born at Aberdeen, in November 1638. His mother was a daughter of Mr. David Anderson, of Finzaugh, or Finshaugh; a gentleman who possessed a singular turn for mathematical and mechanical knowledge. This mathematical genius was hereditary in the family of the Andersons, and from them it seems to have been transmitted to their descendants of the names of Gregory, Reid, &c. Alexander Anderson, cousin german of the said David, was professor of mathematics at Paris in the beginning of the 17th century, and published there several valuable and ingenious works. The mother of James Gregory inherited the genius of her family; and observing in her son, while yet a child, a strong propensity to mathematics, she instructed him herself in the elements of that science. His education in the languages he received at the grammar-school of Aberdeen, and went through the usual course of academical studies in the Marischal college; but he was chiefly delighted with philosophical researches, into which a new door had lately been opened by the key of the mathematics. Galileo, Kepler, Des Cartes, &c. were the great masters of this new method; their works therefore became the principal study of young Gregory, who soon began to make improvements upon their discoveries in Optics. The first of these improvements was the invention of the reflecting telescope; the construction of which instrument he published in his "Optica Promota," in 1663, at twenty-four years of age. This discovery soon attracted the attention of the mathematicians, both of our own and of foreign countries, who immediately perceived its great importance to the sciences of optics and astronomy. But the manner of placing the two specula upon the same axis appearing to Newton to be attended with the disadvantage of losing the central rays of the larger speculum, he proposed an improvement on the instrument, by giving an oblique position to the smaller speculum, and placing the eye-glass in the side of the tube. It is observable, however, that the Newtonian construction of that instrument was long abandoned for the original, or Gregorian, which is now always used when the instrument is of a moderate size; though Herschell has preferred the Newtonian form for the construction of those immense telescopes, which he has of late so successfully employed in observing the heavens.

About the year 1664, or 1665, coming to London, he became acquainted with Mr John Collins, who recommended him to the best optic glass-grinders there, to have his telescope executed. But as this could not be done, for want of skill in the artist to grind a plate of metal for the object speculum into a true parabolic concave, which the design required, he was much discouraged with the disappointment, and, after a few imperfect trials made with an ill-polished spherical one, which did not succeed to his wish, he dropped the pursuit, and resolved to make the tour of Italy, then the mart of mathematical learning, that he might prosecute his favourite study with greater advantage. And the University of Padua being at that time in high reputation for mathematical studies, Mr. Gregory fixed his residence there for some years. Here it was that he published, in 1667, "Vera Circuli et Hyperbolæ Quadratura;" in which he propounded another discovery of his own, the invention of an infinitely converging series for the areas of the circle and hyperbola. He sent home a copy of this work to his friend Mr. Collins, who communicated it to the Royal Society, where it met with the commendations of Lord Brounker and Dr. Wallis. He reprinted it at Venice the following year, to which he added a new work, entitled

"Geometriæ Pars Universalis, inserviens Quantitatum Curvarum, Transmutationi et Mensuræ;" in which he is allowed to have shewn, for the first time, a method for the transmutation of curves. These works engaged the notice, and procured the author the correspondence, of the greatest mathematicians of the age, Newton, Huygens, Wallis, and others. An account of this piece was also read before the Royal Society, of which Mr. Gregory, being returned from his travels, was chosen a member the same year, and communicated to them an account of the controversy in Italy about the motion of the earth, which was denied by Riccioli, and his followers. Through this channel, in particular, he carried on a dispute with M. Huygens, on the occasion of his treatise on the quadrature of the circle and hyperbola, to which that great man had started some objections; in the course of which our author produced some improvements of his series. But in this dispute it happened, as it generally does on such occasions, that the antagonists, though setting out with temper enough, yet grew too warm in the combat. This was the case here, especially on the side of Gregory, whose defence was, at his own request, inserted in the Philosophical Transactions. It is unnecessary to enter into particulars: suffice it therefore to say, that, in the opinion of Leibnitz, who allows Mr. Gregory the highest merit for his genius and discoveries, M. Huygens has pointed out, though not errors, some considerable deficiencies in the treatise above-mentioned, and shown a much simpler method of attaining the same end.

In 1688, our author published at London another work, entitled "Exercitationes Geometricæ," which contributed still much further to extend his reputation. About this time he was elected Professor of Mathematics in the University of St. Andrews, an office which he held for six years. During his residence there he married, in 1669, Mary, the daughter of George Jameson, the celebrated painter, whom Mr. Walpole has termed the Vandyke of Scotland, and who was fellow-disciple with that great artist in the school of Rubens, at Antwerp.

In 1672, he published "The great and new Art of weighing Vanity: or a Discovery of the Ignorance and Arrogance of the great and new Artist, in the pseudo-philosophical Writings. By M. Patrick Mathers, Archbedal to the University of St. Andrews. To which are annexed some Tentamina de Motu Penduli et Projectorum." Under this assumed name, our author wrote this little piece, to expose the ignorance of Mr. Sinclare, professor at Glasgow, in his hydrostatical writings, and in return for some ill usage of that author to a colleague of Mr. Gregory's. The same year Newton, on his wonderful discoveries in the nature of light, having contrived a new reflecting telescope, and made several objections to Mr Gregory's, this gave birth to a dispute between those two philosophers, which was carried on during this and the following year, in the most amicable manner, on both sides; Mr. Gregory defending his own construction, so far as to give his antagonist the whole honour of having made the catoptric telescopes preferable to the dioptric, and showing that the imperfections in these instruments were not so much owing to a defect in the object speculum, as to the different refrangibility of the rays of light. In the course of this dispute our author described a burning concave mirror, which was approved by Newton, and is still in good esteem. Several letters that passed in this dispute are printed by Dr. Desaguliers, in an appendix to the English edition of Dr. David Gregory's "Elements of Catoptrics amd Dioptrics."

In 1674, Mr. Gregory was called to Edinburgh, to fill the chair of mathematics in that university. This place he had held but little more than a year, when, in October 1675, being employed in shewing the satellites of Jupiter through a telescope to some of his pupils, he was suddenly struck with total blindness, and died a few days after, to the great loss of the mathematical world, at only 37 years of age.

As to his character, Mr. James Gregory was a man of very acute and penetrating genius. His temper seems to have been warm, as appears from his conduct in the dispute with Huygens: and, conscious perhaps of his own merits as a discoverer, he seems to have been jealous of losing any portion of his reputation by the improvements of others upon his inventions. He possessed one of the most amiable characters of a true philosoper, that of being content with his fortune in his situation. But the most brilliant part of his character is that of his mathematical genius as an inventor, which was of the first order; as will appear by the following list of his inventions and discoveries. Among many others may be reckoned his reflecting telescope; burning concave mirror; quadrature of the circle and hyperbola, by an infinite converging series; his method for the transformation of curves; a geometrical demonstration of Lord Brounker's series for squaring the hyperbola; his demonstration that the meridian line is analogous to a scale of logarithmic tangents of the half-complements of the latitude: he also invented, and demonstrated geometrically, by help of the hyperbola, a very simple converging series for making the logarithms: he sent to Mr Collins the solution of the famous Keplerian problem by an infinite series; he discovered a method of drawing tangents to curves geometrically, without any previous calculations; a rule for the direct and inverse method of tangents, which stands upon the same principle (of exhaustions) with that of fluxions, and differs not much from it in the manner and application; a series for the length of the arc of a circle, from the tangent, and vice versa. These, with others for measuring the length of the elliptic and hyperbolic curves, were sent to Mr. Collins, in return for some received from him of Newton's, in which he followed the elegant example of this author, in delivering his series in simple terms, independently of each other.—These, and other writings of our author, are mostly contained in the following works, *viz.*: 1. Optica Promota; 4to. London, 1663. 2. Vera Circuli et Hyperbolæ Quadratura, 4to. Padua, 1667 and 1668. 3. Geometriæ Pars Universalis, 4to. Padua, 1668. 4. Exercitationes Geometricæ, 4to. London, 1668. 5. The great and new Art of weighing Vanity, 8vo. Glasgow, 1672. The rest of his inventions make the subject of several letters and papers, printed either in the Philos. Trans. vol. iii., the Commerc. Epistol. Joh. Collins, et aliorum, 8vo. 1715, in the appendix to the English edition of Dr. David Gregory's Elements of Optics, 8vo. 1735, by Dr. Desaguliers, and some series in the Exercitatio Geometrica of the same author, 4to. 1684, Edinburgh; as well as in his little piece on Practical Geometry.

Gregory (Dr. David), Savilian professor of astronomy, at Oxford, was nephew of the above-mentioned Mr. James Gregory, being the eldest son of his brother, Mr. David Gregory of Kinardie, a gentleman who had the singular fortune to see three of his sons all professors of mathematics, at the same time, in three of the British universities, viz. our author David at Oxford, the second son James at Edinburgh, and the third son Charles at St. Andrew's. Our author David, the eldest son, was born at Aberdeen, in 1661, where he received the early parts of his education, but completed his studies at Edinburgh: and, being possessed of the mathematical papers of his uncle, soon distinguished himself likewise as the heir of his genius. In the 23d year of his age he was elected professor of mathematics in the University of Edinburgh: and in the same year he published "Exercitatio Geometrica de Dimensione Figurarum, sive Specimen Methodi generalis dimetiendi quasvis Figuras," Edinb. 1684, 4to. He very soon perceived the excellence of the Newtonian philosophy, and had the merit of being the first that introduced it into the schools, by his public lectures at Edinburgh. "He had (says Mr. Whitson, in the Memoirs of his own life, i. 32.) already caused several of his scholars to keep acts, as we call them, upon several branches of the Newtonian philosophy; while we, at Cambridge, poor wretches, were ignominiously studying the fictitious hypothesis of the Cartesian."

In 1691, on the report of Dr. Bernard's intention of resigning the Savilian professorship of astronomy at Oxford, our author went to London; and being patronised by Newton, and warmly befriended by Mr. Flamstead, the astronomer royal, he obtained the vacant professorship, though Dr. Halley was a competitor. This rivalship, however, instead of animosity, laid the foundation of friendship between these eminent men; and Halley soon after became the colleague of Gregory, by obtaining the Professorship of Geometry in the same university. Soon after his arrival in London, Mr. Gregory had been elected a Fellow of the Royal Society; and, previously to his election into the Savilian Professorship, had the degree of Doctor of Physic conferred on him by the University of Oxford.

In 1693, he published in the Philos. Trans. a solution of the Florentine problem, "De Testudine veliformi quadrabili;" and he continued to communicate to the public, from time to time, many ingenious mathematical papers by the same channel.

1695, he printed at Oxford, "Catoptricæ et Dioptricæ Sphæricæ Elementa," a work, which, we are informed, in the preface, contains the substance of some of his public lectures read at Edinburgh eleven years before. This valuable treatise was republished in English first with additions by Dr. William Brown, with the recommendation of Mr. Jones and Dr. Desaguliers; and afterwards by the latter of these gentlemen, with an appendix, containing an account of the Gregorian and Newtonian telescopes, together with Mr. Hadley's tables for the construction of both those instruments. It is not unworthy of remark, that, in the conclusion of this treatise, there is an observation, which shows that the construction of achromatic telescopes, which Mr Dolland has carried to such great perfection, had occurred to the mind of David Gregory, from reflecting on the admirable contrivance of nature in combining the different humours of the eye. The passage is as follows: "Perhaps it would be of service to make the object lens of a different medium, as we see done in the fabric of the eye; where the crystalline humour (whose power of refracting the rays of light differs very little from that of glass) is by nature, who never does any thing in vain, joined with the aqueous and vitreous humours (not differing from water as to their power of refraction) in order that the image may be painted as distinct as possible upon the bottom of the eye."

In 1702, our author published at Oxford, in folio, "Astronomiæ Physicæ et Geometricæ Elementa," a work which is accounted his master-piece. It is founded on the Newtonian doctrines, and was esteemed by Newton himself as a most excellent explanation and defence of his philosophy. In the following year he gave to the world an edition, in folio, of the works of Euclid in Greek and Latin; being done in a prosecution of a design of his predecessor, Dr. Bernard, of printing the works of all the ancient mathematicians. In this work, which contains all the treatises that have been attributed to Euclid, Dr. Gregory has been careful to point out such as he found reason, from internal evidence, to believe to be the productions of some inferior geometrician. In prosecution of the same plan, Dr Gregory engaged soon after, with his colleague Dr. Halley, in the publication of the conics of Apollonius; but he had proceeded only a little way in the undertaking, when he died at Maidenhead in Berkshire, in 1710, being the 49th year of his age.

Besides those works published in our author's life-time, as mentioned above, he had several papers inserted in the Philos. Trans. vol. xviii, xix, xxi, xxiv, and xxv, particularly a paper on the Catenarian curve, first considered by our author.

He left also, in manuscript, a short Treatise of the Nature and Arithmetic of Logarithms, which is printed at the end of Keill's translations of Commandine's Euclid; and a treatise of Practical Geometry, which was afterwards translated, and published in 1745, by Mr. Maclaurin.

Dr. David Gregory married, in 1695, Elizabeth, the daughter of Mr. Oliphant, of Langtown in Scotland. By this lady he had four sons, of whom, the eldest, David, was appointed Regius Professor of modern history, at Oxford, by King George the First, and died at an advanced age in 1767, after enjoying, for many years, the dignity of Dean of Christ Church in that University.

When David Gregory quitted Edinburgh, he was succeeded in the Professorship of that University by his brother James, likewise an eminent mathematician, who held that office for thirty-three years, and retiring in 1725, was succeeded by the celebrated Maclaurin. A daughter of this Professor James Gregory, a young lady of great beauty and accomplishments, was the victim of an unfortunate attachment, that furnished the subject of Mallet's well-known ballad of William and Margaret.

Another brother, Charles, was created Professor of Mathematics at St. Andrews, by Queen Anne, in 1707. This office he held with reputation and ability for thirty-two years; and resigning, in 1739, was succeeded by his son, who eminently inherited the talents of his family, and died in 1763.

GRENADE, or GRENADO, in military affairs, a kind of small bomb or shell, being furnished with a touch-hole and fuse, and is thrown by hand from the tops, hence they are frequently styled hand-grenades. The best way to secure one's-self from the effects of a grenade is to lie flat down on the ground before it bursts.

The grenades are of much later invention and use than the bomb. They are usually about three inches in diameter, and weigh near three pounds. The metal may be one quarter or three-eighths of an inch thick, and the hole about one-sixth.

GREWIA, in botany, so named in honour of Nehemiah Grew, M. D. F. R. S. the famous author of the "Anatomy of

Vegetables," a genus of the Gynandria Polyandria class and order. Natural order of Columniferæ. Tiliaceæ, Jussieu. Essential character: calyx five-leaved; petals five, with a nectareous scale at the base of each; berry four-celled. There are thirteen species.

GRIAS, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Guttiferæ, Jussieu. Essential character: corolla four-petalled; calyx four-cleft; stigma sessile, cross-shaped; drupe with an eight-furrowed nucleus. There is but one species, *viz.* G. cauliflora, anchovy-pear. This tree is about fifty feet in height, branching at the top; leaves on short petioles, pendulous, two or three feet long; flowers from the stem, on short, scaly, many-flowered peduncles. The uprightness of the growth, and the size of the leaves, give this tree a very elegant appearance. The fruit is nearly as large as an alligator's egg, resembling it very much in shape, but of a brown colour; they pickle the fruit, and eat it in the same manner with the East Indian mango, which it resembles in flavour. This beautiful tree is common in many parts of Jamaica, growing generally in low moist places.

GRIELUM, in botany, a genus of the Decandria Pentagynia class and order. Natural order of Gruinales. Essential character: calyx five-cleft: petals five, filament permanent; pericarpium five, with one seed in each. There is only one species, *viz.* G. tenuifolium, a native of the Cape of Good Hope.

GRIFFON, in heraldry, an imaginary animal, feigned by the ancients to be half eagle and half lion; by this form they intended to give an idea of strength and swiftness joined together, with an extraordinary vigilance in guarding the things intrusted to its care. Thus the heathen naturalists persuaded the ignorant, that gold mines were guarded by these creatures with incredible watchfulness and resolution.

GRINDERS. See ANATOMY.

GRINDING, the reducing hard substances to fine powders, either by the mortar, or by way of levigation upon a marble.

GRIPE, in the sea-language, is a piece of timber fayed against the lower piece of the stern, from the fore-most end of the keel, joining with the knee of the head: its use is to defend the lower part of the stern from any injury; but it is often made the larger, to make the ship keep a good wind.

GRIPE is also a sea-term, for a ship's turning her head more to the wind than she should; this is caused either by overloading her a-head, the weight of which presses her down, so that she will not readily fall off from the wind; or by staying or setting her masts too much aft; which is always a fault in short ships that draw much water, since it causes them to be continually running into the wind: though in floating ships, if the masts be not stayed very far aft, they will never keep a good wind.

GRISLEA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Calycanthemæ. Salicariæ, Jussieu. Essential character: calyx four-cleft; petals four, from the incisures of the calyx; filaments, very long, ascending; capsule globular, superior, one-celled, containing many seeds. There are two species, *viz.* G. secunda and G. tomentosa, the latter is a beautiful flowering shrub, a native of the hills and valleys through the northern provinces of the Carnatic in the East Indies.

GRIT, a genus of argillaceous earths, with a texture more or less porous, equable, and rough to the touch. It neither gives fire with steel, nor effervesces with acids. When fresh and breathed on, it exhales an earthy smell. Its specific gravity varies from 2.0 to 2.6, and is used for mill stones and whet-stones, and sometimes for filtering-stones and building.

GROMETS, in the sea-language, small rings formerly fastened with staples to the yards, to make fast the gaskets, but now never used.

GRONOVIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Cucurbitaceæ. Essential character: petals five, together with the stamens inserted into the bell-shaped corolla; berry dry, inferior, containing one seed. There is but one species, *viz.* G. scandens, climbing gronovia, an annual plant; sending out many trailing branches like those of the cucumber, closely set with broad leaves, which have a strong smell. Peduncles many flowered, axillary.

GROSS, in law-books, signifies absolute, or independent of another: thus, an advowson in gross, is one distinct and separate from the manor.

GROSS BEAK, the English name of

a bird called by authors loxia. See LOXIA.

GROSS *weight*, the whole weight of merchandize, with their dust and dross: as also the bag or chest wherein they are contained. An allowance is usually made out of the gross weight for tare and tret. See TARE.

GROTTO, a large deep cavern or den in a mountain or rock. Okey-hole, Elden-hound, Peake's-hole, and Pool's-hole, are famous among the natural caverns or grottoes of our country. The entrance to Okey-hole, on the south side of Mendip-hills, is in the fall of those hills, which is beset all about with rocks, and has near it a precipitate descent of near twelve fathoms deep, at the bottom of which there continually issues from the rocks a considerable current of water. The naked rocks above the entrance shew themselves about thirty fathoms high, and the whole ascent of the hill above is about a mile, and is very steep. As you pass into this vault, you go at first upon a level, but advancing farther, the way is found to be rocky and uneven, sometimes ascending and sometimes descending. The roof of this cavern, in the highest part, is about eight fathoms from the ground, but in many particular places it is so low that a man must stoop to get along. The breadth is not less various than the height, for in some places it is five or six fathoms wide, and in others not more than one or two. It extends itself in length, about two hundred yards. People talk much of certain stones in it resembling men and women, and other things; but there is little matter of curiosity in these, being only shapeless lumps of a common spar. At the farthest part of the cavern there is a good stream of water, large enough to drive a mill, which passes all along one side of the cavern, and at length slides down about six or eight fathoms among the rocks, and then passing through the clefts of them, discharges itself into the valley. The river within the cavern is well stored with eels, and has some trout in it; and these cannot have come from without, there being so great a fall near the entrance. In dry summers, a great number of frogs are seen along this cavern, even to the farthest part of it; and on the roof of it, at certain places, hang vast numbers of bats, as they do in almost all caverns, the entrance of which is either level, or but slightly ascending or descending; and even in the more perpendicular ones they are sometimes found, provided they are not too narrow, and are sufficiently high. The cattle that feed in the pastures through which this river runs have been known to die suddenly sometimes after a flood; this is probably owing to the waters having been impregnated, either naturally or accidentally, with lead ore.

Elden-hole is a huge profound perpendicular chasm, three miles from Buxton, ranked among the natural wonders of the Peak. Its depth is unknown, as it is pretended to be unfathomable.

Peake's-hole, and Pool's-hole, are two remarkable horizontal cavities under mountains; the one near Castleton, the other just by Buxton. They seem to have owed their origin to the springs which have their current through them; when the water had forced its way through the horizontal fissures of the strata, and had carried the loose earth away with it, the loose stones must fall down of course: and where the strata had few or no fissures, they remained entire; and so formed these very irregular arches, which are now so much wondered at. The water which passes through Pool's-hole is impregnated with particles of lime-stone, and has incrusted the whole cavern in such a manner that it appears as one solid rock.

Grotto del Cani, is a little cavern near Pozzuoli, four leagues from Naples; the air contained in it is of a mephitical or noxious quality; it is in truth carbonic acid gas, whence also it is called Bocca Venenosa, the poisonous mouth. Two miles from Naples, (says Dr. Mead,) just by the Lago de Agnano, is a celebrated mofeta, commonly called la Grotta del Cani, and equally destructive to all within the reach of its vapours. It is a small grotto about eight feet high, twelve long, and six broad; from the ground arises a thin, subtile, warm fume, visible enough to a discerning eye, which does not spring up in little parcels here and there, but in one continued stream, covering the whole surface of the bottom of the cave; having this remarkable difference from common vapours, that it does not, like smoke, disperse itself into the air, but quickly after its rise falls back again, and returns to the earth; the colour of the sides of the grotto being the measure of its ascent: for so far it is of a darkish-green, but higher, only common earth. And as I myself found no inconvenience by standing in it, so no animal, if its head is above this mark, is the least injured. But when, as the manner is, a dog, or any other creature, is forcibly kept below it, or, by reason of its smallness, cannot hold its head above it, it presently loses all motion, falls down as dead, or in a swoon, the limbs convulsed and trembling, till at last no more signs of life appear, than a very weak and almost insensible beating of the heart and arteries; which, if the animal is left a little longer, quickly ceases too, and then the case is irrevocable; but if it is snatched out and laid in the open air, it soon comes to life again, and sooner if thrown into the adjacent lake."

Grotto is also used for a small artificial edifice made in a garden, in imitation of a natural grotto.

The outsides of these grottoes are usually adorned with rustic architecture, and their inside with shell-work, coral, &c. and also furnished with various fountains, and other ornaments.

The following is recommended as good cement for grotto work. Take two parts of white resin, melt it clear, add to it four parts of bees'-wax; when melted together, add some flower of the stone you design to cement, two or three parts, or so much as will give the cement the colour of the stone; to this add one part of the flower of sulphur: first incorporate all together over a gentle fire, and afterwards knead it with your hands in warm water. With this fasten the stones, shells, &c. after they are well dried, and warmed before the fire.

GROUND, in painting, the surface upon which the figures and other objects are represented. See Painting.

GROUP, in painting and sculpture, is an assemblage of two or more figures of men, beasts, fruits, or the like, which have some apparent relation to each other.

Groups, with respect to the design, are combinations of several figures, which bear a relation to each other, either upon account of the action, or of their proximity, or of the effect they produce. These we conceive as representing so many different subjects, or at least so many distinct parts or members of one great subject. Thus, in architecture, we say a group of columns, when we speak of three or four columns standing together on the same pedestal.

Groups, with respect to the clair-obscure, are assemblages of figures, where the lights and shadows are diffused in such a manner, that they strike the eye together, and naturally lead it to consider them in one view.

Group, in music, one of the kinds of diminutions of long notes, which, in working, form a sort of group, knot, or bush. It usually consists of four or more crotchets, quavers, &c. tied together at the discretion of the composer.

GRUB, the name of worms produced from the eggs of beetles, which are at length transformed into winged insects, of the same species with their parents.

GROUSE, a species of the Tetrao, which see.

GRUINALES, in botany, the name of the fourteenth order of Linnæus's Fragments. This order furnishes both herbaceous and woody plants. The roots are sometimes fibrous, and sometimes tuberous. In some species of the oxalis, wood-sorrel, they are jointed; the stems are cylindric, and the young branches in some nearly square; the buds are of a conic form, covered with scales; the leaves in some genera are simple, in others compound; the flowers are hermaphrodite; the calyx consists either of five distinct leaves, or of one leaf divided almost to the bottom into five parts; it generally accompanies the seed-bud to its maturity: the petals are five, spreading, and are frequently funnel-shaped; there are generally ten stamens, the anthers oblong, and frequently attached to the filaments by the middle; the seed-vessel is commonly a five-cornered capsule, with one, three, five, or ten cells, with one seed in each cell. In this order are the geranium, crane's-bill; linum, flax; oxalis, wood-sorrel; guiacum, lignum-vitæ.

GRUS, the *crane.* See Ardea.

GRYLLO *talpa*, the *mole-cricket*, a species of gryllus, with the anterior feet palmated. See the next article.

GRYLLUS, in natural history, the *locust*, *grasshopper*, and *cricket*, a genus of insects belonging to the order Hemiptera. Generic character: head inflected, armed with jaws, and furnished with feelers: antenna, in most species, either filiform or setaceous; wings four, deflex, convoluted; lower wings pleated; hind legs formed for leaping; claws double on all the feet. There are sixty-one species, of which the following are most worthy of notice: 1. Among the most numerous species is the gryllus migratorius of Linnæus, or common migratory locust, which, of all the insects capable of injuring mankind, seems to possess the most dreadful powers of destruction. Legions of these animals are from time to time observed in various parts of the world, where the havock they commit is almost incredible: whole provinces are in a manner desolated by them in the space of a few days, and the air is darkened by their numbers: nay, even when dead, they are still terrible; since the putrefaction arising from their inconceivable number is such, that it has been regarded as one of the probable causes of pestilence in the eastern regions. This formidable locust is generally of a brownish colour, varied with pale red, or flesh-colour, and the legs are frequently bluish. In the year 1748, it appeared in irregular flights in several parts of Europe, as in Germany, France, and England; and in the capital itself, and its neighbourhood, great numbers were seen: they perished, however, in a short time, and were happily not productive of any material mischief, having been probably driven by some irregular wind out of their intended course, and weakened by the coolness of our climate. The ravages of locusts in various parts of the world, at different periods, are recorded by numerous authors. In the year 593 of the Christian era, after a great drought, these animals appeared in such vast legions as to cause a famine in many countries. In 677, Syria and Mesopotamia were overrun by them. In 852, immense swarms took their flight from the eastern regions into the west, flying with such a sound that they might have been mistaken for birds: they destroyed all vegetables, not sparing even the bark of trees and the thatch of houses; and devoured the corn so rapidly, as to destroy, on computation, a hundred and forty acres in a day: their daily marches, or distances of flight, were computed at twenty miles; and these were regulated by leaders or kings, who flew first, and settled on the spot which was to be visited at the same hour the next day by the whole legion: these marches were always undertaken at sunrise. The locusts were at length driven, by the force of winds, into the Belgic ocean, and being thrown back by the tide and left on the shores, caused a dreadful pestilence by their smell. In 1271, all the corn-fields of Milan were destroyed; and in the year 1339, all those of Lombardy. In 1541, incredible hosts afflicted Poland, Wallachia, and all the adjoining territories, darkening the sun with their numbers, and ravaging all the fruits of the earth.

2. One of the largest species of locust yet known is the gryllus cristatus of Linnæus, which is five or six times the size of the gryllus migratorius; and, together with some others of the larger kind, is made use of in various parts of the world as an article of food. The gryllus cristatus is a highly beautiful animal, being of a bright red, with the body annulated with black, and the legs varied with yellow; the upper wings tesselated with alternate variegations of dark and pale green; the lower with transverse undulated streaks; the length of the animal from head to tail is about four inches; and the expanse of wings from tip to tip, when fully extended, hardly less than seven inches and a half.

3. The gryllus viridissimus of Linnæus, is one of the largest European species, and is often seen during the decline of summer in England. It is wholly of a pale grass-green, with a slight bluish cast on the head and under part of the thorax, which is marked above by a longitudinal reddish-brown line; the length of the insect, from the mouth to the tips of the wings, is about two inches and a half: the female is distinguished by a long sword-shaped process at the end of the body, being the instrument with which she pierces the ground in order to deposit her eggs; it consists of a pair of valves, through the whole length of which the eggs are protruded; they are of an oblong form, and of a pale brown colour.

4. The gryllus gryllotalpa, or mole-cricket, is by far the most curious; and in its colour and manners differ greatly from the rest. It is of an uncouth and even formidable aspect, measuring more than two inches in length, and is of a broad and slightly flattened shape, of a dusky brown colour, with a ferruginous cast on the under parts, and is readily distinguished by the extraordinary structure of its fore-legs, which are excessively strong, and furnished with very broad feet, divided into several sharp claw-shaped segments, with which it is enabled to burrow under ground in the manner of a mole; the lower wings, which when expanded are very large, are, in their usual state, so complicated under the very short and small upper wings, or sheaths, that their ends alone appear, reaching, in a sharpened form, along the middle of the back; the abdomen is terminated by a pair of sharp pointed, lengthened, hairy processes, nearly equalling the length of the antennæ in front, and contributing to give this animal an appearance, in some degree, similar to that of a blatta. The mole-cricket emerges from its subterraneous retreats only by night, when it creeps about the surface, and occasionally employs its wings in flight. It prepares for its eggs an oval nest, measuring about two inches in its longest diameter; the eggs are about two hundred and fifty or three hundred in number, nearly

round, of a deep brownish-yellow colour, and of the size of common shot: on the approach of winter, or any great change of weather, these insects are said to remove the nest, by sinking it deeper, so as to secure it from the power of frost; and, when the spring commences again, raising it in proportion to the warmth of the season, till at length it is brought so near the surface as to receive the full influence of the air and sun-shine; but should unfavourable weather again take place, they again sink the precious deposit, and thus preserve it from danger. The young at their first exclusion are about the size of ants, for which, on a cursory view, they might be mistaken; but on a close inspection are easily known by their broad feet, &c. In about the space of a month they are grown to the length of more than a quarter of an inch; in two months, upwards of three quarters; and in three months, to the length of more than an inch. Of this length they are usually seen during the close of autumn, after which they retire deep beneath the surface, not appearing again till the ensuing spring. During their growth they cast their skin three or four times. The mole-cricket lives entirely on vegetables, devouring the young roots of grasses, corn, and various esculent plants, and commits great devastation in gardens. It inhabits Europe and America.

GUAIACUM, in botany, a genus of the Decandria Monogynia class and order. Natural order of Gruinales. Rutaceæ, Jussieu. Essential character: calyx five-cleft, unequal; petals five, inserted into the receptacle; capsule angular, five-celled. There are four species. From the G. officinale is obtained a resin, which exudes spontaneously, and is also driven out artificially by means of heat. This substance has been long known and celebrated as a medicine in various cases; and in the Transactions of the Royal Society for the year 1806, we have a very complete analysis of it: by distillation 100 parts yielded,

Acidulous water - - -	5.5
Thick brown oil - - -	24.5
Thin empyreumatic oil -	29.0
Charcoal - - - - - -	30.5
Gases consisting of carbonic acid and carbureted hydrogen - - - -	10.5
	100.0

Hence it is inferred, that guaiacum agrees in many respects with the resins, but it differs from them, 1. in the quantity of charcoal it leaves when distilled in close vessels; 2. in the action that nitric acid has upon it; and, 3. in the changes of colour that it undergoes when its solutions are treated with nitric and oxymuriated acids. Its properties may be thus enumerated: it is a solid substance resembling a resin; its colour varies, but is generally greenish; it is readily dissolved in alcohol; alkaline solutions dissolve it with ease: most of the acids act upon it with considerable energy; if digested in water, a portion is dissolved, the water acquiring a greenish-brown colour: the liquid, being evaporated, leaves a brown substance, which possesses the properties of an extract, being soluble in hot water and alcohol, but scarcely at all in sulphuric ether, and forming precipitates with the muriates of alumina, tin, and silver.

GUANA. See Lacerta.

GUANO, a substance found on many of the small islands in the South Sea, which are the resort of numerous flocks of birds, particularly of the Ardea and Phænicopterus genus. It is dug from beds fifty or sixty feet thick, and used as a valuable manure in Peru, chiefly for Indian corn. It is of a dirty yellow colour, nearly insipid to the taste, but has a powerful smell, partaking of castor and valerian. According to the analysis of Fourcroy and Vauquelin, about one-fourth of it is uric acid, partly saturated with ammonia and lime. It contains likewise oxalic acid, partly saturated with ammonia and potash; phosphoric acid, combined with the same bases and with lime; small quantities of sulphate and muriate of potash and ammonia; a small portion of fat matter; and sand, partly quartzose, partly ferruginous.

GUARD, in a general sense, signifies the defence or preservation of any thing; the act of observing what passes, in order to prevent surprise; or the care, precaution, and attention we make use of, to prevent any thing happening contrary to our intention or inclinations.

Guard, in the military art, is a duty performed by a body of men, to secure an army or place from being surprised by an enemy.

In a garrison the guards are relieved every day, and it comes to every soldier's turn once in three days, so that they have two nights in bed, and one upon guard. To be upon guard, to mount the guard, to dismount the guard, to relieve the guard, to change the guard, the officer of the guard, or the serjeant of the guard, are words often used, and well understood.

Guard, *advanced*, is a party of either horse or foot, that marches before a more considerable body, to give notice of any approaching danger.

When an army is upon the march, the grand guards which should mount that day serve as an advanced guard to the army: in small parties six or eight horse are sufficient, and these are not to go above four or five hundred yards before the party.

An advanced guard is also a small body of twelve or sixteen horse, under a corporal or quarter-master, posted before the grand guard of a camp.

Guard, *artillery*, is a detachment from the army, to secure the artillery: their corps de garde is in the front, and their centries round the park. This is a forty-eight hours guard: and upon a march they go in the front and rear of the artillery, and must be sure to leave nothing behind. If a gun or wagon break down, the captain is to leave a part of his guard to assist the gunners and matrosses in getting it up again.

Guard, *main*, that from whence all the other guards are detached.

Those who are to mount the guard meet at their respective captain's quarters, and go from thence to the parade; where, after the whole guard is drawn up, the small guards are detached for the posts and magazines; and then the subaltern officers throw lots for their guards, and are commanded by the captain of the main guard.

Guard, *piquet*, a good number of horse and foot always in readiness in case of an alarm: the horse are all the time saddled, and the riders booted. The foot draw up at the head of the battalion, at the beating of the tattoo; but afterwards return to their tents, where they hold themselves in readiness to march upon any sudden alarm. This guard is to make resistance, in case of an attack, till the army can get ready.

Guard *boat*, a boat appointed to row the rounds among the ships of war in any harbour, to observe that their officers keep a good look-out, calling to the guard-boat as she passes, and not suffering her crew to come on board, without having previously communicated the watch-word of the night.

Guard *irons*, are curved bars of iron placed over the ornamental figures on a ship's head or quarter, to defend them from injury.

Guard *ship*, a vessel to superintend the marine affairs in a harbour or river, and to see that the ships which are not commissioned have their proper watch duly kept; she is also to receive seamen who are impressed in time of war: she generally has an admiral's flag at one of her mast's head.

Guard, in fencing, is a posture proper to defend the body from an enemy's sword.

There are four general guards of the sword; to form a perfect idea of which, we must suppose a circle drawn on a wall, and divided into four cardinal points, *viz.* top and bottom, right and left. When the point of the sword is directed to the bottom of the circle, with the hilt opposite to its top, the body inclining very forward, this is called the prime or first guard. The second guard, by many improperly called the tierce, is when the point is directed to the right or second point of the same circle, with the hilt of the sword turned to the left, and the body proportionably raised. The tierce, or third guard, is when the point of the sword is raised to the uppermost part of the same circle; in which case the body, the arm, and the sword, are in their natural position, and in the mean of the extremes of their motion. The quart, or fourth guard, is when the point of the sword is directed to the fourth point of the circle, descending to the right as far as one-fourth of the tierce, with the outward part of the arm and the flat of the sword turned towards the ground, and the body out of the line to the right, and the hilt of the sword towards the line to the left. There is also a quint, or fifth guard, which is only the return of the point of the sword to the right, after traversing the circle to the point of the prime from whence it had departed, with a different disposition of the body, arm, and sword. The common centre of all those motions ought to be in the shoulder.

In all these kinds of guards there are, the high-advanced, high-retired, and high-intermediate guard, when disposed before the upper part of the body, either with the arm quite extended, quite withdrawn, or in a mean state. The mean-advanced guard, or simply mean guard, is when the sword is placed before the middle part of the body. The low-advanced, retired, or intermediate guards, are those where the arm and sword are advanced, withdrawn, or between the two extremes, before the lower part of the body.

GUARDIAN, in law. A guardian is

one appointed to take care of a person and his affairs, who, by legal imbecility and want of understanding, is incapable of acting for his own interest; and it seems by our law, that his office originally was to instruct the ward, under the feudal tenures, in the arts of war, as well as those of husbandry and tillage, that, when he came of age, he might be the better able to perform those services to his lord, whereby he held his own land.

There are several kinds of guardians, as, guardian by nature, guardian by the common law, guardian by statute, guardian by custom, guardian in chivalry, guardian in socage, and guardian by appointment of the Lord Chancellor.

Guardian by nature, is the father or mother; and by the common law every father hath a right of guardianship of the body of his son and heir, until he attains to the age of twenty-one years. This guardianship extends no further than the custody of the infant's person. The father may disappoint the mother, and other ancestors, of the guardianship by nature, by appointing a testamentary guardian under the statutes 4 and 5 Phil. and Mary, and 12 Char. II. A guardian by nature hath only the care of the person and education of the infant, and hath nothing to do with his lands, merely in virtue of his office; for such guardian may be, though the infant have no lands at all, which a guardian in socage cannot.

Guardian, by the common law, or *Guardian in Socage*. If a tenant in socage die, his heir being under fourteen, whether he be his issue or cousin, male or female, the next of blood to the heir, to whom the inheritance cannot descend, shall be guardian of his body and land till fourteen; and although the nature of socage tenure is in some measure changed from what it originally was, yet it is still called socage tenure, and the guardian in socage is still only where lands of that kind, as most of the lands in England now are, descend to the heir within age; and though the heir after fourteen may choose his own guardian, who shall continue till he is twenty-one, yet, as well the guardian before fourteen, as he whom the infant shall think fit to choose after fourteen, are both of the same nature, and have the same office, without any intervention or direction of the infant himself; they are to transact all affairs in their own name, and not in the name of the infant, which they would be obliged to do, if their authority were derived from him.

This guardianship is so little resorted to, although all lands are now of socage tenure, that it is needless to inquire further into it here.

Guardian *by statute*, or *Testamentary Guardian*. By the common law, no person could appoint a guardian, because the law had appointed one, whether the father were tenant by knight service, or in socage.

The first statute that gave the father a power of appointing was the 4 and 5 Philip and Mary, c. 8, which provides, under severe penalties, such as fine and imprisonment for years, against taking any maid, or woman child unmarried, being within the age of sixteen years, out of or from the possession, custody, or governance, and against the will of the father of such maid or woman child, or of such person or persons, to whom the father of such maid or woman child, by his last will and testament, or by any other act in his life time, shall grant the education and governance of such child.

But the principal guardianship is now by the statute 12 Charles II. c. 24, by which any father, under or of full age, may, by deed or will, attested by two witnesses, appoint, dispose of the custody of his child, born or unborn, to any person, except a popish recusant convict, either in possession or reversion, till such child attain twenty-one. This guardian supersedes the guardian in socage, and has all actions which that guardian might have had. Besides which he has the care of the estate, real and personal. A father cannot under this statute appoint one to his natural child; and a case has been decided upon the marriage act, in which a marriage with consent of a guardian applied to a natural child was held void. The chancellor, however, will upon application appoint the same person guardian.

Guardians by custom, are appointed in the City of London, in the county of Kent, and, with respect to copyhold lands, in some manors.

Guardians by appointment of the ecclesiastical court, were appointed to take care of the infant's personal estate, till fourteen in males, and twelve in females; but their authority over the person is now denied, and they are only confined to guardianship for the purpose of a suit in an ecclesiastical court.

Guardian, in chivalry, is obsolete, but extended to twenty-one years.

Guardian, by appointment of the Lord Chancellor. It is not easy to state how this jurisdiction was acquired; for it is certainly of no very ancient date, though now indisputable; for it is clearly agreed, that the king, as pater patriæ, is universal guardian of all infants, idiots, and lunatics, who cannot take care of themselves; and as this care cannot be exercised otherwise than by appointing them proper curators or committees, it seems also agreed, that the king may, as he has done, delegate the authority to his chancellor: and that therefore at this day the Court of Chancery is the only proper court that hath jurisdiction in appointing and removing guardians, and in preventing them and others from abusing their persons or estates. And as the Court of Chancery is now vested with this authority, hence in every day's practice we find that court determining, as to the right of guardianship, who is the next of kin, and who the most proper guardian; as also orders are made by that court, on petition or motion, for the provision of infants during any dispute therein; as likewise guardians removed or compelled to give security; they and others punished for abuses committed on infants, and effectual care taken to prevent any abuses intended them in their persons or estates; all such wrongs and injuries being reckoned a contempt of that court, that hath, by an established jurisdiction, the protection of all persons under natural disabilities. All courts of justice appoint guardians to infants, to see and prosecute their rights in their respective courts, when the occasion calls for it.

There are also some cases where an infant may elect a guardian, and the Court of Chancery allows him to do so after fourteen.

Guardian *of the Spiritualities*, is he to whom the spiritual jurisdiction of any diocese is committed, during the vacancy of the see. The archbishop is guardian of the spiritualities, on the vacancy of any see within his province; but when the archiepiscopal see is vacant, the dean and chapter of the archbishop's diocese are guardians of the spiritualities.

GUAREA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Meliæ, Jussieu. Essential character: calyx four-cleft; petals four; nectary cylindric, bearing the anthers at its mouth; capsule four-celled, four-valved; seeds solitary. There is only one species, *viz.* G. trichilioides, ash-leaved guarea. This tree is remarkable for its strong odour of musk, particularly the bark, and is used instead of that perfume for many purposes. The wood is full of a bitter resinous substance, which renders it unfit for rum hogsheads, having been observed to communicate both its smell and taste to spirituous liquors. It is a native of South America and the West India islands. The English call it muskwood.

GUDGEONS, in a ship, are the eyes drove into the stern-post, into which the pintles of the rudder go, to hang it.

GUERICKE, Otto, or Otho, a very eminent German experimental philosopher in the seventeenth century, who, with Torricelli, Pascal, and Boyle, greatly contributed to explain the various properties of the air and their effects, was born in the year 1602, and died, at Hamburgh, in the year 1686. He was councellor to the Elector of Brandenburg; and burgomaster, or consul, of Magdeburg; but his memory derives greater honour from his philosophical discoveries, than from the civil dignities to which he was raised. To him is to be attributed the invention of the air-pump, for though Mr. Boyle had, about the same time, made some approaches towards a similar discovery, yet he ingenuously acknowledged, in a letter to his nephew, Lord Dungarvon, that the information which he received from Schottus's "Mechanica Hydraulico Pneumatica," published in 1657, in which was an account of Guericke's experiments, first enabled him to bring his design to any thing like maturity. Guericke was also the inventor of the two brass hemispheres, to illustrate the pressure of the air, which, being applied to each other, and the air exhausted, resisted the force of sixteen horses to draw them asunder. He likewise invented an instrument to show the variations in the state of the atmosphere, consisting of a tube, in which was a little image of glass, that descended in rainy or stormy weather, and rose again when the weather became fine and serene. This last machine fell into disuse on the invention of the barometer, and especially after the improvements made in that instrument by Huygens and Amontons. By consulting his tube, Guericke would frequently foretel approaching storms; whence the ignorant populace gave him the character of a sorcerer. In this opinion of him they were confirmed, by a thunder storm discharging itself one day upon his house, and shivering to pieces several machines, of which he had made use in his experiments. That event they considered to be an unequivocal indication of the anger of Heaven, and a just punishment inflicted upon him for his impiety. He was the author of several treatises in natural philosophy, the principal of which is entitled "Experimenta Magdeburgica," 1672, folio, and contains his experiments on a vacuum.

GUETTARDA, in botany, a genus of the Monoecia Heptandria class and order. Natural order of Tricoccæ. Rubiaceæ, Jussieu. Essential character: calyx cylindric; corolla six or seven cleft, funnel-shaped; pistil one; drupe dry. There are four species, natives of the East and West Indies.

GUGLIELMINI (Dominic), an eminent Italian mathematician and civil engineer, was descended from an honourable family, and born at Bologna in the year 1655. His favourite studies were the mathematics and medicine, in the former of which he had for tutor the celebrated M. Germ. Montanari; and in the latter, the illustrious Malpighi. He entered into the dispute between M. Montanari and M. Cavina, concerning the extraordinary luminous meteor which was observed in most parts of Italy in 1676, and supported the opinions of his master. In the year 1678 he was admitted to the degree of doctor of medicine by the university of Bologna. Upon the appearance of the remarkable comet in the years 1680 and 1681, he published a treatise "De Cometarum Natura et Ortec," &c. 1681, in which he proposed a new system on the subject, which he thought would serve to explain all the phenomena of those heavenly bodies; but it did not meet with the approbation of the scientific world. His next astronomical treatise, containing remarks on the solar eclipse which took place on the 12th of July, 1684, and which he published in Latin, at Bologna, in the same year, reflected greater credit on his knowledge and accuracy of observation. Soon afterwards the Senate of Bologna appointed him principal professor of mathematics in the university of that city, and in the year 1686, created him intendant-general of the rivers of the Bolognese. The office last mentioned engaged him to pay more particular attention to the study of hydrostatics and hydraulics; in consequence of which, in the year 1690, he published the first part, and in the following year the second part, of an excellent hydrostatical treatise, entitled "Aquarum Fluentium Mensura, Novo Methodo Inquisita." Some of his observations in this work were attacked by M. Papin, who also entered into a contest with the author on the subject of Syphons. Their difference in opinion gave rise to two letters by Guglielmini, which were printed under the title of "Epistolæ Duæ Hydrostaticæ." He was engaged in settling the differences which arose between the cities of Bologna and Ferrara, respecting the management of the embankments and sluices in their contiguous districts; and received as a reward of his services, from his native city, the appointment to a new office in the university, which was that of professor of hydrometry. In the year 1695 he assisted M. Cassini in repairing the famous meridian line, which he had constructed forty years before in the church of St. Petronius, at Bologna; on which occasion our author published a memoir, descriptive of the method pursued in laying it down, and establishing its claims to correctness and accuracy. In the year 1697 he published his grand physico-mathematical treatise on the nature of rivers, entitled "Della Natura de Fiumi," which raised his reputation to the highest pitch, for correct scientific knowledge, ingenuity, and judgment in hydraulics. Montucla commends it in warm terms, and says that it ought to be carefully studied by every person who would wish to become thoroughly master of this branch of science. The reputation which Guglielmini acquired by this performance occasioned his being employed by the Dukes of Mantua, of Parma, and Modena, the Grand Duke of Tuscany, Pope Clement XI. the Republics of Venice and Lucca, &c. in the invention and construction of the necessary hydraulic works in their respective territories. In the year 1698 he was induced, by the Republic of Venice, to accept of the mathematical chair in the university of Padua; but the senate of Bologna decreed that he should still retain, notwithstanding his new employment, the title of professor in their university, and the emoluments annexed to it. In the year 1702, he exchanged his mathematical chair at Padua for the more lucrative one of medicine; after which he published different treatises on medical and chemical subjects, &c. He died at Padua in 1710, in the fifty-fifth year of his age. He had been admitted a member of the Academy of Sciences at Paris in the year 1696, and was also associate or corresponding member of the Academies of Berlin and Vienna, and of the Royal Society at London. The best edition of his treatise on the nature of rivers was published at Bologna in 1756, with the notes of Manfredi; and the whole of his works were printed in a collective form at Geneva, in 1719, in two volumes quarto.

GUIAC. See RESIN.

GUIDE, in music, the name given to that note in a fugue, which leads off and announces the subject.

GUILANDINA, in botany, *bonduc* or *nicker tree*, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx one-leafed; salver-shaped; petals inserted into the neck of the calyx, nearly equal; seed vessel a legume. There are six species.

GUILD, or GILD, a fraternity or company. As to the original of these guilds, or companies, it was a law among the Saxons, that every free man of fourteen years of age should find sureties to keep the peace, or be committed; upon which the neighbours entered into an association, and became bound for each other, either to produce him who committed any offence, or to make satisfaction to the injured party: in order to which they raised a sum among themselves, which they put into a common stock; out of which they, upon occasion, made a pecuniary compensation, according to the quality of the offence committed. These gilds are now companies, joined together with laws and orders made by themselves, by the licence of the prince.

GUITAR. See MUSICAL *instruments*.

GULES, in heraldry, signifies the colour red, which is expressed in engraving by perpendicular lines falling from the top of the escutcheon to the bottom.

GUM, a thick transparent tasteless fluid, which exudes occasionally from certain species of trees. It is adhesive, and gradually hardens without losing its transparency. Gum is chiefly obtained from different species of the mimosa, particularly from M. nilotica, a native of Egypt and Arabia, which is known by the name of gum arabic. The specific gravity of gum is about 1.4. It is not changed by exposure to the air, but is deprived of its colour by the action of the sun. By heat it becomes soft, and is speedily reduced to the state of charcoal, which enters largely into its composition. The constituent parts of gum are, carbon, hydrogen, and oxygen, with smaller proportions of nitrogen and lime. The oxygen is much less in quantity than the saccharine matter. See SUGAR. The existence of lime and nitrogen in gum renders it essentially different from fecula and sugar, to which, in other respects, it bears a near relation; they, however, are able to undergo the vinous fermentation, which is not the case with gum. Gum readily dissolves in water, and the solution, which is thick and adhesive, is known by the name of mucilage. It is soluble also in the vegetable acids. Sulphuric acid decomposes it, and converts it into water, acetic acid, and charcoal. With the assistance of heat, muriatic acid, and nitric acid, produce a similar effect. It is insoluble in alcohol and ether. Such are the chief properties of gum arabic. There are, besides this, other gums, of which the principal is denominated tragacanth, from the astragalus tragacantha, a native of the island of Crete, which is in the form of vermicular masses; it is less transparent and more adhesive than gum arabic, but by distillation it yields similar products. In our gardens and orchards we find, in good quantities, gum exuding from the cherry and plumb trees, which differs chiefly from gum arabic in being softer and more soluble. Gum, in a state of mucilage, exists in a number of plants, especially in the roots and leaves. It is most abundant in bulbous roots, and of these the hyacinth seems to contain the largest quantity. A pound of the bulbs of this root, when dried, yields four ounces of a powder, which, when macerated in water, give a mucilage that acts well as a mordant for fixing the colours in calico-printing. Gum is used in medicine, and is considered as a specific against the strangury occasioned by blisters; it constitutes, under particular forms, a nutritious food, and it is well known as an important article in the manufacture of our ink.

GUM *resins*, are certain substances that have long been used in medicine. They are all solid, generally brittle and opaque, have a strong smell, and a pungent and bitter taste. They consist chiefly of gum and resin, the proportions varying with the particular substance. They are never obtained by means of spontaneous exudation, but are procured by wounding the plants which contain them. The principal of the gum-resins are, 1. AMMONIAC, which see. 2. Assafœtida, obtained from the ferula assafœtida, a plant found in Persia. The gum resin is extracted from the roots by cutting off the extremities; a milky juice flows out, which is dried in the sun. It is brought to Europe in masses; its smell is very fœtid, and its taste acrid. It is partially soluble in water and alcohol. 3. Euphorbium, obtained from the euphorbia officinalis, a native of Ethiopia, by making incisions in the plant. It is brought from Africa in the form of tears, is soluble in alcohol. It has no smell; after a time it communicates a burning taste to the tongue. It is regarded as poisonous. 4. Galbanum, which see. 5. Gamboge, which see. 6. Myrrh, which is brought from the East Indies, in the form of tears, is light, brittle, of a reddish colour, and has an unctuous feel; it is bitter and aromatic; it is soluble in water and alcohol in slight degrees 7. Opoponax, obtained from the pastenaca opoponax, a perennial plant, which grows wild in the south of Europe. This is extracted by wounding the stock or root, and is known here in the form of round drops or tears, or in irregular masses of a reddish colour. It is bitter and acrid to the taste, and with a peculiar smell. It forms a milky solution with water, and yields an essential oil by distillation. 8. Sapagenum, supposed to be had from the ferula persica, and brought in large masses, or distinct tears, from Alexandria. It has a hot taste and disagreeable smell. It is moderately soluble in alcohol, but much more so in water.—By distillation it yields a fœtid volatile oil. From some experiments made upon ipecacuanha, it is thought to contain a gum resin. All the gum resins that have been analysed have been found to contain ammonia.

GUN, a fire arm or weapon of offence, which forcibly discharges a ball, shot, or other offensive matter, through a cylindrical barrel, by means of gunpowder.—Gun is a general name, under which are included divers, or even most species of fire arms. They may be divided into great and small.

Great guns, called also by the general name cannons, make what we also call ordnance or artillery; under which come the several sorts of cannon. See Cannon, Artillery, &c.

Gun is also a name given to an instrument used by miners in cleaving rocks with gun-powder. It is an iron cylinder of an inch and a half thick, and about six inches long; and having a flat side to receive the side of a wedge; and a hole drilled through it, to communicate with the inside of the hole in the rock: this hole is made about eight inches deep, and in the bottom of it is put about two or three ounces of gun-powder: then this gun is driven forcibly in, so as to fill up the hole, and the wedge is driven in on its flat side, to secure it. The priming at the hole is then fired by a train, and the orifice being so well stopped by this gun, the force of the powder is determined to the circumjacent parts of the rock, which it splits.

Gun *room*, in a ship, the apartment under the great cabin, where the master-gunner and his crew rendezvous, get ready their cartridges, &c. and do all things belonging to their business.

GUNDELIA, in botany, so called in honour of Dr. Andrew Gundelscheimer, who found this plant in his travels, in company with Tourneforte, in the Levant; a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx scarcely any, five-flowered; corolla tubular, male and hermaphrodite; receptacle chaffy; down none. There is but one species, *viz.* G. tournefortii, a milky plant, with alternate prickly leaves; flowers terminating. It is a native of the Levant.

GUNNER, an officer appointed for the service of the cannon; or one skilled to fire the guns. In the Tower of London, and other garrisons, as well as in the field, this officer carries a field staff, and a large powder horn in a string over his left shoulder; he marches by the guns, and when there is any apprehension of danger, his field staff is armed with match; his business is to lay the gun to pass, and to help to load and traverse her.

Gunner of a ship, or master-gunner, has the charge of all the ordnance the ship carries, to see that they be serviceably mounted, and sufficiently supplied with sponges, ladles, and rammers; that in foul weather they be traversed within board, especially those of the lower tier, and that the ports be shut, and caulked up; and that at all times they may be well lashed, and made fast, lest any of them break loose, to the imminent danger of foundering the ship. In the time of an engagement, the gunner is to see that every piece be sufficiently manned; he is answerable to give an account of all his charge upon demand. He has a mate and quarter-gunners for his assistance.

Gunner, *master*, a patent officer of the ordnance, who is appointed to teach all such as learn the art of gunnery, and to certify to the master-general the ability of any person recommended to be one of the King's gunners. To every scholar he administers an oath, not to serve, without leave, any other prince or state; or teach any one the art of gunnery, but such as have taken the said oath.

GUNNERA, in botany, so named in honour of J. E. Gunnerus, Bishop of Drontheim, in Norway, a genus of the Gynandria Diandria class and order. Natural order of Urticæ, Jussieu. Essential character: ament with one-flowered scales; calyx and corolla none; germ two toothed; styles two; seed one. There is but one species, *viz.* G. Perpensa, marsh marygold-leaved gunnera. Native of the Cape.

GUNNERY, is the art of determining the course and directing the motion of bodies shot from artillery, or other warlike engines.

The great importance of this art is the reason it is distinguished from the doctrine of projectiles in general; for it is no more than an application of those laws which all bodies observe, when cast into the air, to such as are put in motion by the explosion of guns, or other engines of that sort. And it is the same thing, whether it is treated in the manner of projectiles in general, or of such only as belong to gunnery; for from the moment the force is impressed, all distinction with regard to the power which put the body first in motion is lost, and it can only be considered as a simple projectile. See PROJECTILES.

Prob. I. The impetus of a ball, and the horizontal distance of an object aimed at, with its perpendicular height or depression, if thrown on ascents or descents, being given, to determine the direction of that ball.

From the point of projection A (Plate VI. Miscell. fig. 8, 9, 10, 11) draw A *m* representing the horizontal distance, and B *m* the perpendicular height of the object aimed at: bisect A *m* in H, and A H in *f*; on H and *f* erect H T, *f* F perpendicular to the horizon, and bisecting A B the oblique distance or inclined plane in D, and A D in F. On A raise the impetus A M at right angles with the horizon, and bisect it perpendicularly in *c*, with the line G G. Let the line A C be normal to the plane of projection A B, and cutting G G in C; from C as centre, with the radius C A, describe the circle A G M, cutting, if possible, the line F S in S, *s*, points equally distant from G; lines drawn from A through S, *s*, will be the tangents or directions required.

Continue A S, A *s* to T, *t*; bisect D T, D *t*, in V, *v*; and draw lines from M to S, *s*; then the angle A S F = angle M A S = angle A M *s* = angle *s* A F; and for the same reason angle A *s* F = angle MA*s* = angle A M S = angle S A F; wherefore the triangles M A S, S A F, *s* A F are similar, and A M : A *s* : : A *s* : *s* F = *t v*; consequently A T is a tangent of the curve passing through the points A, *v*, and B; because *t v* = *v* D, A D is an ordinate to the diameter T H, and where produced must meet the curve to B.

In horizontal cases (fig. 10.) *v* is the highest point of the curve, because the diameter T *v* H is perpendicular to the horizon.

When the mark can be hit with two directions (the triangles S A M, *s* A F being similar) the angle which the lowest direction makes with the plane of projection is equal to that which the highest makes with the perpendicular A M, or angle *s* A F = angle S A M. And the angle S A *s*, comprehended between the lines of direction, is equal to the angle S C G, and is measured by the arch S G.

When the points S, *s* coincide with G, or when the directions A S, A *s* become A G (fig. 11.) A B will be the greatest distance that can be reached with the same impetus on that plane; because S F coinciding with G *g*, the tangent of the circle at G, will cut off A *g*, a fourth part of the greatest amplitude on the plane A B. The rectangular triangles *m* A B, *c* A C are similar, because the angle of obliquity *m* A B = *c* A C; wherefore *m* A : *m* B : : one-half impetus : *c* C, and *m* A : A B : : A *c* : A C.

Horizontal Projections (*ibid.* fig. 10, 11.)

When the impetus is greater than half the amplitude, there are two directions, T A H and *t* A H, for that amplitude; when equal to it, only one; and when less, none at all; and conversely. For in the first case the line F S cuts the circle in two points S, *s*, in the second case it only touches it, and in the last it meets not with it at all; and conversely. When there is but one direction for the amplitude A *m*, the angle of elevation is 45°; and when the angle of elevation is of 45°, A *m* is the greatest amplitude for that impetus, and equal to twice the impetus. The impetus remaining the same, the amplitudes are in proportion to one another as the sines of double the angles of elevation, and conversely. For drawing *s* N (fig. 10.) parallel and equal to A F, a fourth part of the amplitude, and supposing lines drawn from *s* to the points C and M, the angle A C *s* = 2 A M *s* = 2 *s* A F; therefore

N *s*, the sine of A C *s*, is the sine of twice the angle *s* A F; half the impetus being radius.

Whence, at the directions of 15° or 75°, the amplitude is equal to the impetus; for, from what has been said, half the impetus being radius, a fourth part of the amplitude is the sine of twice the angle of elevation; but the sine of twice 15°, that is, the sine of 30°, is always equal to half the radius; or in this case a fourth part of the impetus is equal to a fourth part of the amplitude. From this and the preceding proposition, there are two easy practical methods for finding the impetus of any piece of ordnance. The fourth part of the amplitude is a mean proportional between the impetus at the curve's principal vertex and its altitude. For M N : N *s* : : N A = *s* F = *v* D

The altitudes are as the versed sines of double the angles of elevation, the impetus remaining the same. For making half the impetus radius, A N the altitude is the versed sine of the angle A C *s* = twice angle *s* A F. And also, radius : tangent angle elevation :: one-fourth amplitude : altitude: that is, R : tangent angle *s* A *f* : : A *f* : *f s* = D *v*.

Projections on Ascents and Descents, fig. 8, 9.

If the mark can be hit only with one direction A G, the impetus in ascents will be equal to the sum of half the inclined plane and half the perpendicular height, and in descents it will be equal to their difference; but if the mark can be reached with two directions, the impetus will be greater than that sum or difference. For when A G is the line of direction, the angle *g* G A being = M A G = G A *g*; G *g* = A *g*, and *g z* added to or substracted from both, makes G *z* half the impetus equal to the sum or difference of A *g*, a fourth part of the inclined plane, and *g z* a fourth part of the perpendicular height. In any other direction F P is greater than F *o* = A F; and F *f*, added to or subtracted from both, makes *f* P half the impetus greater than the sum or difference of A F, a fourth part of the inclined plane, and F *f* a fourth part of the perpendicular height. Whence, if in ascents the impetus be equal to the sum of half the inclined plane and half the perpendicular height, or if in descents it be equal to their difference, the mark can be reached only with one direction; if the impetus is greater than that sum or difference, it may be hit with two directions; and if the impetus is less, the mark can be hit with none at all.

Prob. II. The angles of elevation, the horizontal distance, and perpendicular height, being given, to find the impetus. Fig. 8, 9.

From these data you have the angle of obliquity, and length of the inclined plane; then as

A *s* : A M : : S. angle A M *s* : S. angle A *s* M : : S. angle *s* A F : S. angle M A F, and A F : A *s* : : S. angle M A S : S. angle M A F; whence, by the ratio of equality, A F : A M : : S. angle $\overline{s\ A\ F \times}$ S. angle M A *s* : S. angle $\overline{M\ A\ F \times}$ S. angle M A F, which gives this rule.

Add the logarithm of A F to twice the logarithmic sine of the angle M A F; from their sum subtract the logarithmic sines of the angles *s* A F and M A *s*, and the remainder will give the logarithm of A M the impetus.

When the impetus and angles of elevation are given, and the length of the inclined plane is required, this is the rule. Add the logarithm of A M to the logarithmic sines of the angles *s* A F and M A *s*; from their sum subtract twice the logarithmic sine of angle M A F, and the remainder will give the logarithm of A F, the fourth part of the length of the inclined plane.

If the angle of elevation *t* A H, and its amplitude A B (fig. 11,) and any other angle of elevation *t* A H is given; to find the amplitude A *b* for that other angle, the impetus A M and angle of obliquity D A H remaining the same.

Describe the circle A G M, take A F a fourth part of A B, and A *f* a fourth part of A *b*; from the points F, *f*, draw the lines F *s*, and *f p* parallel to A M, and cutting the circle in the points *s*, *p*; then A F : A M : : S. angle $\overline{s\ A\ F} \times$ S. angle M A *s* : S. angle M A F $\times$ $\overline{\text{S. angle}}$ MAF; and A M : A *f*: : S. angle $\overline{MAF \times}$ S. angle M A F : S. angle *p* A *f* $\times$ S. angle *p* A M; whence by the ratio of equality,

A F : A *f* : : S. angle $\overline{s\ A\ F}$ $\times$ S. angle M A *s* : S. angle $\overline{p\ A\ f}$ $\times$ S. angle *p* A M, which gives this rule.

Add the logarithm of A F to the logarithmic sines of the angles *p* A *f*, *p* A M; from their sum subtract the logarithmic sines of the angles *s* A F, *s* A M, and the remainder will give the logarithm of A *f*, a fourth part of the amplitude required.

Prob. III. To find the force or velocity of a ball or projectile at any point of the curve, having the perpendicular height of that point, and the impetus at the point of projection given. From these two data find out the impetus at that point; then

2 × 16 feet 1 inch is the velocity acquired by the descent of a body in a second of time; the square of which (4 × the square of 16 feet 1 inch) is to the square of the velocity required, as 16 feet 1 inch is to the impetus at the point given; wherefore multiplying that impetus by four times the square of 16 feet 1 inch, and dividing the product by 16 feet 1 inch, the quotient will be the square of the required velocity: whence this rule. Multiply the impetus by four times 16 feet 1 inch, or 64 feet $\frac{1}{3}$, and the square root of the product is the velocity.

Thus suppose the impetus at the point of projection to be 3,000, and the perpendicular height of the other point 100; the impetus at that point will be 2,900. Then 2,900 feet multiplied by 64$\frac{1}{3}$ feet gives 186,566 feet, the square of 432 nearly, the space which a body would run through in one second, if it moved uniformly.

And to determine the impetus or height, from which a body must descend, so as at the end of the descent it may acquire a given velocity, this is the rule:

Divide the square of the given velocity (expressed in feet run through in a second) by 64$\frac{1}{3}$ feet, and the quotient will be the impetus.

The duration of a projection made perpendicularly upwards is to that of a projection in any other direction whose impetus is the same, as the sine complement of the inclination of the plane of projection (which in horizontal projections is radius) is to the sine of the angle contained between the line of direction and that plane.

Draw out A *t* (fig. 8,) till it meets *m* B continued in E, the body will reach the mark B in the same time it would have moved uniformly through the line A E; but the time of its fall through M A the impetus, is to the time of its uniform motion through A E, as twice the impetus is to A E. And therefore the duration of the perpendicular projection being double the time of its fall, will be to the time of its uniform motion through A E, as four times the impetus is to A E; or as A E is to E B; that is, as A *t* is to *t* D; which is as the sine of the angle *t* D A (or M A B its complement to a semicircle) is the sine of the angle *t* A D.

Hence the time a projection will take to arrive at any point in the curve may be found from the following data, *viz.* the impetus, the angle of direction, and the inclination of the plane of projection, which in this case is the angle the horizon make with a line drawn from the point of projection to that point.

Hence also, in horizontal cases, the durations of projections in different directions with the same impetus are as the sines of the angles of elevation. But in ascents or descents, their durations are as the sines of the angles which the lines of direction make with the inclined plane. Thus, suppose the impetus of any projection were 4,500 feet; then 16 feet 1 inch : 1″ : : 4,500 feet : 275″, the square of the time a body will take to fall perpendicularly through 4,500 feet, the square root of which is 16″ nearly, and that doubled gives 32″, the duration of the projection made perpendicularly upwards Then, to find the duration of a horizontal projection at any elevation, as 20°; say R : S. angle 20° : : 32″ : duration of a projection at that elevation with the impetus 4,500. Or if with the same impetus a body at the direction of 35° was projected on a plane inclined to the horizon 17°, say as sine 73° : sine 18° : : 32″ : duration required.

The tables in the next leaf, at one view, give all the necessary cases, as well for shooting at objects on the plane of the horizon, with proportions for their solutions, as for shooting on ascents and descents. We shall in this place mention some of the more important maxims laid down by Mr. Robins, as of use in practice. 1. In any piece of artillery, the greater quantity of powder with which it is charged, the greater will be the velocity of the bullet. 2. If two pieces of the same bore, but of different lengths, are fired with the same charge of powder, the longer will impel the bullet with a greater celerity than the shorter. 3. The ranges of pieces at a given elevation are no just measures of the velocity of the shot: for the same piece fired successively at an invariable elevation, with the powder, bullet, and every other circumstance, as nearly the same as possible, will yet range to very different distances. 5. The greatest part of the uncertainty in the ranges of pieces arises from the resistance of the air. 6. The resistance of the air acts upon projectiles by opposing their motion, and diminishing celerity; and it also diverts them from the regular track which they would otherwise follow. 7. If the same piece of cannon be successively fired at an invariable elevation, but with various charges of powder, the greatest charge being the whole weight of the ball in powder, and the least not less than the fifth part of that weight; then, if the elevation be not less than eight or ten degress, it will be found that some ranges, with the least charge, will exceed some of those with the greatest. 8. If two pieces of cannon with the same bore, but of different lengths, are successively fired at the same elevation, with the same charge of powder, then it will frequently happen that some of the ranges with the shorter piece will exceed some of those with the longer. 9. Whatever operations are performed with artillery, the least charges of powder with which they can be effected are always to be preferred. 10. No field-piece ought at any time to be loaded with more than one-sixth, or at most one-fifth, of the weight of its bullet in powder, nor should the charge of any battering piece exceed one-third of the weight of its bullet.

TABLE I. For Horizontal Projections. Fig. 10.

Cases.	Given.	Required.	Proportions.
1	A M, A *m*	*t* A H H *v*	2 A M : A *m* : : R : S. 2 angle *t* A H R : T. angle *t* A H : : $\frac{A\ m}{4}$: H *v*.
2	A M, *t* A H	A *m*	R : S. 2 angle *t* A H : : A m : A *m*.
3	A *m*, *t* A H	A M	S. 2 angle *t* A H : R : : $\frac{A m}{2}$: AM
4	A M, H *v*	A *m*	$\sqrt{A\ N \times NM} = \frac{A\ m}{4}$, or ½ Log. A N×½ Log. N M=Log. ¼ A *m*.
5	A *m*, H *v*	*t* A H A M	$\frac{A\ m}{4}$: H *v* : : R : T. angle *t* A H. A N : $\frac{A\ m}{4}$: : $\frac{A\ m}{4}$: N M, and A N × N M = A M.
6	H *v*, *t* A H	A *m*	T. angle *t* A H : R : : H *v* : $\frac{A\ m}{4}$
7	*t* A H, A *m* and any other angle. any other amplitude.	any other amplitude belonging to that angle. any other angle belonging to that amplitude.	S. 2 angle *t* A H : S. any other angle :: A *m* : amplitude required. A *m* : any other amplitude : : S. 2 angle *t* A H : S. 2 angle required.
8	*t* A H, H *v* any other angle. any other altitude.	any other altitude. any other angle.	V. S. 2 angle *t* A H : V. S. 2 any other angle :: H *v* : altitude required. H *v* : any other altitude :: V. S 2. angle *t* A H : V. S. 2 angle required.

TABLE II. For Projections on Ascents and Descents. Fig. 8, 9.

Cases.	Given.	Required.	Proportions.
1	A M, A *m*, B *m*, A B,	T A H, *t* A H.	A *m* : B *m* :: R : T angle B A *m*, half of which added to 45°, gives angle G A *z* A M : A B :: A *c* : A C = C G T angle G A *z* : R :: G *z* : A *z*, and A *z*—A *f* = *fz* = P G. C G : P G :: R : V. S. of S G, half of which added to, or taken from, G A *z*, gives the higher or lower direction required
2	T A H, *t* A H, A F	A M	Log. of A M = Log. of A F × 2 Log. S angle M A F — Log. S. angle *s* A F — Log. S. angle M A *s*.
3	T A H, *t* A H, A M	A F	Log. of A F = Log. A M + Log. S. angle *s* A F + Log. S. angle M A *s* — 2 Log. S. angle M A F.
4	B A *m*, *t* A H, A B, and any other angle *t* A H	A *b* the amplitude for that other angle.	Fig. 8 Log. A *f* = Log A F + Log. S. angle *p* A *f* + Log. S. angle *p* A M — Log. S. angle *s* A F — Log. S. angle M A *s*.
5	A M, D A H	A *g*	Fig. 5, 6. T. angle G A *z* : Sec. angle *g* A *z* :: G *z* : A *g*.

GUNPOWDER, a composition of nitre, sulphur, and charcoal, mixed together, and usually granulated. This easily takes fire, and when fired it rarifies or expands with great vehemence, by means of its elastic force. It is to this powder that we owe all the effect and action of guns, and ordnance of all sorts, so that fortification, with the modern military art, &c. in a great measure depends upon it.

The invention of gunpowder is ascribed by Polydore Virgil to a chemist, who having accidentally put some of his composition in a mortar, and covered it with a stone, it happened to take fire, and blew up the stone. Thevet says, that the person here spoken of was a monk of Fribourg, named Constantine Anelzen; but Belleforet, and other authors, with more probability, hold it to be Bartholdus Schwartz, or the black, who discovered it, as some say, about the year 1320; and the first use of it is ascribed to the Venetians in the year 1380, during the war with the Genoese. But there are earlier accounts of its use, after the accident of Schwartz, as well as before it: for Peter Mexia, in his "Various Readings," mentions, that the Moors being besieged, in 1343, by Alphonsus the Eleventh, King of Castile, discharged a kind of iron mortars upon them, which made a noise like thunder: and this is seconded by what is related by Don Pedro, Bishop of Leon, in his Chronicle of King Alphonsus, who reduced Toledo, *viz.* that in a sea combat, between the King of Tunis and the Moorish King of Seville, about that time, those of Tunis had certain iron tubs or barrels, with which they threw thunderbolts of fire.

Du Cange adds, that there is mention made of gunpowder in the registers of the chambers of accounts in France, as early as the year 1338. But it appears that Roger Bacon knew of gunpowder near one hundred years before Schwartz was born; and M. Dutens carries the antiquity of gunpowder still much higher, and refers to the writings of the ancients themselves for the proof of it. It appears too, from many authors and many circumstances, that this composition has been known to the Chinese and Indians for thousands of years.

For some time after the invention of artillery, gunpowder was of a much weaker composition than that now in use, or that described by Marcus Græcus, which was chiefly owing to the weakness of their first pieces. Of twenty-three different compositions, used at different times, and mentioned by Tartaglia in his "Ques. and Inv. lib. 3, ques. 5;" the first, which was the oldest, contained equal parts of the three ingredients. But when guns of modern structure were introduced, gunpowder of the same composition as the present came into use. In the time of Tartaglia the cannon powder was made of four parts of nitre, one of sulphur, aud one of charcoal; and the musket-powder of forty-eight parts of nitre, seven parts of sulphur, and eight parts of charcoal; or of eighteen parts of nitre, two parts of sulphur, and three parts of charcoal. But the modern composition is six parts of nitre to one of each of the other two ingredients: though Mr. Napier says, he finds the strength commonly to be greatest when the proportions are, nitre three pounds, charcoal about nine ounces, and sulphur about three ounces. See his paper on gunpowder in the Transactions of the Royal Irish Academy, vol. ii. The cannon-powder was in meal, and the musket-powder grained; and it is certain, that the graining of powder, which is a very considerable advantage, is a modern improvement.

To make gunpowder duly, regard is to be had to the purity or goodness of the ingredients, as well as the proportions of them, for the strength of the powder depends much on that circumstance, and also on the due working or mixing of them together. See NITRE.

These three ingredients in their purest state being procured, long experience has shown that they are then to be mixed together in the proportion before mentioned, to have the best effect, viz. three quarters of the composition to be nitre, and the other quarter made up of equal parts of the other two ingredients, or, which is the same thing, six parts nitre, one part sulphur, and one part charcoal.

But it is not the due proportion of the materials only, which is necessary to the making of good powder; another circumstance, not less essential, is the mixing them well together; if this be not effectually done, some parts of the composition will have too much nitre in them, and others too little; and in either case there will be a defect of strength in the powder. After the materials have been reduced to fine dust, they are mixed together, and moistened with water, or vinegar, or urine, or spirit of wine, &c. and then beaten together for twenty-four hours, either by hand or by mills, and afterwards pressed into a hard, firm, solid cake. When dry, it is grained or corned, which is done by breaking the cake of powder into small pieces, and so running it through a sieve: by which means the grains may have any size given them, according to the nature of the sieve employed, either finer or coarser; and thus also the dust is separated from the grains, and again mixed with other manufacturing powder, or worked up into cakes again.

Powder is smoothed or glazed, as it is called, for small arms, by the following operation: a hollow cylinder or cask is mounted on an axis, turned by a wheel; this cask is half filled with powder, and turned for six hours, and thus, by the mutual friction of the grains of powder, it is smoothed or glazed. The fine mealy part, thus separated or worn off from the rest, is again granulated.

The velocity of expansion of the flame of gunpowder, when fired in a piece of artillery, without either bullet or other body before it, is prodigiously great, *viz.* seven thousand feet per second, or upwards, as appears from the experiments of Mr. Robins. But M. Bernoulli and M. Euler suspect it is still much greater; and Dr. Hutton supposes it may not be less, at the moment of explosion, than four times as much.

It is this prodigious celerity of expansion of the flame of gunpowder which is its peculiar excellence, and the circumstance in which it so eminently surpasses all other inventions, either ancient or modern; for as to the momentum of these projectiles only, many of the warlike machines of the ancients produced this in a degree far surpassing that of our heaviest cannon shot or shells; but the great celerity given to these bodies cannot be in the least approached by any other means but the flame of powder.

To prove gunpowder. There are several ways of doing this. 1. By sight; thus if it be too black, it is a sign that it is moist, or else that it has too much charcoal in it; so also, if rubbed upon white paper, it blackens it more than good powder does; but if it be of a kind of azure colour, somewhat inclining to red, it is a sign of good powder. 2 By touching; for if, in crushing it with the fingers' ends, the grains break easily and turn into dust, without feeling hard, it has too much coal in it; or if, in pressing it under the fingers upon a smooth hard board, some grains feel harder than the rest, it is a sign the sulphur is not well mixed with the nitre. Also by thrusting the hand into the parcel of powder, and grasping it, as if to take out a handful, you will feel if it is dry and equal grained, by its evading the grasp and running mostly out of the hand. 3. By burning; and here the method most commonly followed for this purpose with us, says Mr. Robins, is, to fire a small heap of it on a clean board, and to attend nicely to the flame and smoke it produces, and to the marks it leaves behind on the board; but besides this uncertain method, there are other contrivances made use of, such as powder-triers, acting by a spring, commonly sold at the shops, and others again that move a great weight, throwing it upwards, which is a very bad sort of eprouvette.

The best eprouvette consists in a small cannon, the bore of which is about one inch in diameter, and is usually charged with two ounces of powder, and with powder only, as a ball is not necessary, and the strength of the powder is accurately shewn by the arc of the gun's recoil. The whole machine is so simple, easy, and expeditious, that, as Dr. Hutton observes, the weighing of the powder is the chief part of the trouble, and so accurate and uniform, that the successive repetitions, or firings, with the same quantity of the same sort of powder, hardly ever yield a difference in the recoil of the one hundreth part of itself.

To recover damaged powder. The method of the powder merchants is this: they put part of the powder on a sail-cloth, to which they add an equal weight of what is really good, then with a shovel they mingle it well together, dry it in the sun, and barrel it up, keeping it in a dry and proper place.

Others again, if it be very bad, restore it by moistening it with vinegar, water, urine, or brandy; then they beat it fine, sift it, and to every pound of powder add an ounce, or an ounce and a half, or two ounces (according as it is decayed) of melted nitre, and afterwards these ingredients are to be moistened and well mixed, so that nothing may be discerned in the composition, which may be known by cutting the mass, and then they granulate it is as usual. In case the powder be quite spoiled, the only way is to extract the salt-petre with water, in the usual way, by boiling, filtrating, evaporating, and crystallizing, and then with fresh sulphur and charcoal to make it up afresh.

On the subject of gunpowder, see also Euler on Robins's Gunnery, Antoni Examen de la Poudre, Baume's Chemistry, and Thompson's Experiments in the Philosophical Transactions for 1781.

Soon after the discovery of the oxygenated-muriatic acid and its combination with potash, it was found that this oxymuriate produced a much more violent detonation with combustible bodies, than is afforded by nitre. It has been estimated to possess more than double the force; but on account of this extraordinary power of gunpowder made with the new salt, and some fatal accidents by its exploding, in consequence of friction or percussion, to which it is liable, as well during the manufacture as afterwards, this modern compound has not been brought into use in military operations, but is likely to continue among the articles of scientific curiosity.

Gunpowder and Combustibles. No person shall make gunpowder but in the regular manufactories established at the time of making the statute 12 George III. c. 61, or licensed by the sessions, pursuant to certain provisions, under forfeiture of the gunpowder, and two shillings per pound; nor are pestle mills to be used under a similar penalty.

Only forty pounds of powder is to be made at one time under one pair of stones, except Battle-powder, made at Battle and elsewhere in Sussex.

Not more than forty hundred weight to be dried at one time in one stove; and the quantity only required for immediate use to be kept in or near the place of making, except in brick or stone magazines, fifty yards at least from the mill.

Not more than twenty-five barrels to be carried in any land carriage, nor more than two hundred barrels by water, unless going by sea or coastwise, each barrel not to contain more than one hundred pounds.

No dealer to keep more than two hundred pounds of powder, nor any person, not a dealer, more than fifty pounds, in the cities of London and Westminster, or within three miles thereof, or within any other city, borough, or market-town, or one mile thereof, or within two miles of the king's palaces or magazines, or half a mile of any parish church, on pain of forfeiture, and two shillings per pound, except in licensed mills, or to the amount of three hundred pounds for the use of collieries, within two hundred yards of them.

GUNTER (Edmund,) an English mathematician of the seventeenth century, was descended from an ancient and respectable family in Brecknocshire, South Wales, and was born in the county of Herefordshire in the year 1580. He received his classical education on the royal foundation at Westminster School, whence he was elected at about eighteen years of age to Christ Church College, in Oxford. He was admitted to the degree of B. A. in 1603, and to that of M. A. in 1606; after which he entered into orders, and proceeded bachelor of divinity in the year 1615. His genius had early led him to the pursuit of mathematical studies; and at the time when he took his degree of M. A. he had merited the title of an inventor by his new projection of the sector, of which he then wrote a description in Latin, and permitted his friends to transcribe it, though the English account of his invention was not published till several years afterwards. In the year 1618, he had invented a small portable quadrant, for the more easy finding the hour and azimuth, and more useful astronomical purposes. The reputation which he had now acquired in the mathematical world occasioned his introduction to the acquaintance of some of the most able mathematicians of his time, by whose recommendation and interest he was elected professor of astronomy at Gresham College, London, in the year 1619. In this situation he soon distinguished himself by his lectures and his writings, which contributed greatly to the improvement of science, and reflected credit to the choice that had been made of him to that professorship. His first publication after his election appeared in 1620, and was entitled "Canon Triangulorum, sive Tabulæ sinuum artificialium ad radium 10.0000000, et ad Scrupula prima Quadrantis," 8vo. This treatise was accompanied with the first 1,000 of Brigg's logarithms of common numbers. In the second edition of it, which was published in English in 1624, under the title of "Canon Triangulorum, or Table of artificial Sines and Tangents to a radius of 10.0000000 Parts to each Minute of the Quadrant," 4to., the logarithms were continued from 1,000 to 10,000, and a rule was given at the end for augmenting them to 100,000. These tables were the first of the kind which had been given to the world, and, if the author had published nothing else, would have preserved his memory to the latest posterity, by the admirable aid which they afforded to students in astronomy; for they greatly facilitated the practical parts of that science, by furnishing a method of solving sperical triangles without the aid of secants or versed sines: the same thing being effected by addition and subtraction only, which in the use of the former tables of right sines and tangents required multiplication and division. Due praise was bestowed upon him by many of the most eminent mathematicians among his contemporaries, for the service which he rendered to science by this most excellent work; and his right to the improvement of logarithms, by their application to spherical triangles, was satisfactorily established by Mr. Edmund Windgate, Mr. Robert Burton, and Mr. Henry Bond, sen.

In the year 1622, Mr. Gunter made his important discovery, that the *variation* of the magnetic needle *varies*. To this discovery he was led in the course of lectures he made on the variation at Deptford, by which he found, that the declination of the needle had changed almost five degrees in the space of forty-two years. The truth of this discovery was afterwards confirmed and established by Mr. Gellibrand, his successor at Gresham College. Soon after this he invented his famous "rule of proportion," which is an easy and excellent method of combining arithmetic and geometry, adapted to the understanding of persons of the most ordinary capacities. It consists in applying the logarithms of numbers and of sines and tangents to straight lines drawn on a scale or rule, by which, proportions in common numbers and trigonometry may be resolved by the mere application of a pair of compasses: a method founded on this property, that the logarithms of the terms of equal ratios are equidifferent. This was called Gunter's proportion and Gunter's line; and the instrument in the form of a two foot scale is now in common use for navigation and other purposes, is and commonly called the Gunter. In the year 1624, this invention was carried into France by Mr. Wingate, who not only communicated it to most of the principal mathematicians then at Paris, but also, at their request, published an account of it in the French language. Mr. Gunter likewise greatly improved the sector, and other instruments for the same uses, the description of all which he published in 1624, in a treatise, entitled "The Cross Staff, in three books," &c. 4to. In the same year he published, by King James's order, a small tract, entitled "The Description and Use of his Majestie's Dials in Whitehall Garden," 4to. Mr. Gunter had been employed by the direction of King Charles in drawing the lines on these dials, and at his desire wrote this description, to which we refer those readers who wish to see a particular account of the construction and uses of those dials, which are no longer in existence. Our author was the first who used the word co-sine for the sine of the complement of an arc. He also introduced the use of arithmetical complements into the logarithmical arithmetic; and it has been said, that he first started the idea of the logarithmic curve, which was so called, because the segments of its axis are the logarithms of the corresponding ordinates. To him likewise the mathematical world is indebted for many other inventions and improvements, most of which were the subjects of his lectures at Gresham College, and afterwards disposed into treatises, which were printed in his works. From the genius and abilities which he had displayed in his works already noticed, the highest expectations were formed of his future services in the cause of useful science; but they were unhappily disappointed by his death, in 1626, when he was only in the forty-fifth year of his age. His name, however, will be transmitted with honour to posterity, as that of the parent of instrumental arithmetic. His works have been collected, and various editions of them have been published. The fifth is by William Leybourn, in 1673, 4to. containing the description and use of the sector, cross-staff, bow, quadrant, and other instruments; with several pieces added by Samuel Foster, Henry Bond, and William Leybourn.

GUNTER's *chain*, the chain in common use for measuring land, according to true or statute measure; so called from Mr. Gunter, its reputed inventor. The length of the chain is 66 feet, or 22 yards or 4 poles, of 5½ yards each; and it is divided into 100 links, of 7.92 inches each. This chain is the most convenient of any thing for measuring land, because the contents thence computed are so easily turned into acres. The reason of which is, that an acre of land is just equal to 10 square chains, or 10 chains in length and one in breadth, or equal to 100,000 square links. Hence the dimensions being taken in chains, and multiplied together, it gives the content in square chains, which therefore being divided by 10, or a figure cut off for decimals, brings the content to acres; after which the decimals are reduced to roods and perches, by multiplying by 4 and 40. But the better way is to set the dimensions down in links, as integers, considering each chain as 100 links; then having multiplied the dimensions together, producing square links, divide these by 100,000, that is, cut off five places for decimals, the rest are acres, and the decimals are reduced to roods and perches as before. Suppose a field to be measured be 887 links in length, and 750 in breadth, to find its area we say

```
  887
  750
 -----
 44350
 6209
 -------
 6.65250
       4
 -------
 2.61000
      40
 -------
    24.4
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The contents are 6 *A.* 2 *R.* 24 *P.*

GUNTER's *line*, a logarithmic line, usually graduated upon scales, sectors, &c. It is also called the line of lines and line of numbers; being only the logarithms graduated upon a ruler, which therefore serves to solve problems instrumentally, in the same manner as logarithms do arithmetically. It is usually divided into an hundred parts, every tenth thereof is numbered, beginning with 1, and ending with 10; so that if the first great division marked 1, stand for one tenth of any integer, the next division, marked 2, will stand for two-tenths; 3, three-tenths, and so on; and the intermediate divisions, will in like manner represent 100th parts of the same integer. If each of the great divisions represent 10 integers, then will the lesser divisions stand for integers; and if the great divisions be supposed each 100, the subdivisions will be each 10.

GUNTER's *line, use of.* 1. "To find the product of two numbers." From 1 extend the compasses to the multiplier; and the same extent, applied the same way from the multiplicand, will reach to the product. Thus, if the product of 4 and 8 be required, extend the compasses from 1 to 4, and that extent, laid from 8 the same way, will reach to 32, their product. 2. "To divide one number by another." The extent from the divisor to unity will reach from the dividend to the quotient; thus, to divide 36 by 4, extend the compasses from 4 to 1, and the same extent will reach from 36 to 9, the quotient sought. 3. "To three given numbers, to find a fourth proportional." Suppose the numbers 6, 8, 9; extend the compasses from 6 to 8, and this extent, laid from 9 the same way, will reach to 12, the fourth proportional required. 4. "To find a mean proportional between any two given numbers." Suppose 8 and 32: extend the compasses from 8 in the left-hand part of the line to 32 in the right; then bisecting this distance, its half will reach from 8 forward, or from 32 backward, to 16, the mean proportional sought. 5. "To extract the square root of any number." Suppose 25: bisect the distance between one on the scale and the point representing 25; then the half of this distance, set off from 1, will give the point representing the root 5. In the same manner the cube root, or that of any higher power, may be found, by dividing the distance on the line, between 1 and the given number, into as many equal parts as the index of the power expresses; then one of those parts, set from 1, will find the point representing the root required.

Gunter's *quadrant*, one made of wood, brass, &c. containing a kind of stereographic projection of the sphere, on the plane of the equinoctial; the eye being supposed placed in one of the poles. Besides the use of this quadrant in finding heights and distances, it serves also to find the hour of the day, the sun's azimuth, and other problems of the globe.

Gunter's *scale*, usually called by seamen the Gunter, is a large plain scale, having various lines upon it, of great use in working the cases or questions in navigation. This scale is usually two feet long, and about an inch and a half broad, with various lines upon it, both natural and logarithmic, relating to trigonometry, navigation, &c. On the one side are the natural lines, and on the other the artificial or logarithmic ones. The former side is first divided into inches and tenths, and numbered from one to twenty-four inches, running the whole length near one edge. One half the length of this side consists of two plain diagonal scales, for taking off dimensions to three places of figures. On the other half or foot of this side are contained various lines relating to trigonometry, in the natural numbers, and marked thus, *viz.*

Rumb, the rumbs or points of the compass;

Chord, the line of chords;

Sine, the line of sines;

Tang. the tangents;

S. T. The semi-tangents; and at the other end of this half are,

Leag. leagues, or equal parts;

Rumb, another line of rumbs;

M. L. miles of longitude;

Chor. another line of chords.

Also in the middle of this foot are L, and P, two other lines of equal parts: and all these lines on this side of the scale serve for drawing or laying down the figures to the cases in trigonometry and navigation. On the other side of the scale are the following artificial or logarithmic lines, which serve for working or resolving those cases; *viz.*

S. R. the sine rumbs;

T. R. the tangent rumbs;

Numb. line of numbers;

Sine, sines;

V. S. the versed sines;

Tang. the tangents;

Meri. Meridional parts;

E. P. Equal parts.

GUN-WALE, or *gunnel*, is the uppermost wale of a ship, or that piece of timber which reaches on either side from the quarter-deck to the forecastle, being the uppermost bend which finishes the upper works of the hull, in that part in which are put the stanchions which support the waste-trees.

GUSSET, in heraldry, is formed by a line drawn from the dexter or sinister chief points, and falling down perpendicularly to the extreme base.

GUST, in sea-language, a sudden and violent squall of wind, bursting from the hills upon the sea, so as to endanger the shipping near the shore. These are peculiar to some coasts, as those of South Barbary and Guinea.

GUSTAVIA, in botany, so named in memory of Gustavus III. King of Sweden: a genus of the Monadelphia Polyandria class and order. Natural order of Myrti, Jussieu. Essential character: calyx none; petals several; berry many-celled; seeds appendicled. There is but one species, *viz.* G. augusta, which is a tree from twenty to thirty feet in height. It is a native of Surinam and Cayenne.

GUTTA *serena*, a disease in which the patient, without any apparent fault in the eye, is entirely deprived of sight.

GUTTÆ, in architecture, are drops depending from the soffit of the mutules under the corona of the entablature, being in shape either the frustra of cones, or cylindrical sections half their diameter in height. In the Greek doric each mutule contains three rows of guttæ, six in number; they are also six in number at the base of each triglyph, immediately under the regula.

GUTTER, in architecture, a channel on the roofs of houses, serving to receive and carry off the rain.

GUTTURAL, a term applied to letters or sounds pronounced or formed as it were in the throat, *viz.* אחהע, which, for memory's sake, are termed *ahachah.*

GUTTY, in heraldry, a term used when any thing is charged or sprinkled with drops. In blazoning, the colour of the drops is to be named, as gutty of sable, of gules, &c.

GUY, in a ship, is any rope used for keeping off things from bearing or falling against the ship's sides when they are hoisting in.

That rope, which at one end is made fast to the fore-mast, and seized to a single block at the pendant of the garnet, is called the guy of the garnet.

GYBING, the art of shifting any boom-sail from one side of the vessel to another. By a boom-sail is meant any sail, the bottom of which is extended by a boom, (see BOOM) the fore-end of which is hooked to its respective mast, so as to swing occasionally on either side of the vessel, describing an arch, of which the mast is the centre. As the wind changes, it becomes necessary to change the position of the boom, together with its sail, which is accordingly shifted to the other side of the vessel, as a door turns upon its hinges.

GYMNANTHES, in botany, a genus of the Monoecia Monodelphia class and order. Essential character: male ament naked; perianth and corolla none; stamina pedicels three-parted or three-forked, anther bearing; female ament or germ pedicelled; corolla none: style trifid; capsule tricoccous, three-celled. There are two species, natives of the West Indies.

GYMNASTICS. This word, derived from the Greek, comprehends all those athletic exercises by which the ancients rendered the body pliant and healthy, and enabled the muscles to do their offices with treble effect. The variety of methods contrived for this purpose was very numerous, and the ardour with which they were pursued, at every opportunity, contributed to banish all dread of personal danger, and prepared the youth of each nation for the military life.

Persons were appointed to teach the various sports, and the gymnasium was a public receptacle for their performance; the exercises amounted to nearly sixty descriptions, and the parties concerned in them originally appeared in drawers, but afterwards totally naked, in order to give full scope to their limbs. The gymnasium was under the superintendance of a master, styled gymnasiarch, who had two assistants, the xystarch and the gymnastis. The master was selected from the higher classes of the people, as his office was of considerable importance, and his deputies presided over the inferior persons employed in teaching; the former directing the wrestlers, and the latter the progress of the other exercises, that the youths might neither suffer through accident or too violent exertion.

It has been asserted, that the whole system of education amongst the Greeks was comprehended in two essential points, gymnastics and music; dancing, under several divisions, invariably accompanied their music in warlike, festive, and bacchanalian movements, to which they added, at proper times, tumbling, numerous modes of playing with the ball, leaping, foot-races, pitching the discus, throwing the javelin, wrestling, boxing, &c. Tumbling was entitled cubistics; the amusements of the ball they comprehended under the term spheristics; the exercises of leaping, foot-racing, the discus, the javelin, and wrestling, they included in the word palestrics.

The moralists and medical men of antiquity highly approved of those sports which were calculated to bring health, strength, and grace, in their train; but were energetic and vehement in their censures of the athletes, who wrestled and boxed with angry violence, and afterwards indulged in vicious excesses.

Leaping a considerable distance with ease was one of the innocent and useful acquirements of the Grecian youth, which they soon attained, but which they appear to have despised, as incapable of difficulty; therefore, to render the art laborious, and increase their weight, they adopted the practice of bearing lead on their heads and shoulders, fastening it to their feet, and holding it in their hands. A youth, thus loaded, and almost pinioned to the earth by attraction, who sprung a greater distance than his competitors under the same circumstances, was hailed with loud plaudits, proportioned to the surprise excited by his uncommon strength of muscles.

The pedestrian races admitted of more ardent endeavours than leaping; not a moment could be lost or granted for relaxation; the shouts of the teachers, and of the spectators, were incentives for exertion, and, divested of clothing, the efforts of the least successful were wonderful. Homer illustrates this part of the subject in his inimitable "Iliad."

'Rang'd in a line the ready racers stand;
Pelides points the barrier with his hand;
All start at once; Oileus led the race;
The next, Ulysses, measuring pace with pace;
Behind him, diligently close, he sped,
As closely following as the running thread
The spindle follows, and displays the charms
Of the fair spinster's breast and moving arms:
Graceful in motion thus, his foe he plies,
And treads each footstep ere the dust can rise:
His glowing breath upon his shoulders plays;
The admiring Greeks loud acclamations raise;
To him they give their wishes, hearts, and eyes,
And send their souls before him as he flies."

Iliad, book xxiii. 885, 895

Rapidity of motion might be useful to the ancients in many particulars, though less so than to the uncivilized nations, generally termed savage; the inhabitants of the latter seem indeed compelled to acquire swiftness in running, as the pursuit of wild animals is absolutely necessary to maintain their existence; and some of the native chiefs of India and its dependencies retain persons to convey dispatches from station to station by pedestrian exertion.

Throwing the dart or spear was of decided importance in ancient warfare, and the skill of their soldiers was probably very great. In this instance, however, it may be doubted, whether all the advantages of their gymnasiums enabled them to excel some of the tribes of Hottentots, exclusive of savages in a superior state of civilization; the debased people alluded to possess wonderful ability in throwing and arresting the progress of spears; the writer of the present article had an opportunity of knowing, from a witness of the scene, that a Hottentot frequently caught a heavy pole hurled at him by a strong man, ere it had power to injure him.

Throwing the discus, now known by the name of the quoit, required equal strength and skill; the shape of the discus was nearly oval, about a foot in length, and three or four inches thick in the centre, whence it tapered on each side to the extremity, in the manner of a lens, and a hole was perforated in the middle. Statues of persons employed at this game exhibit them with the discus "rested on the four fingers, which were closed, with their ends pointing upward on the inside of it; the thumb was extended horizontally along the outside."

Salzmann says, the thrower obtained the necessary impulse by swinging the arm, and at the proper moment he gave the discus a rotatory motion, and sent it through the air to the mark. Kennet asserts, in describing the Roman Circensian shows, that they obtained their quinquertium, or the five exercises of running, wrestling, leaping, throwing, and boxing, from the Grecian games, and adds, that the discus or quoit of the former people "was made of stone, iron, or copper, five or six fingers broad, and more than a foot long, inclining to an oval figure; they sent this to a vast distance, by the help of a leathern thong tied round the person's hand that threw." The latter particular has been disputed, and the position is maintained, by observing that, had a thong been used, it was unnecessary for the discobuli to rub their hands on the earth, to prevent the discus from slipping; besides, the strap would have interrupted the rotatory whirl, thought indispensable for its steady course.

If we may depend upon Homer, the weight of the discus was an object of some importance:

"Then hurl'd the hero, thund'ring on the ground,
A mass of iron, (an enormous round,)
Whose weight and size the circling Greeks admire,
Rude from the furnace, and but shap'd by fire,

This mighty quoit Aĕtion wont to rear,
And from his whirling arm dismiss in air;
The giant by Achilles slain, he stow'd
Among his spoils this memorable load.
For this he bids those nervous artists vie,
That teach the disc to sound along the sky."

Book xxiii. 975.

Galen classed the discus in the medicinal gymnastics, in hurling which he was declared the victor, who sent it highest in the air, the greatest distance, and the nearest to the mark. Circular quoits, resembling a broad ring, and made of iron, are still used in England, but it is extremely doubtful whether the most experienced player could rival the inferior discobuli of ancient times.

Wrestling was the only exercise, of those already mentioned, which could be said to be improper or dangerous. Tertullian reprobated it, and Galen suffered a dislocation of his shoulder when wrestling, which satisfactorily accounts for his enmity to the sport. It is rather singular, that this method of trying muscular strength should have prevailed, when it is remembered that strains of the muscles and dislocation of the joints, and even fractured limbs and skulls, were consequences not improbable: in addition to these objections, it must be allowed, that no method more certain could be devised for the excitement of sudden anger and blows. To obviate the first of these disadvantages, the Grecian athletes anointed their bodies with oil, hoping by this means to render their joints more flexible, though some authors have supposed the practice originated from an intention to prevent their adversaries obtaining a firm grasp of the limbs, and others think it was done to check profuse and debiliating perspirations. The mode adopted to save the limbs from fractures was absurd indeed: they lived well, and contrived every possible way to make themselves corpulent, that their flesh might act, between their bones and the earth, as a medium or cushion, forgetting that, as their gravity increased, the bruises they received were proportionably more violent, and a fracture more difficult to reduce.

Besides the application of oil, and rubbing it on the surface of the skin till the friction produced a glow, it is said they added dust or sand, but for what purpose, unless to close the pores, cannot well be decided. Salzmann says, "after this preparation the exercise itself commenced. The combatants began with handling each other slightly, each pressing or pulling his antagonist backwards and forwards, till they grew warm, then butting him with his head, thrusting him from his ground, assailing him with all his force, wrenching his limbs, shaking him, twisting his neck so as to choke him, lifting him up in his arms, &c. This kind of wrestling was called *ορθια παλη*, because it was performed standing: and he was declared victor who threw his antagonist thrice. Another kind was performed on the ground. This was called *ανακλινοπαλη*. Every thing was practised in this that was in wrestling erect, as far as the posture would allow. The combatants voluntarily lay down, and he whose strength was first exhausted lost the victory, which he acknowledged by words, or by holding up one of his fingers.

"With wrestling, the athletes afterwards united the savage practice of boxing, which was known before the Trojan war. Hence arose the two-fold contest, called *παγκρατιον*, which was pursued to excess by the athletes, but could scarcely be considered as a part of medicinal gymnastics in the schools. No ancient physician recommends boxing in a medical view. The boxers likewise laid great stress on rendering their bodies corpulent, that they might be the better able to bear the blows of their antagonists." The same author adds, "The boxers fought erect, never hugging their antagonist, and throwing him down, but merely striking him: the wrestlers were not allowed to strike: the pancratiasts united the two, both wrestling and striking."

Kennet refers the Ludus Trojæ, celebrated by bands of boys, to the invention of Ascanius. The youths engaged in this exercise were selected from the most honourable families of Rome, were elegantly habited, and armed with weapons of a size proportioned to their age. The commander received the title of Princeps Juventutis, and was sometimes the son of a senator, and not unfrequently the heir to the empire. Augustus was extremely partial to their infantile imitations of the ardour of manhood; and Virgil, aware of his partiality, introduced a description of their celebrations in his Eneid. They wore chaplets of flowers on their heads, and their hair flowed loose from beneath it; their vests were purple; and twists of gold, disposed in circles, attached to the neck, spread down their breasts; quivers hung on their shoulders: they carried two spears; and were mounted on spirited horses. Virgil, in the passage alluded to, divides the youths into three troops, each consisting of twelve, under the command of a captain, amounting in the aggregate to thirty-nine individuals. Thus equipped, they walked their horses round the circus.

"When sage Epitides, to give the sign,
Crack'd his long whip, and made the course begin."

They then started forward at full speed, and afterwards formed into divisions, returning back.

"—— while, from their fingers borne,
Their hostile darts aloft upon the wind
Fly shivering; then in circling numbers join'd,
The manag'd coursers with due measures bound,
And run the rapid ring, and trace the mazy round.
Files facing files, their bold companions dare,
And wheel and charge, and urge the sportive war.
Now flight they feign, and naked backs expose;
Now with turn'd spears drive headlong on the foes;
And now confederate grown, in peaceful ranks they close,"

The chariot races do not strictly belong to this article, but they were so far connected with personal exercises in the Circus, that it would be almost unpardonable to pass them without notice. Strength and agility were entirely useless in the conduct of the chariot; courage and address in guiding the fiery steeds were all that was requisite in the driver. The charioteers were formed into companies in the Roman Circensian spectacles, and they excited great interest throughout Rome, the inhabitants of which were generally divided into parties, each attached to their favourite company. This, in common with their other sports, was derived from the Greeks. The different ancient divisions were distinguished by the colours of their habits, which were green, red, white, and blue: and they were termed the Prasina, the Russata, the Alba, and the Veneta.

The antiquity of the Pyrhica, or Saltatio Pyrhica, led ancient authors into many fanciful ideas, whence this warlike dance originated. Homer introduces it in its primitive state, in his description of the twelfth department of the shield of Achilles. "The skilful Vulcan then designed the figure and various motions of a dance, like that which Dædalus, of old, contrived in Gnossus for the fair Ariadne. There the young men and maidens danced hand in hand; the maids were dressed in linen garments, the men in rich and shining stuffs; the maids had flowery crowns on their heads, the men had swords of gold hanging from their sides in belts of silver. Here they seem to run in a ring with active feet, as swiftly as a wheel runs round when tried by the hands of the potter. There they appeared to move in many figures, and sometimes to meet, sometimes to wind from each other. A multitude of spectators stood round, delighted with the dance. In the middle, two nimble tumblers exercised themselves in feats of activity, while the song was carried on by the whole circle."

At the period when the dance was practised in the Roman amphitheatres, it had assumed a warlike appearance, the performers advancing and flying alternately, as if engaged in battle. Claudian says,

"Their moving breasts in tuneful changes rise,
The shields salute their sides, or straight are shewn
In air high waving; deep the targets groan,
Struck with alternate swords, which thence rebound,
And end the concert and the sacred sound."

Scaliger informs us, with some degree of vanity, that he had often danced the pyrhic in presence of the Emperor Maximilian, to the admiration and amazement of the inhabitants of Germany, and, as it appears, to that of the Emperor, who, he adds, exclaimed, "This boy either was born in a coat of mail, instead of a skin, or else has been rocked in one instead of a cradle."

Real or supposed improvements in the customs of the European nations have now nearly abolished or altered almost all of the ancient gymnastic exercises; active feats and sudden turns of the body, or tumbling, are totally despised and confined to the most pitiful public exhibitions; playing with the ball is very little practised; leaping and foot-races are limited to a few wagers; pitching the quoit seldom extends beyond the apprentice and the labourer; throwing the javelin is entirely discontinued; wrestling, long a favourite athletic exercise in England, belongs almost exclusively to the wanton schoolboy; boxing, (thanks to our morals) to the lowest wretches in society; the tournament, evidently derived from the Ludus Trojæ, is nearly forgotten; the chariot race is in the same state of disuse; and we have nothing which resembles the military pyrhic; and even the faint similarity of the games enumerated are supported by the caprice of a few individuals, who are often condemned for employing their time to so little purpose.

On the other hand, if we turn our attention to the rest of the world, we shall find that many of the gymnastic sports are in full use at this moment, without the inhabitants suspecting that nations very remote from them had similar some thousand years past. Two instances of this fact are so exactly in point, that we cannot refrain from giving them. Mr. Cordiner, who very lately presented the public with an excellent work, descriptive of the island of Ceylon, relates the particulars of a Cingalese play, in the following words:

"Gay and noisy amusements do not often interrupt the predominant repose of the genuine Celonese; but a sort of comical representation is sometimes attempted, to gratify a man of elevated rank, or to celebrate an occasion of extraordinary festivity. On the 28th of December, 1803, while Lord Viscount Valentia was visiting Governor North, at Columbo, a numerous company of the British inhabitants were favoured, after dinner, with the sight of an exhibition, called by the natives a Cingalese play, although, from the rude nature of the performance, it can hardly be ranked among the productions of the dramatic art. The stage was the green lawn before his Excellency's villa at St. Sebastian, and the open theatre was lighted with lamps supported on posts, and flambeaus held in men's hands. The entertainment commenced with the feats of a set of active tumblers, whose naked bodies were painted all over with white crosses. They walked on their hands, and threw themselves round, over head and heels, three or four times successively, without a pause. Two boys embracing one another, with head opposed to feet, tumbled round like a wheel, but necessarily with a slower motion, as a momentary stop was required, when each person touched the ground. The young performers, singly, twisted their bodies with a quickness and flexibility which it would be difficult to imitate in a less relaxing climate. Some of the movements produced sensations by no means agreeable, as they conveyed the idea of occasioning uneasiness to the actors. After this, six or seven professed dancers appeared on the stage. They were dressed like the gay damsels on the coast of Coromandel; but the greater part of them appeared not to be females, and an inferiority of gesticulation was visible in the style of their performance. Two men, raised upon stilts, walked in amongst them, exhibiting a most gigantic stature; pieces of bamboo were tied round their legs, reaching only a little above the knee, and elevating them three feet from the ground; they moved slowly, without much ease, and had nothing to support them but the equipoise of their own bodies: a man then appeared masked, armed with a sword and switch, and habited in the old Portuguese dress; two others, resembling Dutchmen, and masked, preceded, who skipped about and drove all before them in an imperative manner; groupes of horrible masks, set with teeth, one of which had the head and proboscis of an elephant, followed; the persons who bore them carried lighted torches in each hand, those they whirled rapidly round, alternately lighting and extinguishing them in the course of their revolutions; these personified devils, and sometimes laughed to excess, but said little; imitations of wild animals next appeared; "but the prettiest part of the entertainment was a circular dance, by twelve children about ten years of age; they danced opposite to one another, two and two, all curtsied at one time down to the ground, shook their whole bodies with their hands fixed in their sides, and kept time to the music with two little clattering sticks, one in each hand. Going swiftly round, being neatly dressed, of one size, and perfect in the performance, this youthful dance produced a very pleasing effect, and brought to remembrance the pictures of the fleeting hours."

Captain Cook relates, in the second volume of the account of his voyage to the Pacific Ocean and the Sandwich Islands, that the natives play at bowls with pieces of whetstone, in shape resembling a small cheese, rounded at the edges, highly polished, and weighing about a pound. "They also use, in the manner that we throw quoits, small, flat, round pieces of the writing-slate, of the diameter of the bowls, but scarcely a quarter of an inch thick, also well polished."

GYMNOTHORAX, the *muræna*, in natural history, a genus of fishes of the order Apodes. Generic character: body eel-shaped, no pectoral fins; spiracle single, on each side the neck, small, oval, and uncovered. There are four species, according to Gmelin, but Shaw enumerates eleven. The G. romana abounds on the Mediterranean coasts, and attains nearly to the size of the common eel. It is principally found in salt water, but will live equally well in fresh. It is highly voracious, and preys upon a vast variety of smaller animals. It was regarded by the Romans as one of the first of delicacies, and the rich and noble frequently kept these fishes in large reservoirs, in which they were at once fed for the table, and afforded entertainment by the tameness and familiarity to which they were easily disciplined. V. Pollio once ordered a slave, who had offended him by neglect, in the presence of the Emperor, to be cut in pieces and given for food to his murænas, at which the Emperor Augustus was so much disgusted, that he instantly ordered the ponds of this nobleman to be filled up, and his slave to be liberated, and was induced to spare the life of this tyrant, only from a regard to an acquaintance of considerable duration.

GYMNOTUS, the *gymnote*, in natural history, a genus of fishes of the order Apodes. Generic character: the head with lateral opercula; two tentacula on the upper lip; eyes covered by the common skin; gill-membrane five-rayed; body compressed, generally without a dorsal fin, but carinated by a fin beneath. There are nine species, of which we shall notice G. electricus, or the electrical gymnote. This is generally of the length of three or four feet, is of an unpleasant appearance, much like a large eel, but thicker in proportion to the length, and always of the colour of a blackish brown.

It has, occasionally, been seen of the length of ten feet. It is found in the hot climates of Africa and America, particularly in the rivers of Surinam and Senegal. Towards the close of the 17th century, a memoir was presented by M. Richer to the French Academy, announcing his discovery of a very pecular quality of this fish, by which it communicated to the person touching it a very sudden and violent shock. This statement, however, was considered as fabulous for a considerable time, and it was not till about the middle of the last century that all scepticism on this subject, even among learned and scientific men, completely vanished, and this very peculiar property was universally allowed to attach to the fish in question. Dr. Garden, of Charlestown, in South Carolina, after giving an elaborate description of the form and structure of this animal, adds, that it has the power of giving an electrical shock to any person, or to any number of persons who join hands together, the extreme person on each side touching the fish. There were five of these fishes under his immediate inspection at the above town, all which possessed this property in a high degree, and they could communicate the shock to any number of individuals, either by the immediate touch of the fish by one of them, or through the medium of a metalline rod; but when they were first caught, this power was more fully possessed by them than some time afterwards. He observed that, in his own case, the shock was never experienced, when the fish was laid hold of by him with one hand only; when it was held by both hands, at a considerable distance apart, he never failed to receive a sensible and smart one. Indeed, if it be held by one hand, and the other hand be immersed in the water immediately over the body of the fish, the same effect will follow as if the fish were held by both hands, and so it will be with respect to any number of persons joining in a circle, one hand of the person at one extremity holding the fish, and the person at the other extremity placing his hand in the water over the gymnote. This shock is considered as completely electrical, all the circumstances of it resembling those of the electricity of the atmosphere. It is passed by the same conductors, and interrupted by the same electrics. These fishes are caught in Surinam river, considerably above the reach of the sea-water. They subsist on fishes, worms, or any animal food, which is small enough for them to swallow; and when any fish is thrown at them, they will immediately communicate to it a shock, by which it is stupified. If the fish be large, several shocks are requisite, and are applied for this purpose, and many are thus destroyed by the gymnote which it is unable to swallow, and after repeated attempts finds itself obliged to abandon. The shock inflicted by these creatures on others, intended by them for prey, is by no means always, nor perhaps generally, fatal, and many have been speedily recovered, after being removed into another vessel from that in which they received the shock, and in which they were rendered motionless, and to all appearance dead, by it. It appears that the electrical fish has no teeth, and the most minute examination of the fishes contained in their stomachs could discover no marks of laceration, even in the slightest degree. Gymnotes of three feet in length are incapable of swallowing any fish larger than three inches and a half. It appears that the strength of their peculiar talent is in proportion to their magnitude, and it is stated that there are some in Surinam river, whose length is twenty feet, and whose shock is followed by immediate death to any human being, who is so unfortunate as to be exposed to it. It is observed, that even after the electrical fish is dead, it retains, for a considerable time, more or less of this singular property. It is a fish greatly and justly dreaded by the inhabitants of those countries, the rivers of which it frequents; it is, however, notwithstanding this circumstance, used by them for food, and even by some considered as a capital delicacy. For a representation of the gymnotus electricus, see Pisces, Plate IV. fig. 5.

GYNANDRIA, in botany, the name of the twentieth class in the Linnæan system. It consists of plants with hermaphrodite flowers, in which the stamina are placed upon the style, or upon a pillar-shaped receptacle resembling a style, which rises in the middle of the flower, and bears both the stamina and pointal. There are seven orders in this class, each of which is founded on the number of the stamina in the plants which compose it. See Botany.

GYNOPOGON, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Apocineæ, Jussieu. Essential character: calyx half five-cleft, inferior, permanent; corolla five-parted, tube ventricose below the tip, throat contracted; stigma globular, two-lobed; berry pedicelled, sub-globular; seed cartilaginous, sub-bilocular. There are three species, natives of the islands in the South Seas.

GYPSIES. There are several statutes against them, by which they are treated as rogues and vagabonds.

GYPSOPHILA, in botany, a genus of the Decandria Digynia class and order. Natural order of Caryophyllei. Essential character: calyx one-leafed, bell-shaped, angular; petals five, ovate, sessile; capsule globular, one-celled. There are twelve species.

GYPSUM, a substance well known to the ancients, and one that is very abundant in nature, and is now denominated, according to the new chemical arrangement, the sulphate of lime. It forms immense strata, composing entire mountains; it is found in almost every soil, either in greater or less quantities; it is contained in the waters of the ocean, and in almost all river and spring water. In these its presence is the cause of the quality termed hardness, which may be known by the water being incapable of forming a solution of soap, the sulphuric acid seizing on the alkali of the soap, and the oil forming a compound with the lime. Sulphate of lime is insipid, white, and soft to the touch. Water will not hold a 500th part of it in solution. Exposed to heat it appears to effervesce, which phenomenon is caused by the expulsion of water. It becomes opaque, and falls into powder. This powder, when its water has been driven off by the application of a red heat, absorbs water rapidly, so that if it be formed into a paste with water, it dries in a few minutes. In this state it is called plaster of Paris, and is employed for forming casts, and for a variety of purposes in the art of statuary.

GYRINUS, in natural history, *water-flea*, a genus of insects of the order Coleoptera. Antennæ cylindrical; jaws horny, one-toothed, sharp-pointed; eyes four, two above and two beneath; thorax and shells margined, the latter shorter than the body; legs formed for swimming. The insects of this genus are to be found on the surface of waters, on which they run, and describe circles with a great degree of swiftness; when attempted to be taken they plunge to the bottom, drawing after them a bubble very similar to a globule of quicksilver. Eleven species of the gyrinus have been described, of which one only is found in Europe; and in the United States about six additional ones, *viz.* G. natator, a small insect, not more than a quarter of an inch long, of a blackish colour, but with so bright a surface as to shine like a mirror in the sun. The larva is of a very singular aspect, having a lengthened body, furnished with many lateral appendages down the body, exclusively of six legs. Dr. Shaw says, its motions are extremely agile, swimming in a kind of serpentine manner, and preying on the smaller and weaker water-insects, minute worms, &c. It is a highly curious object for the microscope. When its change arrives, it forms for itself a small oval cell or case on a leaf of some water plant, and after casting its skin it becomes a chrysalis. These animals, in large numbers, give out a disagreeable smell, and, like other water beetles, they fly only by night. Their eggs are white, and are laid on the stems of water-plants, where they are hatched in the course of a week, and instantly begin to swim about very swiftly in quest of prey; inhabits Europe.

H.

H, Or *h*, the eighth letter, and sixth consonant in our alphabet; though some grammarians will have it to be only an aspiration or breathing.

It is pronounced by a strong expiration of the breath between the lips, closing, as it were, by a gentle motion of the lower jaw to the upper, and the tongue nearly approaching the palate.

There seems to be no doubt, but that our *h*, which is the same with that of the Romans, derived its figure from that of the Hebrew ח. And, indeed, the Phœnicians, most ancient Greeks and Romans, used the same figure with our H, which in the series of all these alphabets keeps its primitive place, being the eighth letter.

H, used as a numeral, denotes 200; and with a dash over it, $\overline{H}$, 200,000.

HABEAS *corpus*, a writ of various uses, and of different importance. It was originally a writ, which a man indicted of a trespass before justices of the peace, or in a court of franchise, and being apprehended for it, may have out of the King's Bench, to remove himself thither at his own costs, and to answer the cause there. In its more usual sense, it is the most celebrated writ in the English law. The most efficacious kind, in all manner of illegal confinement, is that of *habeas corpus ad subjiciendum*, which is the subject's writ of right, in cases where he is aggrieved by illegal imprisonment, or any unwarrantable exercise of power.

This writ is founded upon common law, and has been secured by various statutes, of which the last, and most efficacious, was the 31 Charles II. c. 2, which is emphatically termed the habeas act, and may justly be deemed a second magna charta, and as relates to modern times is far more efficacious, for it is the grand protection of the subject against unlawful imprisonment.

By this important statute it is enacted, that on complaint, in writing, by or on behalf of any person committed and charged with any crime (unless committed for felony or treason expressed in the warrant, or as accessary, or on suspicion of being accessary before the fact, to any petit treason or felony plainly expressed in the warrant, or unless he be convicted or charged in execution by legal process), the Lord Chancellor, or any other of the twelve judges, in vacation, upon viewing a copy of the warrant, or affidavit that the copy is denied, shall (unless the party have neglected for two terms to apply to any court for his enlargement) award an *habeas corpus* for such prisoner, returnable immediately before himself, or any other of the judges, and, upon return made, shall discharge the party, if bailable, upon giving security to appear, and answer to the accusation in the proper court of judicature.

That such writs shall be indorsed, as granted in pursuance of the act, and signed by the person awarding them. That the writ shall be returned, and the prisoner brought up within a limited time according to the distance, not exceeding in any case twenty days. That the officers and keepers neglecting to make due returns, or not delivering to the prisoner, or his agent, within six hours after demand, a copy of the warrant of commitment, or shifting the custody of a prisoner from one to another, without sufficient reason or authority (specified in the act), shall, for the first offence, forfeit one hundred pounds, and for the second offence two hundred pounds, to the party grieved, and be disabled to hold his office. That no person, once delivered by habeas corpus, shall be recommitted for the same offence, on penalty of five hundred pounds.

That every person committing treason or felony shall, if he require it, the first week of the next term, or the first day of the sessions of oyer and terminer, be indicted in that term or session, or else be admitted to bail, unless the king's witnesses cannot be produced at that time; and if acquitted, or if not indicted and tried in the second term or session, he shall be discharged from his imprisonment for such imputed offence; but no person, after the assize shall be open for the county in which he is detained, shall be removed by habeas corpus till after the assizes are ended, but shall be left to the justice of the judges of assize. That any such prisoner may move for and obtain his *habcas corpus*, as well out of the Chancery or Exchequer, as out of the King's Bench or Common Pleas; and the Lord Chancellor, or judges, denying the same on sight of the warrant, or oath that the same is refused, shall forfeit severally, to the party grieved, the sum of five hundred pounds. That this writ of habeas corpus shall run into the counties palatine, cinque ports, and other privileged places, and the islands of Jersey, Guernsey, &c. That no inhabitants of England (except persons contracting, or convicts praying to be transported, or having committed some capital offence in the place to which they are sent) shall be sent prisoners to Scotland, Ireland, Jersey, Guernsey, or any places beyond the seas, within or without the king's dominions, on pain that the party committing, his advisers, aiders, and assistants, shall forfeit to the party grieved a sum not less than five hundred pounds, to be recovered with treble costs, shall be disabled to bear any office of trust or profit, shall incur the penalties of premunire, and shall be incapable of the king's pardon.

The writ of habeas corpus, being an high prerogative writ, issues out of the King's Bench or Common Pleas, not only in term, but in vacation, by a fiat from the chief justice, or any other judge; and runs into all parts of the king's dominions. If it issues in vacation, it is usually returnable before the judge himself who awarded it, and he proceeds by himself thereon, unless the term should intervene, when it may be returned in court.

To obtain this writ, application must be made to the court by motion, as in the case of all other prerogative writs. This writ may also be obtained, to remove every unjust restraint on personal freedom in private life, though imposed by an husband, or a father; but when women or infants are brought up by the habeas corpus, the court will set them free from an unmerited or unreasonable confinement, and will leave them at liberty to choose where they will go.

The habeas corbus *ad subjiciendum* is a prerogative writ, and also, in regard to the subject, is his writ of right, to which he is entitled to *ex debito justiciæ*, being in nature of writ of error to examine the legality of the commitment, and commanding the day, the caption, and cause of detention, to be returned.

The habeas corpus *ad faciendum et recipiendum* issues only in civil cases, and lies where a person is sued, and in gaol, in some inferior jurisdiction, and is willing to have the cause determined in some superior court; in this case the body is to be removed by *habeas corpus*, but the proceedings must be removed by *certiorari*. This writ suspends the power of the court below; so that if it proceeds after, the proceedings are void, and deemed *coram non judice*. The proceedings in the inferior court are, in fact, at an end; for the person of the defendant being removed to the superior court, they have lost their jurisdiction over him, and all the proceedings in the superior court are *de novo*, so that bail *de novo* must be put in, in the superior court.

Habeas corpus *ad respondendum*, is where a man hath a cause of action against one who is confined by the process of some inferior court; in which case, this writ is granted to remove the prisoner to answer this new action in the court above, which is often done, to remove a prisoner from the prison of the Fleet into the King's Bench, and *vicc versa*.

Habeas corpus *ad deliberandum et recipiendum*, is a writ which lies to remove a person to the proper place or county where he committed some criminal offence.

Habeas corpus *ad satisfaciendum*, lies after a judgment, when the party wishes to bring up a prisoner to charge him in execution in the inferior court.

Habeas corpus upon a *cepi*, lies where the party is taken in execution in the court below.

Habeas corpus *ad testificandum*, lies to remove a person in confinement, in order to give his testimony in a cause depending.

These are all writs, in civil cases, to bring the party into court for a special purpose, and are mere ordinary processes; but the grand writ, by which the liberty of the subject is secured, is that of the habeas corpus mentioned first, which is justly deemed a palladium of British liberty. Its efficacy consists in the right that every man has to have his cause of commitment publicly stated and inquired into by the lawful judges of the land, according to the ordinary rules of law, and it provides not only against the oppression and cruelty, but also against the indolence and ignorance, of a government; for it it is well observed by Blackstone, that under a despotic authority, and when the habeas corpus act has been suspended, the unfortunate persons who have been confined have been too often suffered to linger, because they were forgotten. One important use of the habeas corpus, to which it is now daily applied, is in bringing up seamen who have been impressed, to ascertain whether they are subject to that rigorous authority. In times of particular alarm, it has been the practice to suspend the operation of the habeas corpus act, and it is to be feared that ministers have rather sought and made, than properly found, a just occasion for this measure. It is easy to cry that the church and state are in danger, and there are enough ready to take or to feign an alarm; the habeas corpus act is suspended, and men are taken up by warrants from the Secretary of State, upon mere charges of libel, or what is indefinitely called sedition, to give a colour to the harsh usurpation of power. Instances have been known where men so confined have been afterwards released without trial; because, in reality, no charge could be supported against them. In the ordinary course of law, these men would be entitled to indemnity; but the minister, who has the address to procure an indemnity bill, avoids the just compensation due to injured innocence, and the man who has been ruined by an unjust charge is without redress. Surely, when these are the possible consequences of a suspension of the habeas corpus act, every Briton ought to resist it. If crimes are committed, the law has vigour to punish. The habeas corpus is the protection only of the innocent, and they should never be deprived of it.

With respect to removing civil causes out of inferior courts by habeas corpus, there are some useful restrictions, such as that they shall not be removed, if the debt or damages be less than *5l.* &c.

HABENDUM, in a deed, that formal part of it, which is to determine what estate or interest is granted by it, the certainty thereof, for what time, and to what use. It is expressed by the words "to have and to hold for such a term," &c. It sometimes qualifies the estate, so that the general extent, which, by construction of law, passes by the words used in the premises, may by the habendum be controlled. The habendum may, therefore, lessen or enlarge the estate previously granted, but it cannot totally contradict or be repugnant to it. As if a grant be to one, and the heirs of his body, habendum, to have to him and his heirs for ever, here he has an estate tail by the grant; and by the habendum a fee-simple expectant thereon. But if it had been in the premises to him and his heirs to have for life, the habendum would be utterly void: for an estate of inheritance is vested in him before the habendum comes, and shall not afterwards be taken away, or divested by it. The habendum cannot pass any thing that is not expressly mentioned, or contained by implication, in the premises of the deed; because the premises being part of the deed by which the thing is granted, and consequently that makes the gift, it follows, that the habendum, which only limits the certainty and extent of the estate in the thing given, cannot increase or multiply the gift, because it were absurd to say, that the grantee shall hold a thing which was never given him. See DEED.

HABIT, in philosophy, an aptitude or disposition, either of mind or body, acquired by a frequent repetition of the same act.

HACKLE, an implement used in dressing flax.

HÆMANTHUS, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Spathaceæ. Narcissi, Jussieu. Essential character: involucre six-leaved, many flowered; corolla six-parted, superior; berry three-celled. There are eight species.

HÆMATOPUS, the *Oyster-catcher*, in natural history, a genus of birds of the order Grallæ. Generic character: bill compressed, the tip an equal wedge; nostrils linear; tongue about a third part of the length of the bill; toes three; all placed forwards, the outer one joined to the middle by a strong membrane. This bird is sixteen inches in length, and about the size of a crow; it is to be met with on almost every sea-shore, and is rather common in the United States on the sea coast. In the winter season, these birds are seen in considerable flocks, but in summer only in pairs. The female prepares no nest, but deposits her eggs on the naked shore, a little above high-water mark. If the oyster-catcher be taken young, it is tamed with great ease, and will accompany the ducks to the ponds, and the poultry in general to their roosts. The general food of these birds, in their natural state, consists of shell-fish; they will, with astonishing ease, force the limpet from the rock, notwithstanding its tenacious hold, and it is said that on perceiving the slightest opening of its shells by an oyster, they insert their bills in it with admirable dexterity, and tear the tenant from his mansion. See Aves, Plate VII. fig. 6.

HÆMATOXYLUM, in botany, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx five-parted; petals five; legume lanceolate; valves boat-shaped. There is but one species, viz. H. campecheinum, logwood, blood-wood, or campeche-wood. This tree grows naturally in the bay of Campeche, at Honduras, and many parts of the Spanish West-Indies, where it frequently rises to four-and-twenty feet in height.

HÆMORRHOIDS, or *Piles*. See MEDICINE.

HÆRUCA, in natural history, a genus of the Vermes Intestina class and order. Body cylindrical, the fore-part two-necked, and surrounded with a single row of prickles, without any proboscis. Only one species is mentioned by Gmelin, viz. the H. muris, which inhabits the intestines of the mouse, and is distinguished from the genus Echinorhynchus, by being destitute of the retractile proboscis.

HAIL, in natural history, a meteor generally defined frozen rain, but differing from it, in that the hailstones are not formed of single pieces of ice, but of many little spherules agglutinated together; neither are these spherules all of the same consistence; some of them being hard and solid, like perfect ice; others soft, and mostly like snow hardened by a severe frost. Hail-stone has a kind of core of this soft matter; but more frequently the core is solid and hard, while the outside is formed of a softer matter. Hailstones assume various figures, being sometimes round, at other times pyramidal, crenated, angular, thin, and flat, and sometimes stellated with six radii, like the small crystals of snow. Natural historians furnish us with various accounts of surprising showers of hail, in which the hail-stones were of extraordinary magnitude. Of these we mention one or two, said to have happened in England.

"Dr. Halley, and others also, relate, that in Cheshire, Lancashire, &c. April 29th, 1697, a thick, black cloud, coming from Carnarvonshire, disposed the vapours to congeal in such a manner, that, for about the breadth of two miles, which was the limit of the cloud, in its progress for the space of sixty miles, it did inconceivable damage; not only killing all sorts of fowls and other small animals, but splitting trees, knocking down horses and men, and even ploughing up the earth; so that the hail-stones buried themselves under ground an inch or an inch and a half deep. The hail-stones, many of which weighed five ounces, and some half a pound, and being five or six inches about, were of various figures; some round, others half round; some smooth, others embossed and crenated; the icy substance of them was very transparent and hard, but there was a snowy kernel in the middle of them.

"In Hertfordshire, May 4, the same year, after a severe storm of thunder and lightning, a shower of hail succeeded, which far exceeded the former; some persons were killed by it, and their bodies beaten all black and blue; vast oaks were split, and fields of rye cut down as with a scythe. The stones measured from ten to thirteen or fourteen inches about. Their figures were various, some oval, others picked, and some flat." Phil. Trans. Number 229. See METEOROLOGY.

HAILING, in naval language, the salutation or accosting a ship at a distance, which is usually performed with a speaking-trumpet: the first exclamation is, "hoa, the ship, ahoy," to which she replies, "holloa;" then follow the requisite questions and replies.

HAIR, small filaments issuing out of the pores of the skins of animals, and serving most of them as a tegument or covering. In lieu of hair, the nakedness of some animals is covered with feathers, wool, scales, &c. Hair is found on all parts of the human body, except the soles of the feet and the palms of the hands; but it grows longest on the head, chin, breast, in the armpits, &c. It is known that every hair does properly and truly live, and receive nutriment to fill and distend it like the other parts; which they argue hence, that the roots do not turn grey in aged persons sooner than the extremities, but the whole changes colour at once, and the like is observed in boys, &c. which shows, that there is a direct communication, and that all the parts are affected alike. It may be observed, however, that, in propriety, the life and growth of hairs is of a different kind from that of the rest of the body, and is not immediately derived therefrom, or reciprocated therewith. It is rather of the nature of vegetation. They grow as plants do out of the earth; or, as some plants shoot from the parts of others, from which, though they draw their nourishment, yet each has, as it were, its several life, and a distinct economy. They derive their food from some juices in the body, but not from the nutritious juices; whence they may live though the body be starved.

The hairs ordinarily appear round or cylindrical; but the microscope also discovers triangular or square ones, which diversity of figure arises from that of the pores, to which the hairs always accommodate themselves. Their length depends on the quantity of the proper humour to feed them, and their colour on the quality of that humour: whence, at different stages of life, the colour usually differs. Their extremities split into two or three branches, especially when kept dry, or suffered to grow too long; so that what appears only a single hair to the naked eye, seems a brush to the microscope.—The hair of a mouse, viewed by Mr. Derham with a microscope, seemed to be one single transparent tube, with a pith made up of fibrous substances, running in dark lines, in some hairs transversely, in others spirally. The darker medullary parts or lines, he observes, were no other than small fibres convolved round, and lying closer together than in the other parts of the hair; they run from the bottom to the top of the hair, and, he imagines, may serve to make a gentle evacuation of some humour out of the body: hence, the hair of hairy animals, this author suggests, may not only serve as a fence against cold, &c. but as an organ of insensible perspiration. Hair makes a very considerable article in commerce, especially since the mode of perukes has obtained. The hair of the growth of the northern countries, as England, &c. is valued much beyond that of the more southern ones, as Italy, Spain, the south parts of France, &c. The merit of good hair consists in its being well fed, and neither too coarse nor too slender; the bigness rendering it less susceptible of the artificial curl, and disposing it rather to frizzle, and the smallness making its curl of too short duration. Its length should be about twenty-five inches; the more it falls short of this, the less value it bears.

The scarceness of grey and white hair has put the dealers in that commodity upon the methods of reducing other colours to these. This is done by spreading the hair to bleach on the grass like linen, after first washing it out in a bleaching water: this ley, with the force of the sun and air, brings the hair to so perfect a whiteness, that the most experienced person may be deceived therein, there being scarce any way of detecting the artifice, but by boiling and drying it, which leaves the hair of the colour of a dead walnut-tree leaf. Hair, like wool, may be dyed of any colour.

Hair, which does not curl or buckle naturally, is brought to it by art, by first boiling, and then baking it, in the following manner: after having picked and sorted the hair, and disposed it in parcels according to lengths, they roll them up, and tie them tight down upon little cylindrical instruments, either of wood or earthen ware, a quarter of an inch thick, and hollowed a little in the middle, called pipes; in which state they are put in a pot over the fire, there to boil for about two hours. When taken out, they let them dry; and when dried, they spread them on a sheet of brown paper, cover them with another, and thus send them to the pastry-cook, who making a crust or coffin around them, of common paste, sets them in an oven till the crust is about three-fourths baked. The end by which a hair grows to the head is called the head of the hair; and the other, with which they begin to give the buckle, the point. Formerly, the peruke-makers made no difference between the ends, but curled and wove them by either indifferently; but this made them unable to give a fine buckle, hair woven by the point never taking a right curl.

Hair is also used in various other arts and manufactures: in particular the hair of beavers, hares, conies, &c. is the principal matter whereof hats are made. Spread on the ground, and left to putrefy on corn-lands, hair, as all other animal substances, viz. horns, hoofs, blood, &c. proves good manure.

This, like every part of the animal system, has been chemically analysed, and has been found to contain a large portion of gelatine, which may be separated from it by boiling. It then becomes brittle, the gelatine being the principal cause of its suppleness and toughness. From some experiments by Mr. Hatchett, it is inferred, that the hair which loses its curl in moist weather, and which is softest and most flexible, is that which yields its gelatine most readily; whereas strong and elastic hair yields it with the greatest difficulty, and in the smallest proportion. By an experiment of Berthollet's 1,152 parts of hair yielded

Carbonate of ammonia .	90
Water	179
Oil	288
Gases	271
Coal	324
	1152

The oil was soluble in alcohol, burnt with brilliancy, and with scintillations like the hair itself. The coal was attracted by the magnet, which proves it contains iron. The alkalies, at a boiling heat, dissolve hair, and form with it an animal soap. Sulphuric acid dissolves hair, with the aid of heat. Hair is usually distinguished into various kinds: the stiffest and strongest is called bristles, such as that on the backs of swine. When remarkably soft and pliable, it is denominated wool, as that on sheep; and the finest of all is called down. From wool more than half its weight of oxalic acid is obtained. Feathers possess similar properties to those of hair; the quill is composed of coagulated albumen, but no gelatine. Muriatic acid dissolves hair, and the solution is very like a solution of glue in the same acid. When plunged into acid, in the state of gas, it is very soon converted into a pulp.

Hair, or Down, *of plants*, a general term, expressive of all the hairy and glandular appearances on the surface of plants, to which they are supposed by naturalists to serve the double purpose of defensive weapons and vessels of secretion. These hairs are minute threads, of greater or less length and solidity, some of them visible to the naked eye, whilst others are rendered visible only by the help of glasses. Examined by a microscope, almost all the parts of plants, particularly the young stalks or stems, appear covered with hairs. Hairs on the surface of plants present themselves under various forms; in the leguminous plants they are generally cylindric; in the mallow tribe, terminated in a point; in agrimony, shaped like a fish-hook; in nettle, awl-shaped and jointed; and in some compound flowers, with hollow or funnel-shaped florets, they are terminated in two crooked points.

Hair's *breadth*, a measure of length, being the forty-eighth part of an inch.

HAKE, in ichthyology, the English name of the gadus, with two fins on the back, and the under jaw longest. It grows to two feet or more in length, but is the slenderest of all the gadi. See Gadus.

HALBARD, or Halbert, in the art of war, a well-known weapon, carried by the serjeants of foot and dragoons. It is a sort of spear, the shaft of which is about five feet long, and made of ash or other wood. Its head is armed with a steel point, edged on both sides, not unlike the point of a two-edged sword: but besides this sharp point, which is in a line with the shaft, there is a cross piece of steel, flat, and pointed at both ends; but generally with a cutting edge at one extremity, and a bent sharp point at the other; so that it serves equally to cut down, or push withal. It is also useful in determining the ground between the ranks, and in adjusting the files of a battalion.

HALE, in the sea language, signifies pull; as to hale up, is to pull up; to hale in or out, is to pull in or out. To overhale a rope, is to hale it too stiff, or to hale it the contrary way.

HALES, (Stephen,) D. D. in biography, an eminent natural philosopher and excellent parish clergyman, was sixth son of Thomas Hales, Esq. of Beckesbourn, in Kent, where he was born in 1677. At the age of nineteen he was entered a pensioner of Bene't College, Cambridge, of which he was elected a fellow in 1702. He afterwards proceeded M. A. and entered into holy orders. During his residence at Cambridge, he distinguished himself by his diligent researches into various branches of natural knowledge, particularly botany and anatomy. In these studies he had for an associate William Stukely, afterwards M. D. and an eminent antiquary. A turn of novel and ingenious experiments, and of mechanical inventions, early characterised Mr. Hales, and a contrivance for obtaining a preparation of the lungs in lead, with the construction of a planetarium upon the Newtonian system of astronomy, are mentioned among the products of his skill at this period. In 1710 he was presented to the perpetual curacy of Teddington, in Middlesex. Not long after he vacated his fellowship by accepting the living of Portlock, in Somersetshire, which he exchanged for that of Farringdon, in Hampshire. He then married the daughter of a clergyman, who died after two years, leaving no issue. Henceforth he lived entirely as a single man, devoting himself entirely to science, and objects of public utility. In 1717 he was elected a member of the Royal Society, and in the following year he read before that body an account of some experiments concerning the effect of the sun's heat in raising the sap in vegetables. The farther prosecution of these experiments gave rise to an excellent work, published in 1727, entitled "Vegetable Statics, or an account of some Statical experiments on the Sap of Vegetables; being an Essay towards a Natural History of Vegetation: also, a Specimen of an attempt to Analyse the Air by a variety of Chemico-Statical Experiments, which were read at several meetings before the Royal Society," 8vo. This piece is justly esteemed a model of experimental investigation. Haller characterizes it as "liber eximus, cusus paucissimos habemus æmulos qui toties potius legi volet, quam decerpi." It begins by ascertaining the vast quantity of watery humour perspired by plants, sometimes equalling their whole weight in a single day. It then specifies the power with which they attract the nutricious juice through their capillary tubes, and considers the lateral motion of this juice from trunk to branches, and vice versa. It disproves any proper circulation of this fluid, but establishes its ascent during the day, and descent during the night. The leaves are proved to be inspiratory organs, both of air and water. There are besides a number of curious remarks upon the vegetable system, as well as upon the constitution of atmospherical air, into which he was one of the experimental enquirers. His experiments upon air relate indeed solely to its generation and absorption, its elastic and non-elastic states, and do not proceed to the discovery of any of those species of air or gases, which have so much engaged the attention of modern philosophers, though they manifestly led to such discoveries. A second edition of this work appeared in 1731, and in 1733 he published, as a kind of sequel to it, his "Statical Essays, containing Hæmastatics; or an account of some Hydraulic and Hydrostatical experiments made on the Blood and Blood-vessels of Animals; also, an Account of some Experiments on Stones in the Kidneys and Bladder, &c." In this he discussed some fundamental points relative to physiology, as the force and celerity with which the blood is propelled in the arteries, its retardation in the capillary vessels, the area of the heart, and the weight of blood sustained by it, the effects of respiration, and the alteration of air by breathing, &c. His enquiries concerning the urinary calculus relates to its chemical composition, and to the means of dissolving it; of which, suggested by him, is fixed air, or that produced by sulphuric acid and fixed alkali in a state of effervescence. He also proposes injections into the bladder, and gives a contrivance for that purpose. This subject he afterwards pursued more particularly, and published an account of some experiments on Mrs. Stephen's celebrated medicines, in 1740. The reputation of this worthy man kept pace with his useful labours. In 1732 he was appointed one of the trustees for settling a colony in Georgia; and, in 1733, the University of Oxford presented him with the degree of D. D. He performed a valuable service to the health and morals of the poor, by printing, anonymously, "A Friendly admonition to the Drinkers of Gin, Brandy, and other Spirituous Liquors," which has been several times reprinted, and distributed gratis. In 1739 he printed "Philosophical Experiments on Sea Water, Corn, Flesh, and other Substances," 8vo. chiefly intended for the use of navigators. A paper on a similar subject, and the solution of the stone in the bladder, obtained him, in the same year, the gold medal from the Royal Society. One of the most useful of Dr. Hales' inventions was that of ventilators for renewing the air in mines, prisons, hospitals, and holds of ships, which he disclosed to the Royal Society in 1741. Some years afterwards his machines were fixed on the Savoy and Newgate Prisons, to the great benefit of the persons confined in them, among whom the progress of the gaol-fever was much diminished. His plans for producing a free circulation of air were also applied by him for the cleansing and preservation of corn; for the former purpose he invented a machine, called a back-heaver, which he described in the Gentleman's Magazine for 1745 and 1747. His attention to medical subjects was farther evinced, by a paper read before the Royal Society, in describing a method for conveying liquors into the abdomen after tapping; by some experiments and observations on tar-water; and a detection of some fallacious boasts concerning the efficacy of a lithontriptic, called the liquid shell. A sermon, which he preached before the College of Physicians, in 1751, on Dr. Crown's foundation, contains some curious physiological remarks relative to the benevolence of the Deity, as displayed in the human frame. His literary honours were augmented in 1753, by his election as a foreign member of the French Academy of Sciences, in the room of Sir Hans Sloane.

Dr. Hales, though he spent his time in retirement at Teddington, was not unknown to many persons of rank, whom he visited, and received at his house with all the simplicity of his modest and unaffected character. Frederick, Prince of Wales, honoured himself with frequent calls upon the philosopher, his neighbour, whom he delighted to surprise in his experimental researches. At the death of that prince, he was, without any solicitation, made clerk of the closet to the Princess Dowager. It was hinted to him, that there was an intention of presenting him to the canonry of Windsor; but he desired to be excused accepting a promotion, which might have brought with it obligations of spending his time, interfering with the plan which for so many years he had adopted. His parochial duties, and the uninterrupted pursuit of his useful studies, continued to occupy him to an advanced period of life, during which he was never forsaken by his habitual cheerfulness and serenity of mind, sustained by temperance, piety, and conscious worth. He seems to have passed through life without an enemy, and perhaps the annals of biography cannot produce a character more marked by the union of blamelessness with active benevolence. Pope has recorded "Plain Parson Hales" as his model of sincere piety. Haller describes him as "pious, modest, indefatigable, and born for the discovery of truth." He died at Teddington, in January, 1761, in his eighty-fourth year, and was buried under the tower of the church, which he had rebuilt at his own expense. The Princess of Wales erected a monument to him in Westminster Abbey, in the Latin inscription of which the reader will be surprised to find nothing recorded of him but that he was her chaplain. But the reception his works met with throughout Europe, into the principal languages of which they were translated, will sufficiently perpetuate his fame as a philosopher.

HALESIA, in botany, so named in honour of the learned and venerable Stephen Hales, D. D. F. R. S. a genus of the Dodecandria Monogynia class and order. Natural order of Bicornes. Guajacanæ, Jussieu. Essential character: calyx four-toothed, superior; corolla four-cleft; nut quadrangular, with two seeds. There are two species, *viz.* H. tetraptera, four-winged halesia, or snow-drop tree; and H. diptera, two-winged halesia.

HALF *mark*, a noble, or six shillings and eight-pence.

HALF *moon*, in fortification, an outwork composed of two faces, forming a saliant angle, whose gorge is in form of a crescent, or half-moon; whence the name.

HALIOTIS, in natural history, the ear-shell. Animal a limax: shell univalve, dilated, ear-shaped, with a longitudinal row of orifices along the surface; spire lateral, and almost concealed. There are nineteen species, of which H. tuberculata is the most common; it inhabits southern Europe, and gradually disappears towards the north. The shell is subovate, the outside transversely grooved, rugged, and tuberculate. The inside is like mother of pearl. When living, it adheres to rocks. According to Pennant, this was the sea-ear of Aristotle.

HALL, in architecture, an avenue or room at the entrance of a building.

HALL is also a public building or court of justice, as Westminster-hall, Guildhall, a company's hall, &c. In Westminster-hall are held the Courts of King's Bench, Common Pleas, Chancery, and Exchequer.

HALLERIA, in botany, so called from the famous Albert Haller, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx trifid; corolla quadrifid; filaments longer than the corolla; berry inferior, two-celled. There is but one species, *viz.* H. lucida, African fly honeysuckle, a native of the Cape.

HALLIARDS, in sea language, the ropes or tackles usually employed to hoist or lower any sail upon its respective masts or stay.

HALO, in physiology, a meteor in the form of a luminous ring or circle, of various colours, appearing round the bodies of the sun, moon, or stars. See METEOROLOGY.

HALORAGIS, in botany, a genus of the Octandria Tetragynia class and order. Natural order of Calycanthemæ. Onagræ, Jussieu. Essential character; calyx four-cleft, superior; petals four; drupe dry, inclosing a four-celled nut. There are two species, *viz.* H. prostrata and H. cercodia.

HAMAMELIS, in botany, a genus of the Tetrandria Digynia class and order. Natural order of Berberides, Jussieu. Essential character: involucre three-leaved; perianthers four-leaved; petals four; nut two-horned, two-celled. There is only one species, *viz.* H. virginica, witch hazel.

HAMELIA, in botany, so called from Jean Baptiste du Hamel du Monceau, a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: corolla five-cleft; berry five-celled, inferior, many-seeded. There are four species, all natives of the West Indies.

HAMMER, a well known tool used by mechanics, consisting of an iron head, fixed cross-wise upon a handle of wood.

There are several sorts of hammers used by blacksmiths; as, 1. The hand hammer, which is of such weight that it may be wielded or governed with one hand at the anvil. 2. The up-hand sledge, used with both hands, and seldom lifted above the head. 3. The about-sledge, which is the biggest hammer of all, and held by both hands at the farthest end of the handle, and being swung at arms-length over the head, is made to fall upon the work with as heavy a blow as possible. There is also another hammer used by smiths, called a rivetting hammer, which is the smallest of all, and is seldom used at the forge, unless upon small work.

HAMMOCK, in naval affairs, a piece of hempen cloth, six feet long and three feet wide, gathered together at the two ends by means of a clue, and slung horizontally under the deck, forming a receptacle for a bed. There are about from fourteen to twenty inches in breadth allowed between the decks for every hammock in a ship of war. In preparing for battle, the hammocks, with their contents, are all firmly corded, taken upon deck, and fixed in various nettings, so as to form a barricade against small shot.

HAMSTER. See Mus.

HANAPER *office*, in the Court of Chancery, is that out of which all original writs issue that pass under the great seal, and all commissions of charitable uses, sewers, bankrupts, idiocy, lunacy, and the like. These writs, relating to the business of the subject, and the returns to them, were originally kept in a hamper, *in hanaperio*; the other writs, relating to such matters wherein the crown is immediately or mediately concerned, were preserved in a little sack or bag, *in parva baga;* and thence arises the distinction of the hanaper office, and petty bag office; both of which belong to the common law court in Chancery.

HAND. See Anatomy.

Hand *breadth*, a measure of three inches. By this standard the height of horses is estimated.

Hand *cuffs*, an instrument formed of two circular pieces of iron, each fixed on a hinge on the ends of a very short iron bar, which being locked over the wrists of a malefactor, prevents his using his hands.

Hand-*spikes*, wooden levers used at sea to traverse the ordnance, or to turn the windlass in weighing up the anchor, &c. They are more commodious than iron crows, because their length allows a better poize.

Hands, in heraldry, are borne in coat-armour, dexter and sinister, that is, right and left, expanded or open. These are the most necessary parts of the human body, as they serve to express all sorts of actions, and even our very thoughts and designs; thus joining of hands is an universal token of friendship, and clapping of hands a general mark of applause.

HANKS, in naval affairs, are wooden rings fixed upon the stays to confine stay-sails at different distances. They are in place of gromets, being more convenient, as well as of a later invention. They are formed by bending a tough piece of wood into the form of a wreath, and fastened at the two ends by means of notches, thereby retaining their circular figure and elasticity, whereas the gromets, which are formed of rope, are apt to relax in warm weather, and which adhere.

HANSE *towns*, port-towns of Germany, of which Lubec and Hamburg were the chief. They were formerly all of them imperial cities, confederated for their mutual defence, and the protection of their trade.

HARBOUR, a place where ships may ride safe at anchor, chiefly used in speaking of those secured by a boom and chain, and furnished with a mole. The bottom of a good harbour should be free from rocks and shallows: the entrance should be of sufficient extent to admit large ships: it should have good anchoring ground, and be easy of access; it should have room and convenience to receive the shipping of different nations; it should be furnished with a good light-house, and have at command plenty of wood and other materials for firing, besides hemp, iron, &c.

Harbour *master*, an officer appointed to inspect the moorings, and to see that the laws and regulations of the harbour are strictly attended to by the different ships.

HARDNESS, in physiology, is the resistance opposed by a body to the separation of its particles. This property depends on the force of cohesion, or on that which chemists call affinity, joined to the arrangement of the particles to their figure, and other circumstances. A body, says M. Hauy, is considered more hard, in proportion as it presents greater resistance to the friction of another hard body, such as a steel file; or as it is more capable of wearing or working into such other body to which it may be applied by friction. Lapidaries judge of the hardness of fine stones, &c. from the difficulty with which they are worn down or polished.

HARE. See Lepus.

HARIOT, or Heriot, in law, a due belonging to a lord at the death of his tenant, consisting of the best beast, either horse, ox, or cow, which he had at the time of his death; and in some manors, the best goods, piece of plate, &c. are called hariots.

There is both hariot-service, and hariot-custom: when a tenant holds by service to pay a hariot at his decease, which is expressly reserved in the deed of feofment, this is a hariot-service; and where hariots have been customarily paid time out of mind after the death of a tenant for life, this is termed hariot-custom. For hariot-service, the lord may distrain any beast belonging to the tenant that is on the land. For hariot-custom, the lord is to seise, not distrain; but he may seise the best beast that belonged to the tenant, though it be out of the manor, or in the king's highway, because the claim is as his proper goods by the death of his tenant. Nevertheless, where a woman marries and dies, the lord shall have no hariot-custom, because a feme-covert has no goods to pay as a hariot.

HARMATTAN, the name given to a singular wind, which blows periodically from the interior parts of Africa towards the Atlantic ocean. It prevails in December, January, and February, and is generally accompanied with a fog or haze that conceals the sun for whole days together. Extreme dryness is the characteristic of this wind: no dew falls during its continuance, which is sometimes for a fortnight or more. The whole vegetable creation is withered, and the grass becomes at once like hay. The natives take the opportunity which this wind gives them of clearing the land, by setting fire to trees and plants in this their exhausted state. The dryness is so extreme that household furniture is damaged, and the wainscot of the rooms flies to pieces. The human body is also affected by it, so as to cause the skin to peel off; but in other respects it is deemed salutary to the constitution, by stopping the progress of infection, and curing almost all cutaneous diseases.

HARMONICA, or armonica, is a name which Dr. Fanklin has given to a musical instrument constructed with drinking glasses. It is well known that a drinking glass yields a sweet tone, by passing a wet finger round its brim. Mr. Pockrich, of Ireland, was the first who thought of playing tunes formed of these tones. He collected a number of glasses of different sizes, fixed them near each other on a table, and tuned them by putting into them water, more or less, as each note required. Mr. Delaval made an instrument in imitation, and from this instrument Dr. Franklin took the hint of constructing his Armonica. The glasses for this musical instrument are blown as nearly as possible in the form of hemispheres, having each an open neck or socket in the middle. The thickness of the glass near the brim is about one tenth of an inch, increasing towards the neck, which in the largest glasses is about an inch deep, and an inch and a half wide within; but these dimensions lessen as the size of the glasses diminish, only observing that the neck of the smallest should not be shorter than half an inch. The diameter of the largest glass is nine inches, and that of the smallest three inches: between these there are twenty-three different sizes, differing from each other a quarter of an inch in diameter. For making a single instrument there should be at least six glasses blown of each size, and out of these thirty-seven glasses (which are sufficient for three octaves with all the semitones) may be found, that will either yield the note required, or one a little sharper, and fitting so well into each other, as to taper regularly from the largest to the smallest. The glasses being chosen, and the note for which each glass is intended being marked upon it with a diamond, they are to be tuned, by diminishing the thickness of those that are too sharp, which is done by grinding them round from the neck towards the brim; comparing, by means of a well-tuned harpsichord, the tone drawn from the glass by your finger with the note you want, as sounded by the corresponding string of the harpsichord. The largest glass in the instrument is G, a little below the reach of a common voice, and the highest G, including three complete octaves; and they are distinguished by painting the apparent parts of the glasses within side, every semitone white, and the other notes of the octave with the seven prismatic colours; so that glasses of the same colour (the white excepted) are always octaves to each other. When the glasses are tuned, they are to be fixed on a round spindle of hard iron, an inch in diameter at the thickest end, and tapering to a quarter of an inch at the smallest. For this purpose the neck of each glass is fitted with a cork, projecting a little without the neck: these corks are perforated with holes of different diameters, according to the dimension of the spindle in that part of it where they are to be fixed. The glasses are all placed within one another; the largest on the biggest end of the spindle, with the neck outwards; the next in size is put into the other, leaving about an inch of its brim above the brim of the first; and the others are put on in the same order. From these exposed parts of each glass the tone is drawn, by laying a finger upon one of them as the spindle and glasses turn round. The spindle, thus prepared, is fixed horizontally in the middle of a box, and made to turn on brass gudgeons at each end. A square shank comes from its thickest end through the box, on which shank a wheel is fixed by a screw: this will serve, like a fly, to make the motion equable, when the spindle is turned by the foot like a spinning-wheel. The wheel is eighteen inches in diameter, and conceals near its circumference about twenty-five pounds of lead, and may be made of mahogany. An ivory pin is fixed in the face of the wheel, about four inches from the axis; over which is put the loop of the string that comes up from the moveable step to give it motion. The box is about three feet long, eleven inches wide at the biggest end, and five inches at the smallest end; it is made with a lid, which opens at the middle of its height, and turns up by back-hinges. The instrument, thus completed, stands on a neat frame with four legs. This instrument is played upon by sitting before it, as before the keys of a harpsichord, turning the spindle with the foot, and wetting the glasses, now and then, with a sponge and clean water. The fingers should be first soaked in water; and rubbed occasionally with fine chalk, to make them catch the glass, and bring out the tone more readily. Different parts may be played together by using both hands; and the tones are best drawn out when the glasses turn from the ends of the fingers, not when they turn to them. The advantages of this instrument, says Dr. Franklin, are, that its tones are incomparably sweet beyond those of any other; and that they may be swelled and softened at pleasure by stronger or weaker pressures of the finger; and continued to any length: and, when it is once well tuned, it never again wants tuning. Franklin's Letters, &c.

Harmonical *arithmetic*, that part of arithmetic which considers musical intervals, expressed by numbers, in order to our finding their mutual relations, compositions, and resolutions.

Harmonical *composition*, in a general sense, includes both harmony and melody, *i. e.* of music or songs, both in a single part, and in several parts. In its more proper and limited sense, harmonical composition is restrained to that of harmony; and may be defined the art of disposing and concerting several single parts together, so as to make one agreeable whole.

Harmonical *interval*, in music, denotes the difference of two sounds, which is agreeable to the ear, whether in consonance or succession; and are, therefore, the same with concord.

Harmonical *proportion* or *musical proportion*, is that in which the first term is to the third, as the difference of the first and second is to the difference of the second and third; or when the first, the third, and the said two differences, are in geometrical proportion. Or, four terms are in harmonical proportion, when the first is to the fourth as the difference of the first and second is to the difference of the third and fourth. Thus 2, 3, 6, are in harmonical proportion, because 2 : 6 :: 1 : 3. And the four terms, 9, 12, 16, 24, are in harmonical proportion, because 9 : 24 :: 3 : 8. If the proportional terms be continued in the former case, they will form an harmonical progression, or series. 1. The reciprocals of an arithmetical progression are in harmonical progression: and, conversely, the reciprocals of harmonicals are arithmeticals. Thus, the reciprocals of the harmonicals 2, 3, 6, are $\frac{1}{2}, \frac{1}{3}, \frac{1}{6}$, which are arithmeticals; for $\frac{1}{2} - \frac{1}{3} = \frac{1}{6}$, and $\frac{1}{3} - \frac{1}{6} = \frac{1}{6}$ also: and the reciprocals of the arithmeticals 1, 2, 3, 4, &c. are $\frac{1}{1}, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}$, &c. which are harmonicals; for $\frac{1}{1} : \frac{1}{3} :: \frac{1}{1} - \frac{1}{2} : \frac{1}{2} - \frac{1}{3}$, and so on. And, in general, the reciprocals of the arithmeticals a, $a+d$, $a+2d$, $a+3d$, &c. *viz.* $\frac{1}{a}, \frac{1}{a+d}, \frac{1}{a+2d}, \frac{1}{a+3d}$, &c. are harmonicals; *et e contra.* 2. If three or four numbers in harmonical proportion be either multiplied or divided by some number, the products, or the quotients, will still be in harmonical proportion. Thus, the harmonicals 6, 8, 12, multipled by 2, give 12, 16, 24, or divided by 2, give 3, 4, 6, which are also harmonicals. 3. To find a harmonical mean proportional between two terms: divide double their product by their sum. 4. To find a third term in harmonical proportion to two given terms: divide their product by the difference between double the first term and the second term. 5. To find a fourth term in harmonical proportion to three terms given: divide the product of the first and third by the difference between double the first and the second term. Hence, of the two terms a and b the harmonical mean is $\frac{2ab}{a+b}$; the third harmonical proportion is $\frac{ab}{2a-b}$; also to a, b, c, the fourth harmonical is $\frac{ac}{2a-b}$. 6. If there be taken an arithmetical mean and a harmonical mean between any two terms, the four terms will be in geometrical proportion. Thus, between 2 and 6 the arithmetical mean is 4, and the harmonical mean is 3; and hence 2 : 3 :: 4 : 6. Also, between a and b the arithmetical mean is $\frac{a+b}{2}$, and the harmonical mean is $\frac{2ab}{a+b}$; but $a : \frac{2ab}{a+b} :: \frac{a+b}{2} : b$.

HARMONICAL *series*, a series of many numbers in continual harmonical proportion. Thus, if there are four or more numbers, of which every three immediate terms are harmonical, the whole will make an harmonical series: such is 30 : 20 : 15 : 12 : 10. Or, if every four terms immediately next each other are harmonical, it is also a continual harmonical series, but of another species, as 3, 4, 6, 9, 18, 36, &c.

HARMONICAL *sounds*, an appellation given to such sounds as always make a determinate number of vibrations in the time that one of the fundamentals, to which they are referred, makes one vibration.

Harmonical sounds are produced by the parts of chords, &c. which vibrate a certain number of times, while the whole chord vibrates once.

The relations of sounds had only been considered in the series of numbers, 1 : 2, 2 : 3, 3 : 4, 4 : 5, &c. which produced the intervals called octave, fifth, fourth, third, &c. M. Sauveur first considered them in the natural series, 1, 2, 3, 4, 5, &c. and examined the relations of sounds arising therefrom. The result is, that the first interval, 1 : 2, is an octave; the second, 1 : 3, a twelfth; the third, 1 : 4, a fifteenth or double octave; the fourth, 1 : 5, a seventeenth; the fifth, 1 : 6, a nineteenth, &c.

The new consideration of the relations of sounds is more natural than the old one: and is, in effect, all the music that nature makes without the assistance of art.

HARMONICS, that part of music which considered the differences and proportions of sounds, with respect to acute and grave, in contradistinction to rhyme and metre.

HARMONY, in music, the agreeable result, or union, of several musical sounds, heard at one and the same time; or the mixture of divers sounds, which together have an effect agreeable to the ear. As a continued succession of musical sounds produces melody, so does a continued combination of these produce harmony. See MUSIC.

HARMONY *of the spheres*, or *Celestial Harmony*, a sort of music much talked of by many of the ancient philosophers and fathers, supposed to be produced by the sweetly-tuned motions of the stars and planets. This harmony they attributed to the various proportionate impressions of the heavenly globes upon one another, acting at proper intervals. It is impossible, according to them, that such prodigious large bodies, moving with so much rapidity, should be silent; on the contrary, the atmosphere, continually impelled by them, must yield a set of sounds proportionate to the impression it receives; consequently, as they do not all run the same circuit, nor with one and the same velocity, the different tones arising from the diversity of motions, directed by the hand of the Almighty, must form an admirable symphony, or concert. They therefore supposed, that the moon, as being the lowest of the planets, corresponded to *mi*; Mercury to *fa*; Venus to *sol*; the sun to *la*; Mars, to *si*; Jupiter, to *ut*; Saturn to *re*; and the orb of the fixed stars, as being the highest of all, to *mi*, or the octave.

HARP, a musical instrument of the string kind, of a triangular figure, held upright between the legs of the person who plays upon it. See MUSICAL INSTRUMENTS.

HARP, *Eolian*. See ACOUSTICS.

HARPINGS, in a ship, properly denote her breadth at the bow. Some also give the same name to the ends of the bends that are fastened into the stern.

HARPSICHORD, the most harmonious of all the musical instruments of the string kind. It is played on after the manner of the organ, and is furnished with a set, and sometimes with two sets, of keys; the touching or striking of these keys move a kind of jacks, which also move a double row of chords, or strings, of brass or iron, stretched over four bridges, on the table of the instrument. See MUSIC.

HARPOON, sometimes called harping-iron, a spear or javelin, used to strike the whales in the Greenland and South Sea fisheries. It is furnished with a long shank, and has, at the one end, a broad and flat triangular head, sharpened at both edges, so as to penetrate the whale with facility: to the other end of this weapon is fastened a long cord, called the whale-line, which lies carefully coiled in the boat, so as to run out without being entangled. See FISHERY, *whale*.

The gun-harpoon is a weapon used for the same purpose, but is fired out of a gun, instead of being thrown by hand. It is made of steel, and has a chain attached to it to which the line is fastened.

HARTSHORN, *spirit of*. See AMMONIA.

HARTOGIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: calyx five-cleft; petals four, spreading; drupe ovate, inclosing two seeds. There is but one species, *viz.* H. capensis, found in the woods near the Cape of Good Hope.

HARVEST *fly*, in zoology, a large four-winged fly, of the cicada kind. See CICADA.

HASSELQUISTIA, in botany, so named, in memory of Frederick Hasselquist, M. D. a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: corolla radiated in the disk, male: seeds in the circumference double, with a notched edge; in the disk solitary, pitcher-shaped, hemispherical. There are two species.

HAT *making*. The materials for making hats are, rabbit's fur, cut off from the skin, after the hairs have been plucked out, together with wool and beaver.

The two former are mixed in various proportions, and of different qualities, according to the value of the article intended to be made; and the latter is universally used for facing the finer articles, and never for the body or main stuff. Experience has shown that these articles cannot be evenly and well felted together, unless all the fibres be first separated, or put into the same state with regard to each other. This is the object of the first process, called bowing. The materials, without any previous preparation, are laid upon a platform of wood, or of wire, somewhat more than four feet square, called a hurdle, which is fixed against the wall of the work-shop, and is enlightened by a small window, and separated by two side partitions from other hurdles, which occupy the rest of the space along the wall The hurdle, if of wood, is made of deal planks, not quite three inches wide, disposed parallel to the wall, and at the distance of one fortieth, or one fiftieth of an inch from each other, for the purpose of suffering the dust, and other impurities of the stuff, to pass through; a purpose still more effectually answered by the hurdle of wire.

The workman is provided with a bow, a bow pin, a basket, and several cloths. The bow is a pole of yellow deal-wood, between seven and eight feet long, to which are fixed two bridges, somewhat like that which receives the hair in the bow of the violin. Over these are stretched a cat-gut, about one-twelfth part of an inch in thickness. The bow-pin is a stick with a knob, and is used for plucking the bow-string. The basket is a square piece of ozier work, consisting of open strait bars, with no crossing or interweaving. Its length across the bars may be about two feet, and its breadth eighteen inches.

The sides into which the bars are fixed are slightly bended into a circular curve, so that the basket may be set upright on one of these edges near the right hand end of the hurdle, where it usually stands. The cloths are linen, and dyed of a dark olive brown. Besides these implements, the workman is also provided with brown paper.

The bowing commences by shovelling the materials towards the right hand partition with the basket, upon which the workman, holding the bow horizontally in his left hand, and the bow-pin in his right, lightly places the bow-string, and gives it a pluck with the pin. The string, in its return strikes part of the fur, and causes it to rise, and fly partly across the hurdle in a light open form. By repeated strokes, the whole is thus subjected to the bow, and this beating is repeated, till all the original clots or masses of the filaments are perfectly opened and separated. The quantity thus treated at once is called a batt, and never exceeds half the quantity required to make one hat.

When the batt is sufficiently bowed, it is ready for hardening, which term denotes the first commencement of felting. The prepared material being evenly disposed on the hurdle, is first pressed down by the convex side of the basket, then covered with a cloth, and pressed successively in its various parts by the hands of the workman. The pressure is gentle, and the hands are very slightly moved backwards and forwards, at the same time, through a space of perhaps a quarter of an inch, to favour the hardening or entangling of the fibres. In a very short time, indeed, the stuff acquires sufficient firmness to bear careful handling. The cloth is then taken off, and a sheet of paper, with its corners doubled in, so as to give it a triangular outline, is laid upon the batt, which last is folded over the paper as it lies, and its edges, meeting one over the other, form a conical cap.

The joining is soon made good by pressure with the hands on the cloth. Another batt, ready hardened, is in the next place laid on the hurdle, and the cap here mentioned placed upon it, with the joining downwards. This last batt being also folded up, will consequently have its place of junction diametrically opposite that of the inner felt, which it must therefore greatly tend to strengthen. The principal part of the hat is thus put together, and now requires to be worked with the hands a considerable time upon the hurdle, the cloth being also occasionally sprinkled with clear water. During the whole of this operation, which is called basoning, the article becomes firmer and firmer, and contracts in its dimensions. It may easily be understood, that the chief use of the paper is to prevent the sides from felting together.

The basoning is followed by a still more effectual continuation of the felting, called working. This is done in another shop, at an apparatus called a battery, consisting of a kettle (containing water slightly acidulated with sulphuric acid, to which, for beaver hats, a quantity of the grounds of beer is added, or else plain water for rinsing out,) and eight planks of wood joined together in the form of a frustrum of a pyramid, and meeting in the kettle at the middle. The outer or upper edge of each plank is about two feet broad, and rises a little more than two feet and a half above the ground; and the slope towards the kettle is considerably rapid, so that the whole battery is little more than six feet in diameter. The quantity of sulphuric acid added to the liquor is not sufficient to give a sour taste, but only renders it rough to the tongue. In this liquor, heated rather higher than unpractised hands could bear, the article is dipped from time to time, and then worked on the planks with a roller, and also by folding or rolling it up, and opening it again; in all which, a certain degree of care is at first necessary to prevent the sides from felting together; of which, in the more advanced stages of the operation, there is no danger. The imperfections of the work now present themselves to the eye of the workman, who picks out the knots, and other hard substances, with a bodkin, and adds more felt upon all such parts as require strengthening.

This added felt is patted down with a wet brush, and soon incorporates with the rest. The beaver is laid on towards the conclusion of this kind of working. Some workmen say that the beer grounds used with beaver hats, by rendering the liquor more tenacious, the hat is enabled to hold a greater quantity of it, for a longer time; but others say that the mere acid and water would not adhere to the beaver facing, but would roll off immediately when the article was laid on the plank. It is probable that the manufacturers, who now hold the established practice, may not have tried what are the inconveniences this addition is calculated to remove.

The acid, no doubt, gives a roughness to the surface of the hair, which facilitates the mechanical action of felting. Nitrous acid is used in a process called carroting; in this operation the material is put into a mixture of the nitrous and sulphuric acids in water, and kept in the digesting heat of a stove all night. The hair acquires a ruddy or yellow colour, and loses part of its strength. It must be remembered, that our hat still possesses the form of a cone, and that the whole of the several actions it has undergone have only converted it into a soft flexible felt, capable of being extended, though with some difficulty, in every direction. The next thing to be done is to give it the form required by the wearer. For this purpose, the workman turns up the edge or rim to the depth of about an inch and a half, and then returns the point back again through the centre or axis of the cap, so far as not to take out this fold, but to produce another inner fold of the same depth. The point being returned back again in the same manner produces a third fold; and thus the workman proceeds, until the whole has acquired the appearance of a flat circular piece, consisting of a number of concentric undulations or folds, with the point in the centre. This is laid upon the plank, where the workman, keeping the piece wet with the liquor, pulls out the point with his fingers, and presses it down with his hand, at the same time turning it round on its centre in contact with the plank, till he has, by this means, rubbed out a flat portion equal to the intended crown of the hat. In the next place he takes a block, to the crown of which he applies the flat central portion of the felt, and by forcing a string down the sides of the block, he causes the next to assume the figure of the crown, which he continues to wet and work, until it has properly disposed itself round the block. The rim now appears like a flounced or puckered appendage round the edge of the crown, but the block being set upright on the plank, the requisite figure is soon given by working, rubbing, and extending this part. Water only is used in this operation of fashioning or blocking, at the conclusion of which it is pressed out by the blunt edge of a copper implement for that purpose.

Previous to the dying, the nap of the hat is raised or loosened out with a wire brush or carding instrument; the fibres being too rotten after the dying to bear this operation. The dying materials are logwood, and a mixture of the sulphates of iron and copper, known in the market by the names of green copperas and blue vitriol.

The dyed hats are, in the next place, taken to the stiffening-shop. One workman, assisted by a boy, does this part of the business. He has two vessels, or boilers, the one containing the grounds of strong beer, which costs seven shillings per barrel, and is used in this and other stages of the manufactory as the cheapest mucilage which can be procured; and the other vessel containing melted glue, a little thinner than is used by carpenters. The beer grounds are applied in the inside of the crown, to prevent the glue from coming through to the face, and also to give the requisite firmness, at a less expense than could be produced by glue alone. If the glue were to pass through the hat in different places, it might be more difficult to produce an even gloss upon the face in the subsequent finishing. The glue stiffening is applied after the beer-grounds are dried, and then only upon the lower face of the flap, and the inside of the crown. For this purpose the hat is put into another hat, called a stiffening hat, the crown of which is notched, or slit open, in various directions. These are then placed in a hole in a deal board, which supports the flap, and the glue is applied with a brush.

The dry hat, after this operation, is very rigid, and its figure irregular. The last dressing is given by the application of moisture and heat, and the use of the brush and a hot iron, somewhat in the shape of that used by tailors, but shorter and broader on the face. The hat being softened by exposure to steam, is drawn upon a block, to which it is securely applied by the former method of forcing a string down from the crown to the commencement of the rim. The judgment of the workman is employed in moistening, brushing, and ironing the hat, in order to give and preserve the proper figure.

When the rim of the hat is not intended to be of an equal width throughout, it is cut by means of a wooden or metallic pattern. The contrivance is very simple and ingenious. A number of notches are made in one edge of a flat piece of wood, for the purpose of inserting the point of a knife, and from one side or edge of this piece of wood there proceeds a straight handle, which lies parallel to the notched side, forming an angle somewhat like a carpenter's square. When the legs of this angle are applied to the outside of the crown, and the board lies flat on the rim of the hat, the notched edge will lie nearly in the direction of the radius or line pointing to the centre of the hat. A knife being, therefore, inserted in one of the notches, it is easy to draw it round by leaning the tool against the crown, and it will cut the border very regular and true. This cut is made before the hat is quite finished, and is not carried entirely through, so that one of the last operations consists in tearing off the redundant part, which by that means leaves an edging of beaver round the external face of the flap. When the hat is completely finished, the crown is tied up in gauze paper, which is neatly ironed down. It is then ready for the subsequent operations of lining, &c.

Hats are also made for women's wear, of chips, straw, or cane, by platting, and sewing the plats together; beginning with the centre of the crown, and working round till the whole is finished. Hats for the same purpose are also wove and made of horse-hair, silk, &c. See Straw *hat*.

HATCHEL, or Hitchel, a tool with which flax and hemp are combed into fine hairs. It consists of long iron pins, or teeth regularly set in a piece of board.

HATCHES, in a ship, a kind of trap-doors between the main-mast and fore-mast, through which all goods of bulk are let down into the hold.

Hatches also denote flood-gates set in a river, &c. to stop the current of the water; particularly certain dams or mounds made of rubbish, clay, or earth, to prevent the water that issues from the stream-works and tin-washes in Cornwall from running into the fresh rivers.

HATCHWAY, the place where the hatches are. Thus, to lay a thing in the hatchway, is to put it so that the hatches cannot be come at, or opened.

HATCHING, the maturating fecundated eggs, whether by the incubation and warmth of the parent bird, or by artificial heat, so as to produce young chickens alive.

The art of hatching chickens by means of ovens has long been practised in Egypt; but it is there only known to the inhabitants of a single village named Berme, and to those that live at a small distance from it. Towards the beginning of autumn they scatter themselves all over the country, where each person among them is ready to undertake the management of an oven, each of which is of a different size, but in general they are capable of containing from forty to four score thousand eggs. The number of these ovens placed up and down the country is about three hundred and eighty-six, and they usually keep them working for about six months. As, therefore, each brood takes up in an oven, as under a hen, only twenty-one days, it is easy in every one of them to hatch eight different broods of chickens. Every Bermean is under the obligation of delivering to the person who intrusts him with an oven, only two-thirds of as many chickens as there have been eggs put under his care; and he is a gainer by this bargain, as more than two-thirds of the eggs usually produce chickens. In order to make a calculation of the number of chickens yearly so hatched in Egypt, it has been supposed that only two-thirds of the eggs are hatched, and that each brood consists of at least thirty thousand chickens; and thus it would appear that the ovens of Egypt give life, yearly, to at least ninety-two millions six hundred and forty thousand of these animals.

HATCHMENT, in heraldry, a name sometimes used for an achievement, or escutcheon over a gate, door, or on the side of an house.

Hatchment, also signifies the marshalling of several coats of arms in an escutcheon.

HAUL *the wind*, in naval affairs, to direct the ship's course nearer to that point of the compass from which the wind arises. *Example.* If a ship sail south-west, with the wind northerly, and it is necessary to haul the wind farther to the westward: to perform this operation, it is necessary to arrange the sails more obliquely with her keel, to brace the yards more forward, and to haul the lower sheets farther aft, and finally to put the helm over the larboard side of the vessel. When her head is turned directly to the westward, and her sails are trimmed accordingly, she is said to have hauled the wind four points, that is to say, from south-west to west.

HAUTBOY, a musical instrument of the wind kind, shaped much like the flute, only that it spreads and widens towards the bottom, and is sounded through a reed. See Music.

HAW *finch*, in ornithology, the English name of a bird, known among authors by the name coccothraustes. See Aves, Plate VIII. fig. 6.

HAWKERS and PEDLARS, are such dealers or itinerary petty chapmen, who travel to different fairs or towns with goods or wares, and are placed under the control of commissioners, by whom they are licensed for that purpose, pursuant to stat. 8 and 9 William III. c. 25, and 29 Geo. III. c. 26. Traders in linen and woollen, sending goods to markets and fairs, and selling them by wholesale; manufacturers selling their own manufactures; and makers and sellers of English bone-lace going from house to house, &c. are excepted out of the acts, and not to be taken as hawkers.

HAWSER, in the sea language, a large rope, or a kind of small cable, serving for various uses aboard a ship, as to fasten the main and fore shrouds, to warp a ship as she lies at anchor, and wind her up to it by a capstan, &c. The hawser of a man of war may serve for a cable to the sheet-anchor of a small ship.

HAWSES, in a ship, are two large

holes under the bow, through which the cables run when she lies at anchor. Thus the hawse-pieces are the large pieces of timber in which these holes are made. Hawse-bags, are bags of canvass made tapering, and stuffed full of oakum; which are generally allowed small ships, to prevent the ship from washing in at these holes: and hawse-plugs, are plugs to stop the hawses, to prevent the water from washing into the manger.

There are also some terms in the sea language that have an immediate relation to the hawses. As "a bold hawse," is when the holes are high above the water. "Fresh the hawse," or veer out more cable, is used when part of the cable that lies in the hawse is fretted or chafed, and it is ordered that more cable may be veered out, so that another part of it may rest in the hawses. "Fresh the hawse," that is, lay new pieces upon the cable in the hawses, to preserve it from fretting. "Burning in the hawse," is when the cables endure a violent stress. "Clearing the hawes," is disentangling two cables that come through different hawses. "To ride hawes-full," is when in stress of weather the ship falls with her head deep in the sea, so that the water runs in at the hawses.

HAZARD, a game on dice, without tables. It is played with only two dice; and as many may play at it as can stand round the largest round table.

Two things are chiefly to be observed, *viz.* main and chance; the latter belonging to the caster, and the former, or main, to the other gamesters. There can be no main thrown above nine, nor under five; so that five, six, seven, eight, and nine, are the only mains flung at hazard. Chances and nicks are from four to ten: thus four is a chance to nine, five to eight, six to seven, seven to six, eight to five; and nine and ten a chance to five, six, seven, and eight: in short, four, five, six, seven, eight, nine, and ten, are chances to any main, if any of these nick it not. Now nicks are either when the chance is the same with the main, as five and five, or the like; or six and twelve, seven and eleven, eight and twelve. Here observe, that twelve is out to nine, seven, and five; eleven is out to nine, eight, six, and five; and ames-ace and deuce-ace, are out to all mains whatever.

But to illustrate this game by a few examples: suppose the main to be seven, and the caster throws five, which is his chance; he then throws again, and if five turn up, he wins all the money set him; but if seven is thrown, he must pay as much money as there is on the board: again, if seven be the main, and the caster throws eleven, or a nick, he sweeps away all the money on the table; but if he throws a chance, as in the first case, he must throw again: lastly, if seven be the main, and the caster throws ames-ace, deuce-ace, or twelve, he is out: but if he throws from four to ten, he hath a chance; though they are accounted the worst chances on the dice, as seven is reputed the best and easiest main to be flung. Four and five are bad throws (the former of which being called, by the tribe of nickers, little dick-fisher) as having only two chances, *viz.* trey-ace and two deuces, or trey-deuce and quatre-ace: whereas seven hath three chances, *viz.* cinque-deuce, five-ace, and quatre-trey. Nine and ten are in the like condition with four and five; having only two chances. Six and eight have indeed the same number of chances with seven, *viz.* three; but experienced gamesters nevertheless prefer the seven, by reason of the difficulty to throw the doublets, two quatres, or two treys. It is also the opinion of most, that at the first throw the caster hath the worst of it. On the whole, hazard is certainly one of the most bewitching and ruinous games played on the dice. Happy, therefore, the man, who either never heard of it, or who has resolution enough to leave it off in time. See Chances and Gaming.

HAZLE. See Corylus.

HEAD. See Anatomy.

HEADBORROW, or Headborough; the chief of the frank pledge, and he that had the principal government of them within his own pledge. He was called also burrowhead, bursholder, third-burrow, tithing-man, chief-pledge, or borrow-elder. He is now occasionally called a constable.

HEALTH, is a right disposition of the body, and of all its parts; consisting in a due temperature, a right conformation, just connection, and ready and free exercise of the several vital functions.

HEARING. See Sound.

The organ of hearing is the ear, and particularly the auditory nerve and membrane. See Anatomy and Physiology.

HEAT. The laws, according to which the temperature of bodies is subject to increase or diminution, have been discussed in the articles Caloric, Capacity, Cold, Combustion, and Chemistry. In the first of these articles, caloric was considered as a substance capable of passing from body to body, and subsisting in them in different states. This is the general doctrine of chemical philosophers: many of these, however, as well as others, incline to the hypothesis, that heat may consist in an undulatory or other intestine motion, either in the parts of bodies, or in some subtle fluid, or ETHER, which see. Among these, we may reckon Sir Isaac Newton, Mr. Cavendish, Dr. Young, and Count Rumford.

"If heat," says Dr. Young, "when attached to any substance, be supposed to consist in minute vibrations, and, when propagated from one body to another, to depend on the undulations of a medium highly elastic, its effects must strongly resemble those of sound, since every sounding body is in a state of vibration; and the air, or any other medium, which transmits sound, conveys its undulation to distant parts, by means of its elasticity: and we shall find, that the principal phenomena of heat may actually be illustrated by a comparison with those of sound. The excitation of heat and sound are not only similar, but often identical; as in the operations of friction and percussion; they are both communicated sometimes by contact, and sometimes by radiation; for, besides the common radiation of sound through the air, its effects are communicated by contact, when the end of a tuning-fork is placed on a table, or on the sounding-board of an instrument, which receives from the fork an impression that is afterwards propagated as a distinct sound. And the effect of radiant heat, in raising the temperature of a body upon which it falls, resembles the sympathetic agitation of a string, when the sound of another string, which is in unison with it, is transmitted to it through the air. The water, which is dashed about by the vibrating extremities of a tuning-fork dipped into it, may represent the manner in which the particles at the surface of a liquid are thrown out of the reach of the force of cohesion, and converted into vapour; and the extrication of heat, in consequence of condensation, may be compared with the increase of sound produced by lightly touching a chord which is slowly vibrating, or revolving in such a manner as to emit little or no audible sound; while the diminution of heat, by expansion, and the increase of the capacity of a substance for heat, may be attributed to the greater space afforded to each particle, allowing it to be equally agitated with a less perceptible effect on the neighbouring particles. In some cases, indeed, heat and sound not only resemble each other in their operations, but produce precisely the same effects; thus, an artificial magnet, the force of which is quickly destroyed by heat, is affected more slowly in a similar manner, when made to ring for a considerable time; and an electrical jar may be discharged, either by heating it, or by causing it to sound by the friction of the finger." See the articles first mentioned.

HEAT, *animal*. The temperature which animals, and even vegetables, maintain, during life, above that of surrounding objects, is a very striking phenomenon. By general analogies, it has frequently been referred to the process of combustion; and, from facts more distinctly pointed, the doctrine, that it depends upon the absorption of oxygen, has been advanced by modern chemists. But it is to Dr. Crawford we are indebted for a direct series of experiments, by which the nature of the process is directly made out. It would carry us too far into physiological disquisition, if we were to proceed to enquire respecting the nature of the parts, and the functions of organized beings.—The blood which circulates through the lungs absorbs oxygen in the act of respiration, by means of which a portion of the carbon which it contains is acidified, and carried off in the elastic state. After this, and, perhaps, other changes, the fluid passes through the arteries to the extreme vessels, depositing, in some manner, the elementary parts or principles of animal matter during the act of nutrition, in which state of still further change the blood returns by the veins, and again passes through the course of circulation. From his experiments on the capacities of arterial and venous blood, Dr. Crawford found the capacity of the former for heat to be 1.030, and that of the latter only 0.892, whence he concludes, that though heat must be given out in consequence of the diminished capacity of the combined oxygen absorbed by respiration, yet the increased capacity of the arterial blood will prevent its becoming sensible immediately in the lungs; instead of which, it will be given out at the smaller ramifications, where the blood becomes changed in its nature, and in its capacity for heat, by its conversion to the venous state. It has also been established, by the experiments of the same philosopher, that the process of absorption of oxygen is less in a higher than in a low temperature; the difference between the arterial and venous blood being at the same time less, and consequently the augmentation of temperature in the animal less considerable. This law of the animal economy, assisted by the increased evaporation, and by the slow conducting power of an animal body, and, perhaps, by the permanency of the enlarged capacity, seems sufficient to account for the power which animals possess of maintaining their natural temperature, without any remarkable change in an atmosphere greatly heated, as was shewn in the experiments of Fordyce and Blagden. (See Philos. Trans. 1775.) It must be confessed, however, that some farther investigations seem wanting on this subject.

Though the lungs appear to be the great organ of oxygenation in the larger animals, it is well ascertained, that a process of nearly the same nature is carried on at the skin; and in many of the smaller or less perfect animals there appears to be no other means for effecting this absorption.

HEATH. See Erica.

HEAVINESS, in general, the same with weight or gravity. See Gravity and Weight.

HEBENSTREITIA, in botany, a genus of the Didynamia Angiospermia class and order. Essential character: calyx emarginate, cleft underneath; corolla one-lipped, lip ascending, four-cleft; stamens inserted into the edge of the border of the corolla; capsule containing two seeds. There are six species, all natives of the Cape.

HECTIC. See Medicine.

HEDERA, in botany, English *ivy*, a genus of the Pentandria Monogynia class and order. Natural order of Hederaceæ. Caprifolia, Jussieu. Essential character: petals five, oblong; berry five-seeded, surrounded by the calyx. There are six species, with several varieties.

HEDERACEÆ, in botany, the name of the forty-sixth order of Linnæus's "Fragments of a Natural Method," consisting of the ivy, vine, and a few other genera, which, from their general habit and appearance, seem nearly allied. This order consists of herbaceous and shrubby plants, most of which, particularly the ivy and vine, just mentioned, have creeping branches, that attach themselves by tendrils to the bodies in their neighbourhood. The roots are long; the stems and young branches commonly cylindric. The leaves are alternate, sometimes simple, as in the ivy and vine; sometimes winged, as in the zanthoxylum, or tooth-ach tree, in which the surface of the leaves is covered with points. On each side of the foot-stalk of the leaves of the vine are placed two pretty large stipulæ, or scales; from the side opposite to the leaves proceeds a branching tendril, which serves to fasten the plant to the bodies in its neighbourhood. The flowers are either hermaphrodite, as in the ivy and vine; male and female upon different roots, as in the ginseng; or hermaphrodite and male upon different roots, as in the zanthoxylum. The calyx, or proper flower cup, consists of one leaf divided into five parts, which are small, and generally permanent. The petals are commonly five; but in the cissus four, and in the zanthoxylum none. There are five stamina; but the cissus has only four. The anthers, or tops of the stamina, are roundish: in the ivy they are attached to the filaments by the sides. In the zanthoxylum the filaments are crowned with twin anthers. The seed bud is of different shapes; the seed-vessel is of the berry-kind, with one, two, or five cells, and the seeds are from one to five in number, placed either in distinct cells, or, as in the case of the ivy and vine, dispersed through the pulp without any partition. See Panax, &c.

HEDGES, in agriculture, are either planted to make fences round inclosures, or to divide the several parts of a garden. When they are designed as outward fences, they are planted either with hawthorn, crabs, or blackthorn; but those hedges which are planted in gardens, either to surround wilderness-quarters, or to screen the other parts of a garden from sight, are planted according to the fancy of the owner, some preferring evergreens, in which case the holly is best; next the yew, then the laurel, laurustinus, phillyrea, &c. others prefer the beach, the hornbeam, and the elm.

Hedge *hog*. See Erinaceus.

Hedge *sparrow*, the brown motacilla, white underneath, and with a grey spot behind the eyes. See Motacilla.

HEDWIGIA, in botany, so called from J. Hedwig, a genus of the Octandria Monogynia class and order. Essential character: calyx four-toothed; corolla four-cleft; style none; capsule tricoccous; seed a nut. There is only one species, *viz.* H. balsamifera, a lofty tree, more than sixty feet in height, and nearly five feet in circumference, a native of St. Domingo.—The wood is used for many purposes: the red gum that issues from the bark has a strong aromatic smell, and is serviceable in the cure of wounds: it is frequently called bois cochon.

HEDYCARYA, in botany, a genus of the Dioecia Icosandria class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character: calyx eight or ten cleft; corolla none: male, filaments none: anthers in the bottom of the calyx, four-furrowed, bearded at the tip: female, germs pedicelled; nuts pedicelled, one-seeded. There is but one species; *viz.* H. dentata, a native of New Zealand.

HEDYCREA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx one-leafed, hemispherical, five-toothed; corolla none; drupe oval, one-celled; nut ovate, covered with fibres, one-celled; the shell hard. There is but one species; *viz.* H. incana, a native of Guiana, where it is called caligni by the natives, who are remarkably fond of the fruit, which is about the size of a large olive; the pulp is white, and of a sweetish taste; the shell is bony, and separates with dfficulty from the fibres in the pulp; the kernel is two-lobed: it is but a small tree, not exceeding four feet in height.

HEDYOSMUM, in botany, a genus of the Monoecia Polyandria class and order. Essential character: male, ament covered with anthers; no perianth, corolla, or filaments: female, calyx three-toothed; corolla none; style one, three-cornered; berry three-cornered, one-seeded. There are two species, both natives of Jamaica.

HEDYOTIS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ. Jussieu. Essential character: corolla monopetalous, funnel-shaped; capsule two-celled, many-seeded, inferior.—There are eight species, natives of the East and West Indies, also of Cochinchina.

HEDYPNOIS, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cicoraceæ, Jussieu. Essential character: calyx calycled, with short scales; seeds crowned with the calycle; outer without down, covered up in the scales of the calyx; inner having a down of five erectish awned chaffs: receptacle naked, hollow dotted. This genus, according to Professor Martyn, embraces some species of Hyoseris and of Crepis, which see.

HEDYSARUM, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential charactèr: corolla keel transversely obtuse; legume jointed, with one seed in each joint. There are ninety species, only one of which is a native of Great Britain; *viz.* H. onobrychis, saintfoin, or cockshead, and but ten which are natives of Europe. Most of these are perennial. Linnæus relates a remarkable phenomenon belonging to H. gyrans, sensitive hedysarum, which is as follows: "This is a wonderful plant, on account of its voluntary motion, which is not occasioned by any touch, irritation, or movement in the air, as in the Mimosa, Oxalis, and Dionæa; nor is it so evanescent as in Amorpha. No sooner had the plants raised from seeds acquired their ternate leaves, than they began to be in motion this way and that: this movement did not cease during the whole course of their vegetation, nor were they observant of any time, order, or direction; one leaflet frequently revolved, whilst the other on the same petiole was quiescent; sometimes a few leaflets only were in motion, then almost all of them would be in movement at once; the whole plant was very seldom agitated, and that only during the first year. It continued to move in the stove during the second year of its growth, and was not at rest even in winter."

HEEL, in the sea language. If a ship leans on one side, whether she be aground or afloat, then it is said she heels a starboard, or a-port, or that she heels offwards, or to the shore: that is, inclines more to one side than to another.

Heel *of the mast*, that part of the foot of any mast which is pared away slanting on the aftward side thereof, in order that it may be stayed aftward on. The heels of the top-masts are squares.

HEGIRA, in chronology, a celebrated epocha among Mahometans. See Chronology. The event which gave rise to this epocha was the flight of Mahomet from Mecca, with his new proselytes, to avoid the persecution of the Coraischites: who, being then most powerful in the city, could not bear that Mahomet should abolish idolatry, and establish his new religion. This flight happened in the fourteenth year after Mahomet had commenced prophet: he retired to Medina, which he made the place of his residence.

HEIGHT, in geometry, is a perpendicular let fall from the vertex, or top, of any right-lined figure, upon the base or side subtending it. It is likewise the perpendicular height of any object above the horizon; and is found several ways, by two staffs, a plain mirror, with the quadrant, theodolite, or some graduated instrument, &c. The measuring of heights or distances is of two kinds: when the place or object is accessible, as when you can approach to its bottom; or inaccessible, when it cannot be approached. See SURVEYING.

HEIR, in law, is he to whom lands, tenements, hereditaments, by the act of God and right of blood, descend of some estate of inheritance.

HEIR *apparent.* No person can be heir in fact until the death of his ancestor; yet he who stands nearest in degree of kindred to the ancestor is called, even in his life-time, heir apparent.

And the law takes notice of an heir apparent, so far as to allow the father to bring an action of trespass for taking away his son and heir, the father being guardian by nature to his son, where any lands descend to him.

The heir, heir general, or heir at common law, is he, who, after his father's or ancestor's death, has a right to all his lands, tenements, and hereditaments; but he must be of the whole blood, not a bastard, alien, &c. None but the heir general, according to the course of the common law, can be heir to a warrantry, or sue an appeal of the death of his ancestor.

A custom in particular places varying the rules of descent at common law is good; such is the custom of gavel-kind, by which all the sons shall inherit, and make but one heir to their ancestor.—The general custom of gavel-kind lands extends to sons only, but a special custom, that if one brother die without issue, all his brothers may inherit, is good.

To prevent injury to creditors by the alienation of the lands descended, &c. and depriving them of their claim on the lands, it is enacted by 3 and 4 William and Mary, c. 14, that in all cases, where any heir at law shall be liable to pay the debt of his ancestor, in regard of any lands, tenements, or hereditaments, descending to him, and shall sell, alien, and make over the same before any action brought or process used out against him, such heir at law shall be answerable for such debt or debts in an action or actions of debt to the value of the said land so by him sold, alienated, or made over; in which case all creditors shall be preferred, in the same order as in actions against executors and administrators, and such execution shall be taken out upon any judgment or judgments so obtained against such heirs, to the value of the said land, as if the same were his own proper debts; saving that the lands, tenements, and hereditaments, *bona fide* alienated before the action brought, shall not be liable to such execution. Provided, that where any action of debt upon any speciality is brought against any heir, he may plead *riens per descent* at the time of the original writ brought, or the bill filed against him; and the plaintiff in such action may reply, that he had lands, tenements, or hereditaments from his ancestor before the original writ brought, or the bill filed; and if upon issue joined thereupon, it be found for the plaintiff, the jury shall inquire of the value of the lands, tenements, or hereditaments, so descended, and thereupon judgment shall be given, and execution shall be awarded as aforesaid; but if judgment be given against such heir, by confession of the action, confessing the assets descended, or upon demurrer, or *nihil dixit*, it shall be for the debt and damages, without any writ to enquire of the lands, tenements, or hereditaments, so descended.

Before this statute, if the ancestor had devised away the lands, a creditor by speciality had no remedy, either against the heir or devisee. But by this statute it is enacted, that all wills and testaments, limitations, dispositions, or appointments, of or concerning any manors, messuages, lands, tenements, or hereditaments, or of any rent, profit, term, or charge, out of the same, whereof any person at the time of his decease shall be seized in fee-simple, possession, reversion, or remainder, or have power to dispose of the same by his last will and testament, shall be deemed and taken only against such creditor as aforesaid, his heirs, successors, executors, administrators, and assigns, and every of them, to be fraudulent, and clearly, absolutely, and utterly void, frustrate, and of none effect; any pretence, colour, feigned or presumed consideration, or any other matter or thing, to the contrary notwithstanding. And in those cases every such creditor may maintain his action of debt upon his said lands and specialities, against the heir at law of such obligor, and such devisee and devisees, jointly, by virtue of this act; and such devisee and devisees shall be liable and chargeable for a false plea by him or them pleaded, in the same manner as any heir should have been for false plea by him pleaded, or for not confessing the lands or tenements to him descended.—Provided, that where there hath been or shall be any limitation or appointment, devise, or disposition, of any manors, messuages, lands, tenements, or hereditaments, for the raising or payment of any real or just debt, or any portion, sum or sums of money, for any child or children of any person, other than the heir at law, in pursuance of any marriage contract, or agreement in writing, *bona fide* made before such marriage; the same and every of them shall be in full force, and the same manors, &c. may be holden and enjoyed by every such person, his heirs, executors, administrators, and assigns, for whom the said limitation, appointment, devise, or disposition, was made, and by his trustee, his heirs, executors, administrators, and assigns, for such estate or interest as shall be so limited or appointed, devised or disposed, until such debt or debts, portion or portions, shall be raised, paid, and satisfied. And every devisee made liable by this act shall be liable and chargeable in the same manner as the heir at law, by force of this act, notwithstanding the lands, tenements, and hereditaments, to him or them devised, shall be aliened before the action brought. In the construction of this statute it has been held, that though a man is prevented from defeating his creditors by will, that yet any settlement or disposition he shall make in his life-time of his lands, whether voluntary or not, will be good against bond creditors; for that was not provided against by the statute, which only took care to secure such creditors from any imposition, which might be supposed in a man's last sickness; but if he gave away his estate in his life-time, this prevented the descent of so much to the heir, and consequently took away their remedy against him, who was only liable in respect of the lands descended; and as a bond is no lien whatsoever on the lands in the hands of the obligor, much less can it be so, when they are given away to a stranger.

HEIR *looms*, in law, are such goods and personal chattels, as, contrary to the nature of chattels, shall go by special custom to the heir, along with the inheritance, and not to the executor of the last proprietor.

HEISTERA, in botany, so called in honour of Laurence Heister, a genus of the Decandria Monogynia class and order. Natural order of Holoraceæ. Aurantia, Jussieu. Essential character; calyx five-cleft; petals five; drupe with a very large coloured calyx. There is but one species, *viz.* H. coccinea, a native of Martinico, in close woods near torrents. The French inhabitants call it bois perdrix, birds being very fond of the fruit.

HELENIUM, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. There are two species. These plants are natives of America, where they grow wild, in great plenty, in the woods and other shady places where the ground is moist.

HELIACAL, in astronomy, a term applied to the rising or setting of the stars, or, more strictly speaking, to their emersion out of and immersion into the rays and superior splendour of the sun. A star is said to rise heliacally, when, after having been in conjunction with the sun, and on that account invisible, it comes to be at such a distance from him, as to be seen in the morning before sun-rising, the sun, by his apparent motion, receding from the star towards the east; on the contrary, the heliacal setting is when the sun approaches so near a star, as to hide it with his beams, which prevent the fainter light of the star from being perceived, so that the terms apparition and occultation would be more proper than rising and setting.

All the fixed stars in the zodiac, and also the superior planets, Mars, Jupiter, and Saturn, rise heliacally in the morning, a little before sun-rising, and a few days after they have set cosmically. Again, they set heliacally in the evening, a little before their achronycal setting. But the moon, whose motion eastward is always quicker than the apparent motion of the sun, rises heliacally in the evening, after the new moon; and sets heliacally in the morning, when old and approaching to a conjunction with the sun.

The inferior planets, Venus and Mercury, which sometimes seem to go westward from the sun, and sometimes again have a quicker motion eastward, rise heliacally in the morning, when they are retrograde; but when direct in their motions, they rise heliacally in the evening. The heliacal rising or setting of the moon happens when she is seventeen degrees distant from the sun: but for the other planets, twenty degrees are required; and for the fixed stars, more or less, according to their magnitude.

HELIANTHUS, in botany, *sun-flower*, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, somewhat squarrose; down two-leaved; receptacle chaffy, flat. There are twelve species. These are hardy herbaceous plants, most of them tall and large, all perennial excepting two, *viz.* H. annus and H. indicus. They are all natives of America.

HELICOID *parabola*, or *Parabolic Spiral*, is a curve arising from the supposition that the common parabola is bent or twisted, till the axis comes into the circumference of a circle, the ordinates still retaining their places and perpendicular positions with respect to the circle, all these still remaining in the same places.

HELICONIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Scitamineæ. Musæ, Jussieu. Essential character: spathes; perianth none; corolla, three-petalled; nectary two-leaved; pericarpium tricoccous; seeds solitary. There are three species, natives of the West Indies and South America.

HELICONII, in natural history, a division of the genus Papilio, butterfly; the wings are narrow, entire, usually transparent, the anterior ones are oblong, and the interior short and rounded. See PAPILIO.

HELICTERES, in botany, a genus of the Gynandria Decandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: pentagynous; calyx one-leafed, oblique; petals five; nectary of five leaflets; capsule five-twisted. There are nine species, shrubs or trees, natives of both Indies, mostly tomentose; leaves alternate; peduncles axillary, few-flowered.

HELIOCARPUS, in botany, a genus of the Dodecandria Digynia class and order. Natural order of Columniferæ. Tiliaceæ, Jussieu. Essential character: calyx four-leaved; corolla four-petalled; styles simple; capsule two-celled, compressed, longitudinally radiated on both sides. There is only one species, *viz.* H. americana, American heliocarpus. It is found growing wild about La Vera Cruz, in New Spain.

HELIOMETER, the name of an instrument for measuring with particular exactness the diameters of the heavenly bodies, and especially those of the sun and moon. This instrument is a kind of telescope, consisting of two object-glasses of equal focal distance, placed one of them by the side of the other, so that the same eye-glass serves for both. The tube of this instrument is of a conical form, larger at the upper end, which receives the two object-glasses, than at the lower, which is furnished with an eye-glass and micrometer. By the construction of this instrument, two distinct images of an object are formed in the focus of the eye-glass, whose distance, depending on that of the two object-glasses from one another, may be measured with accuracy; nor is it necessary that the whole disc of the sun or moon should come within the field of view, since, if the images of only a small part of the disc be formed by each object-glass, the whole diameter may be easily computed by their position with respect to one another: for if the object be large, the images will approach, or perhaps lie even over one another, and the object-glasses being moveable, the two images may always be brought exactly to touch one another, and the diameter may be computed from the known distance of the centres of the two glasses. Besides, as this instrument has a common micrometer in the focus of the eye-glass, when the two images of the sun or moon are made in part to cover one another, that part which is common to both the images may be measured with great exactness, as being viewed upon a ground that is only one half less luminous than itself; whereas, in general, the heavenly bodies are viewed upon a dark ground, and on that account are imagined to be larger than they really are. By a small addition to this instrument, provided it be of a moderate length, Mr. Bouguer, the inventor, thought it very possible to measure angles of three or four degrees, which is of particular consequence in taking the distance of stars from the moon. With this instrument he found that the sun's vertical diameter, though somewhat diminished by the astronomical refraction, is longer than the horizontal diameter; and, in ascertaining this phenomenon, he also found, that the upper and lower edges of the sun's disc are not so equally defined as the other parts; on this account his image appears somewhat extended in the vertical direction. This is owing to the decomposition of light, which is known to consist of rays differently refrangible in their passage through our atmosphere. Thus the blue and violet rays, which proceed from the upper part of the disc at the same time with those of other colours, are somewhat more refracted than the others, and therefore seem to us to have proceeded from a higher point; whereas, on the contrary, the red rays proceeding from the lower edge of the disc, being less refracted than the others, seem to proceed from a lower point;

so that the vertical diameter is extended, or appears longer, than the horizontal diameter.

HELIOCENTRIC *latitude of a planet*, the inclination of a line drawn between the centre of the sun and the centre of a planet, to the plane of the ecliptic.

HELIOCENTRIC *place of a planet*, in astronomy, the place of the ecliptic, wherein the planet would appear to a spectator placed at the centre of the sun.

HELIOPHILA, in botany, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ Cruciformes. Cruciferæ, Jussieu. Essential character: nectaries two, bowed back towards the bladder of the calyx. There are ten species. These plants are all natives of the Cape of Good Hope.

HELIOSCOPE, in optics, a sort of telescope, peculiarly fitted for viewing the sun, without hurting the eyes. See TELESCOPE.

HELIOTROPE, in mineralogy, a species of the flint genus. It is of a green colour, and occurs massive, in angular and rolled pieces; it is commonly translucent on the edges; the specific gravity from 2.6 to 2.7. It is found in rocks, and is said to be the connecting link between jaspar and chalcedony. In Asia, it is found in Bucharia, Persia, and Siberia; and in Europe, in Iceland, and in Upper Saxony. From the beauty of the colour, and its great hardness, it is reckoned of great value among lapidaries, and that which has the greatest degree of translucency, and most numerous red spots, is of most value.

HELIOTROPIUM, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: corolla salver-shaped, five-cleft, with teeth interposed; throat closed with arches. There are twenty-four species, of which H. Peruvianum, Peruvian turnsole, or heliotrope, is a small shrubby plant, from two to three feet in height; the leaves are long, hairy, and much veined, of an ash-colour on their under side, on short foot-stalks; the flowers are produced at the ends of the branches, in short reflex spikes, growing in clusters; the peduncles divide into two or three, and these again into smaller ones, each sustaining a spikelet of pale blue flowers, which have a strong, sweet odour, somewhat resembling bitter almonds. It grows naturally in Peru; it flowers with us great part of the year, and those flowers which come out early in the summer, are succeeded by ripe seeds in autumn.

HELIX, in geometry, the same with SPIRAL, which see.

HELIX, in natural history, the *snail*, a genus of the Vermes Testacea class and order. Animal a limax; shell univalve, spiral, subdiaphanous, brittle; aperture contracted, semi-lunar or roundish. Of this genus more than three hundred species have been enumerated; they are separated into divisions; A. whorls, with a carinate acute margin; B. umbilicate, the whorls rounded; C. rounded, imperforate; D. tapering; E. ovate, imperforate. Of the species, we shall notice H. cornea, the shell of which above is umbilicate, flat, blackish, with four round whorls. It is found in Europe, and on the coast of Coromandel, from a single line to an inch in diameter; shell chesnut brown, rufous, whitish, yellowish, or blueish, polished and very fine striate transversely; whorls, four or five, rarely turned contrary; the inhabitant is black, with dirty-grey tentacula, and produces a scarlet, but not very durable dye. H. pomatia, a snail with five spires remarkably ventricose, slightly umbilicated, fasciated with a lighter and deeper brown: this is found in the woods of the southern counties of England; it is said to have been introduced by Sir Kenelm Digby, for medical purposes. These are confined to the southern counties, attempts having been made, but without success, to bring them into Northamptonshire. This snail is used in many parts of Europe as food, particularly at Rome during the weeks of Lent: here they are fattened, and grow to a very large size. It is oviparous, very tenacious of life, and, towards winter, covers its aperture with a calcareous lid. H. hortensis, garden-snail, shell imperforate, globular, pale, with broad interrupted brown bands: this species inhabits the garden and orchard in most parts of Europe; it abounds with a viscid slimy juice, which it readily gives out by boiling in milk and water, so as to render them thick and glutinous, and the compound, especially with milk, is reckoned efficacious in consumptive cases. Snails are very destructive to wall-fruit: lime and ashes sprinkled on the ground will keep them away, and destroy the young brood. Fruit, already bitten, should not be taken off the tree, for they will not touch the other, till they have wholly eaten this, if left for them. The eyes of snails are lodged in their horns, one at the end of each horn, which they can retract with pleasure. The manner of examining these eyes, which are four in number, is this: when the horns are out, cut off nimbly the extremity of one of them, and, placing it before the microscope, you may discover the black spot at the end to be really a semiglobular eye.

The dissection of this animal is very curious; for by this means, the microscope not only discovers the heart beating, just against the round hole near the neck, which seems the place of respiration; but also the liver, spleen, stomach, and intestines, with the veins, arteries, mouth, and teeth, are plainly observable. The intestines of this creature are green, from its eating herbs, and are branched all over with fine capillary white veins; the mouth is like a hare's or rabbit's, with four or six needle-teeth, resembling those of leeches, and of a substance like horn. Snails are all hermaphrodites, having both sexes united in each individual; they lay their eggs with great care in the earth, and the young ones are hatched with shells completely formed. Cutting off a snail's head, a little stone appears, which is supposed to be a great diuretic, and good in nephritic disorders: immediately under this stone, the heart is seen beating; and the auricles are evidently distinguishable, and are membraneous, and of a white colour, as are also the vessels which proceed from them. So small an animal as the snail is not free from the plague of supporting other smaller animals on its body; and, as in other animals, we find these secondary ones either living on their surface, as lice, &c. or only in the intestines as worms, it is very remarkable, that the snail is infested in both these manners, lice being sometimes found on the surface of its body, and worms sometimes within its intestines. There is a part of the common garden snail, and of other of the like kinds, commonly called the collar; this surrounds the neck of the snail, and is considerably thick, and is the only part that is visible when the animal is retired quietly into its shell: in this state of the animal, these insects which infest it are usually seen in considerable numbers, marching about very nimbly on this part.

HELLEBORUS, in botany, English *hellebore*, a genus of the Polyandria Polygynia class and order. Natural order of Multisiliquæ. Ranunculaceæ, Jussieu. Essential character: calyx none; petals five, or more; nectary two-lipped, tubular; capsules many-seeded. There are seven species. The hellebores are all hardy herbaceous perennials, with compound leaves, digitate, pedate, palmate, or ternate; the flowers have only a single cover; they grow either several together, at the ends of the stalk and its subdivisions, with a single bracte to each pedicle; or single on a scape, naked, or with a leaf for an involucre. They appear early in the spring, and often in the winter. The root of this plant is tuberous; at first it has no taste, but in a short time a strong acridity becomes sensible to the mouth and throat. By distillation, an oil is obtained which is extremely poisonous: one similar in its effects may be obtained from many plants.

HELM, in naval architecture, a long and flat piece of timber, or an assemblage of several pieces, suspended along the hind part of a ship's stern-post, where it turns upon hinges to the right or left, serving to direct the course of the vessel, as the tail of a fish guides the body. The helm is usually composed of three parts, *viz.* the rudder, the tiller, and the wheel, except in small vessels, where the wheel is unnecessary. As to the form of the rudder it becomes gradually broader in proportion to its distance from the top, or to its depth under the water. The back, or inner part of it, which joins to the stern-post, is diminished into the form of a wedge throughout its whole length, so as that the rudder may be more easily turned from one side to the other, where it makes an obtuse angle with the keel. It is supported upon hinges, of which those that are bolted round the stern-post to the after extremity of the ship are called googings, and are furnished with a large hole in the after-part of the stern-post. The other parts of the hinges, which are bolted to the back of the rudder, are called pintles, being strong cylindrical pins, which enter into the googings and rest upon them. The length and thickness of the rudder is nearly equal to that of the stern-post. The rudder is turned upon its hinges by means of a long bar of timber called the tiller, which is fixed horizontally in its upper end within the vessel. The movements of the tiller, to the right and left, accordingly direct the efforts of the rudder to the government of the ship's course as she advances; which, in the sea language, is called steering. The operations of the tiller are guided and assisted by a sort of tackle, communicating with the ship's side, called the tiller-rope, which is usually composed of untarred rope-yarns, for the purpose of traversing more readily through the blocks or pulleys. In order to facilitate the management of the helm, the tiller-rope, in all large vessels, is wound about a wheel, which acts upon it with the powers of a crane or windlass.

There are several terms in the sea language relating to the helm; as "bear up the helm;" that is, let the ship go more large before the wind: "helm a midship," or "right the helm;" that is, keep it even with the middle of the ship; "port the helm," put it over the left side of the ship: "starboard the helm," put it on the right side of the ship.

HELMET, an ancient defensive armour worn by horsemen both in war and in tournaments. It covered both the head and face, only leaving an aperture in the front secured by bars, which was called the visor. It is still used in heraldry by way of crest over the shield or coat of arms, in order to express the different degrees of nobility by the different manner in which it is borne. Thus, a helmet in profile is given to gentlemen and esquires: to a knight, the helmet standing forward and the beaver a little open: the helmet in profile and open, with bars, belongs to all noblemen under the degree of a duke: and the helmet forward and open, with many bars, is assigned to kings, princes, and dukes.

There is generally but one helmet upon a shield; but sometimes there are two, and even three; if there be two, they ought to face each other; and if three, the middlemost should stand directly forward, and the other two on the sides facing towards it.

HELONIAS, in botany, a genus of the Hexandria Trigynia class and order. Natural order of Coronariæ. Junci, Jussieu. Essential character: calyx none; corolla six-petalled; capsule three-celled, There are two species, *viz.* H. bullata, spear-leaved helonias; and H. asphodeloides, grass-leaved helonias; both natives of North America.

HEMEROBIUS, in natural history, a genus of insects of the order Neuroptera. Mouth with a short horny mandible, the jaws cylindrical, straight, cleft; feelers four, unequal, filiform; wings deflected, not folded; antennæ setaceous, projecting, longer than the thorax, which is convex. There are nearly forty species, in two divisions; A. lip cylindrical, membranaceous, annulate: B. lip horny, rounded at the tip, vaulted. The insects belonging to this genus are, like the ephemeræ, very short-lived, and in every state of their existence prey, with unceasing avidity, upon plant-lice. The larva is six-footed, generally ovate and hairy; the pupa mostly folliculate; the eggs are deposited in clusters on the leaves of plants, each placed on a small gummy pedicle. When touched, many of them have an excrementitious smell. The most common species is the H. perla, an insect of great beauty, seen chiefly in the middle, and towards the decline of summer; and is a slender-bodied fly, of a grass-green colour, with bright gold-coloured eyes, and four large, transparent oval wings, finely reticulated with pale-green veins. The eggs of this insect are supported each one on a delicate stem, of more than half an inch in length, which is attached to the surface of a leaf or twig, and by some persons, unacquainted with their nature, they have been taken for a small species of the fungus. From the eggs are hatched the larva, which in a few days become fitted to undergo their change into the chrysalis state. For this purpose the animal draws a fine silk from the extremity of the body, and in a short space envelopes itself in a round ball, of the size of a small pea, affixed to a leaf or twig of the tree it frequents, and divesting itself of its skin commences a chrysalis; in about three weeks it becomes a complete insect. The hemerobius takes its name from the shortness of its life, as it seldom lives more than two or three days.

HEMEROCALLIS, in botany, English *day lily*, a genus of the Hexandria Monogynia class and order. Natural order cf Lilia, or Liliaceæ. Coronariæ, Linnæus. Narcissi, Jussieu. Essential character: corolla bell-shaped; the tube cylindric; stamina declining. There are five species.

HEMIMERIS, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx five-parted; corolla wheel-form; upper lip cloven, with a nectareous bag at the base. There are three species.

HEMIONITES, in botany, English *male fern*, a genus of the Cryptogamia Filices, or Ferns. Generic character: capsules digested into lines, meeting together, either intersecting each other, or branched. There are eight species, natives of both Indies.

HEMISPHERE, in geometry, the half of a globe or sphere, when it is supposed to be cut through its centre in the plane of one of its great circles. Thus the equator divides the terrestrial globe into the northern and southern hemispheres: in the same manner the meridian divides the globe into the eastern and western hemispheres; and the horizon into two hemispheres, distinguished by the epithets upper and lower. See GLOBE and SPHERE.

The centre of gravity of an hemisphere is five-eighths of the radius distant from the vertex.

HEMISPHERE is also used to denote a projection of half the terrestial globe, or half the celestial sphere, on a plane, and frequently called planisphere.

HEMISTICH, in poetry, denotes half a verse, or a verse not completed.

Of this there are frequent examples in Virgil's Æneid; but whether they were left unfinished by design or not is disputed among the learned; such are, "Ferro accincta vocat," Æn. II. v. 614. And "Italiam non sponte sequor," Æn. IV. v. 361.

HEMP. See CANNABIS.

The cannabis stativa, or hemp-plant, is cultivated on account of its external filaments, which constitute the hemp used for cordage, canvass, cloth, &c. and the seeds abound with oil. This plant is annual; it rises quick into a tall slender sort of shrub; its leaves, growing by fives or sixes from the same pedicle, are a little jagged, and yield a strong smell, which affects the head. The culture and management of hemp makes a considerable article in agriculture, requiring divers operations, as pulling, watering, beating, and swingling. It is sown in May, in a warm, sandy, rich soil; and is of itself sufficient to destroy weeds on any ground. The first season for pulling hemp is usually about the middle of August, when they begin to pull the male plants, called fimble hemp. But the safer method is to pnll it a fortnight or three weeks later, when the male plants have fully shed their farina, without which the seeds will prove only empty husks. At the second pulling, a little after Michaelmas, the female plants, called karle hemp, are taken out of the ground. This karle hemp is laid in the sun to dry, and then housed, for the seed to be thrashed out. The female hemp alone produces seed to perpetuate the kind. The operations of harling, watering, breaking, swingling, and heckling hemp, are very much like those practised in the dressing of flax. The hemp imported into this country chiefly comes from Russia. Amongst it the Riga hemp deserves the preference, which, according to the quality, is divided in rhyne, outshot, pass, and codilla hemp. The Italian, known in this country by the name of Bologna hemp, is of very prime quality, but comes too dear for the consumption of the northern parts of Europe. The best hemp should be clean, soft, tender, of long staple, and a sound palish-yellow colour, neither green nor red.

HEMIPTERA, half-winged, in natural history, the second order of insects, according to the Linnæan system. In this tribe the upper part of the wing-sheaths is of a rough or leathery texture; the lower part is membranaceous. Sometimes almost the whole wing-cover is leathery, but of a softer texture than the coleoptera. Grashoppers, locusts, and the cicadæ, are contained in this division. The wing-covers in this order cross each other when closed, instead of meeting in a direct line. This order contains the following genera:

Aphis	Pneumora
Blatta	Thirips
Chermes	Mantis
Cicada	Nepa
Cimex	Notonecta
Coccus	Gryllus
Fulgora	Macrocephalus

HENDECAGON, in geometry, a figure that hath eleven sides, and as many angles.

HEPAR *sulphurus, liver of sulphur*, a combination of alkali and sulphur. See SULPHURET.

HEPATIC, in medicine and anatomy, any thing belonging to the liver.

HEPATIC *gas*, the old name for sulphuretted hydrogen.

HEPIALUS. See PHALENA.

HEPTACHORD, in the ancient poetry, signifies verses that were sung or played on seven chords, that is, on seven different notes. In this sense it was applied to the lyre, when it had but seven strings. One of the intervals is also called an heptachord, as containing the same number of degrees between the extremes.

HEPTAGON, in geometry, a figure consisting of seven sides, and as many angles. In a regular heptagon, the angle at the centre is $= 51°\frac{3}{7}$; the angle of the polygon is $= 128°\frac{7}{7}$. The area is = the square of one of the sides multiplied by 3.6339, or if a equal the side, the area $= a^2 \times 3.634$ nearly $= a^2 \times \frac{7}{4}t$, where t is the tangent of $64°\frac{2}{7}$, = half the angle of the polygon.

In fortification, a place is termed an heptagon, that has seven bastions for its defence.

HEPTAGONAL *numbers*, in arithmetic, a sort of polygonal numbers, wherein the difference of the terms of the corresponding arithmetical progression is 5. Arithmeticals 1, 6, 11. 16, 21, &c., and these, added together, make Heptagonals 1, 7, 18, 34, 55, &c. One of the properties of these numbers is, that if they be multiplied by 40, and 9 be added to the product, the sum will be a square number.

$$\begin{aligned} \text{Thus } 1 \times 40 + 9 &= 49 = 7^2 \\ 7 \times 40 + 9 &= 289 = 17^2 \\ 18 \times 40 + 9 &= 329 = 27^2 \\ 34 \times 40 + 9 &= 1369 = 37^2 \\ 56 \times 40 + 9 &= 2209 = 47^2 \text{ \&c.} \end{aligned}$$

Here it is evident, that the series of squares thus formed, is 7^2, 17^2, 27^2, 37^2, 47^2, &c. the common difference of whose roots is 10, which is double the common difference of the arithmetical series from which the heptagonals are formed.

HEPTANDRIA, in botany, the seventh class in Linnæus's system, consisting of plants with hermaphrodite flowers, which have seven stamina or male organs. There are four orders of this class, derived from the number of styles.

HEPTARCHY, a government of seven persons: also a state or country divided into seven kingdoms, and governed by seven independent princes; in which sense it is particularly applied to the government of South Britain, when divided amongst the Saxons.

HERACLEUM, in botany, *cow parsnep*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ or Umbelliferæ. Essential character: involucre caducous: corolla difform, inflex, emarginate; fruit elliptic, emarginate, compressed, striated, margined. There are six species, with several varieties.

HERALDRY. We shall commence this article with some account of the great and important services of the heralds in former times, how ancient heraldry hath been their employments in war and peace, and in proclaiming and publishing weighty affairs.

As for their antiquity, they were in request among the ancient Greeks. Homer, in his second book, speaks of nine heralds in the Grecian army: and with the Romans they were in such esteem, that Numa Pompilius, the second king of Rome, instituted a society of heralds, and Ancus Martius, his grandson, and fourth king of Rome, erected a college for them.

Their business was to determine peace and war, leagues, agreements, wrongs offered or taken by them or their enemies, and to execute martial messages, &c. and as the Romans strove chiefly to obtain honour, so the heralds distributed ornaments and rewards to all who performed worthy actions at home and abroad.

The Roman law strictly prohibited any to take up arms against an enemy, without the consent and approbation of these heralds, and one above the rest, being called Pater Petratus, was crowned with vervain, from whence he became their chief, or king, either in denouncing war, or concluding peace, as is now practised in England.

In the time of Edward I. Thomas Earl of Lancaster, Leicester, and Derby, and constable of England, ordained, that no parson, curate, churchwarden, &c. should pull down any hatchment, coat of arms, or pennon, or eraze any tomb out of churches or church-yards; and also, that no goldsmith, coppersmith, glazier, painter, or marbler, have to do with arms, without the consent of the King of Arms of that province, and that they should not set a merchant's mark within an escutcheon; which order was revived in 1707, by Henry Howard, earl of Bindon, deputy earl-marshal of England, with these additions, *viz.* that no engraver, chacer, carver, stone-cutter, coach-maker, funeral undertaker, and others in the premises, should design and appoint, to or for any persons, any arms, or ensigns armorial, &c. as they would answer the contempt thereof at their peril.

The said Thomas Earl of Lancaster also ordained, that (for the better observing of the aforesaid order) all the Kings of Arms should keep their chapters once every quarter of the year, at least, and that they should make their visitations in their provinces, or their marshals for them, every seventh year. And he likewise ordained, that the heralds, at the interment of every gentleman, (where they were called to that service) should take the pedigree, with diligent examination of old folks, and record the same.

The heralds, in former times, frequently attended their sovereigns in their wars abroad; and in their progress were often despatched to other princes, with messages of war, as defiances, &c. and if they received any violence or affront from those princes to whom they were sent, it was highly resented by him whom they served.

In the reign of King Edward III. Henry King of Castile sent an herald to the Black Prince, to know why he invaded his kingdom; and in 1415, King Henry V. of England, sending Antelope Pursuivant at

Arms from Southampton to the French King, to demand restitution of what he had detained wrongfully from him; the said King of France sent Montjoy King of Arms, from Roan, to assure King Henry he would give him battle.

The Emperor's herald defied Francis I. King of France; and giving his master all his titles, of Castile, Leon, Arragon, Naples, &c. in a long roll, King Francis commanded his heralds to receive the challenge, and to repeat Francis as many times as the other had kingdoms and petty titles.

At the baptism of Madame Isabelle de France, to whom King Henry VIII. of England was godfather, the infant's name was proclaimed by the kings and heralds of arms, both of France and England, having their coats of arms adorned with the arms of both kings.

In the year 1635, a French herald was sent from Paris to Flanders, where, by sound of trumpet, he denounced and proclaimed war against the King of Spain, and all his dominions, and fixed up and left the defiance in all the towns that he passed.

Besides kings and princes, divers noblemen in ancient time had also their heralds and pursuivants, as in the reign of Richard II. anno 1379, the Earl of Northumberland sent an herald, named Northumberland, to that king, for a safe conduct to come and commune with him.

In 1436, the duke of Gloucester sent his herald, named Pembroke, to defy the Duke of Burgundy; and the Duke of Bedford had his herald, named Bedford, whom he sent to defy Charles VII. of France.

In 1496, the thirteenth of Henry VII. the earl of Surry sent Norroy king of arms to the captain of Ayton-Castle, (which was one of the strongest places between Berwick and Edinburgh) to deliver him the said castle, which he refused; and whilst the said Earl lay at Ayton, the King of Scotland sent to him Marchmont, and another herald, with a challenge, either to fight army to army, or person to person.

Heralds have likewise been employed in jousts and tournaments; and as to shields and arms, we read that King Henry III. in the twenty-eighth of his reign, anno 1244, commanded the keepers of the Archbishoprick of Canterbury, that they caused to be brought a fair stone, to be laid upon the body of Gerald Fitz-Maurice, who was justice of Ireland, and died at Canterbury, and also commanded them to set thereon his shield with his arms. And thus much may suffice to show the antiquity of heralds, and in some measure their use; next of their college.

Of the College of Heralds. This College is seated upon St. Bennet's Hill, near Doctor's Commons, and was the ancient house of Thomas Stanley, Earl of Derby, who married Margaret Countess of Richmond, mother of Henry VII.: and the Duke of Norfolk, having in lieu thereof exchanged lands with the crown, he procured the same to be bestowed by Queen Mary on the King's heralds and pursuivants of arms for ever: to the end that they might reside together, (if they pleased) and assemble and agree together, for the good government of their faculty, and that their records might be there safely preserved, &c.

Since the fire of London, 1666, which consumed the whole house, it is fairly and conveniently rebuilt, with a large room for the keeping the Court of Honour, together with a library, and houses and apartments for the officers thereto belonging.

They were made a college or corporation by charter of King Richard III. and by him (being wholly employed and entrusted in regulating all affairs belonging to the noble science of arms) had several privileges granted them; as to be free from subsidies, tolls, and all manner of offices in the kingdom; all which privileges were confirmed by King Edward VI. in the third of his reign; and for their regular proceedings have a public signet, wherewith they seal and authorise all business concerted in the office.

Of this collegiate society are (besides the Earl Marshal, who is their head) three kings of arms, six heralds, and four pursuivants; all which we will speak of in their order.

Of the Earl Marshal. This great office, which is hereditary in the noble family of Howard, Dukes of Norfolk, (descended by the mother's side from Thomas de Mowbray, Earl of Nottingham, the first Earl Marshal of England) which office is now held by his Grace Charles Duke of Norfolk; and by the statute of 31 Henry VIII. has his place next after the Lord Great Chamberlain, and Constable, and before the Lord High Admiral, and Lord Steward of the King's house.

This officer, who is governor of the college of heralds, has sometimes been the King's lieutenant general in martial affairs, and is an Earl by his office, which no other officer in England is.

The Earl Marshal's court was held in

the college of heralds, wherein he took cognizance of all matters of war and arms, being commonly guided by the civil law.

He determines all questions and differences that may arise between the heralds and other persons, concerning pedigrees, honour, arms, crest, supporters, and ensigns armorial; and he, or his deputy, being judge and head of the college, has power of making rules, ordinances, and decrees, for regulating thereof.

As in the college of heralds, the arms of all the families and names in England are (or ought to be) recorded, together with the time when their arms were granted, and upon what occasion; and as in the said office every man's fame and dignity are preserved; so his Lordship hath power by special commission, under the great seal of England, of prohibiting the provincial kings (which are Clarencieux and Norroy) to give and grant any new arms without his Lordship's consent; and when any such are usurped, and unjustly borne, he has power to examine and disclaim the same, and to punish the parties that shall falsely assume the arms of another.

He bears a staff of gold tipped with black, having the king's arms enamelled on one end, and his own at the other, and takes his place with the Lord Great Chamberlain, or the Constable, next before the sword.

At a coronation, the Earl Marshal has the ordering of the Abbey of Westminster, and sees the regalities and robes of King Edward the Confessor to be in a readiness where the solemnity is held.

He appoints the building of the throne whereon the King or Queen is to be crowned, and gives orders to the gentlemen-ushers, for the covering and furnishing thereof with hangings, chairs, carpets, cushions, &c.

At such time the Earl Marshal is one of those that does all the nearest offices to the King's person, as to help to lead him, and to support his Majesty in his chair, putting his hand, with others of the nobility, to set the crown on his head, doing his homage first, and then presenting the nobility in their several degrees, being all vested in their robes of estate, wearing their coronets when they do their homage.

At the creation of any great estate, as Duke, Marquis, or Earl, the Earl Marshal has the furniture of the said estate, or a composition for it, as also by ancient custom he has had the like of archbishops, bishops, and abbots, at their consecrations.

At the funeral obsequies of kings, queens, and princes, the Earl Marshal is a chief commissioner, appointed with the Lord Treasurer, the Lord Great Chamberlain, and others of the Lords of the King's Council, to give orders to the wardrobe, for the distribution of black for mourners, for the furnishing the hearse with velvets, palls of cloth of gold, escutcheons, banners, and hatchments, giving charge to the officers of arms to give their attendance, and to see all things royally and princely performed.

Assisted by the king and heralds, he marshals and orders the proclamation and coronation of our kings, their marriages, christenings, funerals, cavalcades, royal interviews, feasts, &c.: and also when war or peace is proclaimed; so that he keeps a court of chivalry in the common hall of the college of heralds, where they sit as his council and assistants, in their rich coats of his Majesty's arms, being all the King's servants in ordinary: and besides these, there are six proctors, who are to plead all causes relating to coats of arms, that are tried before the Earl Marshal, or his deputy, in the college of heralds.

The manner of admitting officers into the College of Arms is as follows:

At their first entry, they are commended to the sovereign by a bill signed by the Earl Marshal's hand; which done, the King signs the same, and so it passes the privy seal and broad seal; and that once obtained, they are to be sworn and created by the Earl Marshal, or his deputy.

Of the Kings of Arms. 1. Garter principal King of Arms of Englishmen, and chief officer of arms of the most noble order of the Garter. 2. Clarencieux King of Arms. 3. Norroy King of Arms.

Garter. This officer was constituted by King Henry V. with the advice and consent of the Knights of the Garter, for the service of the said most noble society, and from thence took his name; and his Majesty, for the greater dignity of the order, being pleased to annex thereto the office of principal King of Arms, from hence he is honoured with two distinct titles, *Garter*, and principal King of Arms.

The duty of his office, in relation to the Garter, is, in general, to perform whatever the sovereign, prelate, or chancellor of the said order, shall enjoin him relating thereto; such as carrying the rod and sceptre at every feast of St. George, when the Sovereign is present, to notify the election of such Knights as are newly elected, to call upon them to be installed at Windsor, to attend the solemnity at their installation, to cause their arms to be put over their seats in the chapel there, to marshal the funeral rites and ceremonies of those knights, to carry the Garter to foreign kings and princes, that are chosen to be knights of that most noble order, to take cognizance of the arms of the nobility, and to make supporters to those created to any new degree of peerage; for which he has allowed him a salary and fees, both from the Sovereign and the knights.

This officer, as principal Herald or King of Arms in England, (as Lion is in Scotland, and Ulster in Ireland), marshals the solemn funerals of the higher nobility of England, as Princes, Dukes, Marquisses, Earls, Viscounts, and Barons, as also does many other services to the King and State; and therefore, as the other Kings have, has a salary out of the Exchequer, and double their fees at the instalments of the Knights of the Garter, and a composition for the uppermost garment of each knight at his installation.

It may not be improper to notice the peculiar bearings or attributes of the greatest antiquity, before we proceed to treat of more modern facts. The Heathen divinities had each their distinctive mark; Jupiter wielded the lightning in his right hand; Neptune bore the three pronged trident; Mars the spear; Saturn the scythe; and Bacchus the spear, encircled by ivy; the Phrygians, the sow; the Goths, a bear; the Thracians, Mars; the ancient French, the lion, which was afterwards changed to the toad, and that again for the fleur de lis, sent them from Heaven by an angel, whose commission was directed to Clovis, their first Christian monarch; the Saxons, a horse; the Flemings, a bull; the King of Antioch, an eagle grasping a dragon; the Romans, the eagle; Pompey, a lion holding a sword; yet the Roman people, who were saved by the cackling of geese, despised that bird in too great a degree to admit it into their ensigns: exclusive of the above, there were many nations and individuals, who distinguished themselves by exhibiting every description of weapons on their banners. It should also be observed, that the most ferocious beasts and birds were selected as emblematic of honour and courage; for this reason, shields, with their figures only, are considered as most honourable and ancient; but those with trees, flowers, plants, the sun, moon, planets, varieties of colours, or charged with any of the honourable ordinaries, or artificial objects, are deemed of less importance.

The science of heraldry consists principally of blazoning and marshalling; the former is the art of diplaying a coat of arms in its proper colours, the latter is the combining various arms in one shield. In blazoning it is usual to begin with the field, and then proceed with the charge, and in naming the objects charged in the field, to mention the most predominant, and next the field, first; and then the most remote. Gwillim observes, that tincture is a variable hue of arms, and as applicable to differences as to the arms, and is distributed into colours and furs. The same author considers colours an external dye, or the gloss of any illuminated object, and the colour alluded is considered general and special. The general implies the natural colour of bodies, whether artificial or otherwise; those borne in their natural colours must be blazoned proper, without mentioning the colours.

There are forms in heraldry which have names only applied to them, and no colour specified in the blazoning, the term sufficiently explaining the colour of each; they resemble a globe or ball, and are called besants, the colour or plates argent; hurts, azure; torteauxes, gules; pellets or ogresses, sable; pomeis, vert; golpes, purpure; orange, tennc; and grosses, sanguine. In these nine varieties are included all the colours generally used in blazonry.

The blazoning of the arms of gentlemen, esquires, knights, and baronets, is derived from metals and colours; those of barons, viscounts, earls, marquisses, and dukes, from precious stones; and those of princes, kings, and emperors, from the planets. See Colours.

Or, gold, is expressed by dots (see Plate I. of Heraldry, fig. 1) and is intended as an intimation that, as gold surpasses all other metals in value and purity, he that bears it should endeavour to excel in the same proportion; the same insinuation is implied in the topaz and the sun.

Argent, or white, is represented by a perfect blank (see fig. 2,) this colour ranks next to Or, and without gold and silver Heraldry would be imperfect; argent signifies innocence, temperance and hope; the pearl was supposed by the ancients to possess a restorative property, and Luna is acknowledged to be the mistress of honour, the seas and tides.

Gules, red, is expressed by perpendicular lines, or lines paleways from the chief to the base (see fig. 3,) this colour has ever been considered as symbolical of majesty and dignity; the ruby cannot be wasted by fire or water, and Mars, the planet, alludes to the heathen God of battle, the patron of courage and military address.

Azure, blue, the lines in this instance are horizontal, (see fig. 4,) and intended for the tint of the air or sky, and is said to denote loyalty, fidelity, and chastity; the precious stone and planet in azure were adopted as possessed of superior qualities, emblematic of the worth of nobles and princes.

Sable, or black, represented by perpendicular and horizontal lines crossing each other at right angles (see fig. 5). Sable indicates gravity, constancy, and grief for the loss of friends; the diamond is the most valuable of all stones, and Saturn presides over counsellors and other grave characters.

Vert, green, the lines are bendways (see fig. 6.) or from the sinister corner of the chief to the opposite of the base, and is emblematical of youth, peace, and concord.

Purpure, is a colour composed of a large part of crimson, and a less of blue, and the lines which express it tend directly contrary to those of vert, (see fig. 7.) this word is derived from the fish called purpura; the amathyst was preferred, for its excellence, to decorate the breast of Aaron, and the planet Mercury signifies goodness of temper.

Tenne, or tawny, is a mixture of red and yellow, and represented by lines like those of purpure; it has been but little used in England, but was formerly in a considerable degree in France.

Sanguine, is composed of lake and a small quantity of Spanish brown, and expressed by lines as purpure; it was much used by the knights of the Bath, and by the serjeants at law, in their vestments; the Sardonix is said by St. John to be the sixth stone in the Heavenly Jerusalem.

Furs are the next object to be considered, the use of which may be thus explained.

Ermine, implies a field argent, with the powdering sable, (see fig. 8.)

Ermines, is the reverse, or a field sable, and the powderings argent.

Erminois, signifies a field or, and the powdering sable.

Pean, is a field sable, and the powderings or.

Vair, is of two descriptions; if it consists of argent and azure, it is sufficient to say vair; but if it is compounded of any other colours, it is usual to say vairy of the colours adopted, (see fig. 9.)

Fig. 10 is blazoned potent-counter-potent, and the colours argent and azure.

Doublings, or furs, were anciently, and are at present, used for the linings of the robes and mantles of senators, consuls, and kings.

The bordure is extended to a great variety, as (fig. 11) gules a bordure, or; (fig. 12) a bordure indented, argent; (fig. 13) a bordure counter compone, argent and gules.

The bordure is generally one-sixth part of the breadth of the shield, and is ingrailed, indented, charged, componed, and countered. If the inner line of the bordure is strait and the latter plain, the colour of the bordure alone is named in blazoning; if it is charged with parts of plants or flowers, it is described as verdoy of trefoils. If it consists of ermines, vair or vairy, or any of the furs, the heralds say purflew of ermines. When charged with martlets, charged with an enaluron of martlets.

The label is the first of the distinctive marks of the branches of a family, and is borne by the eldest son during the life of his father (see fig. 14). The second son bears a crescent, the third a mullet, the fourth a martlet, the fifth an annulet, the sixth a fleur de lis, the seventh a rose, the eighth a cross moline, and the ninth a double quatrefoil. (see figures 15, 16, 17, 18, 19, 20, 21, 22.)

Those differences should be strictly observed by every brother or house, to prevent contention relating to coat armour.

In the second house, the first son bears a crescent charged with a label during his father's life only; the second son, of the same house, a crescent charged with another crescent; the third, a crescent charged with a mullet; the fourth, a crescent charged with a martlet; the fifth, a crescent charged with an annulet; and the sixth, a crescent charged with a fleur de lis.

The mullet, which is the difference of the third house, is thus charged: the first son, with a label during the life of his father; the second, with a crescent; the third, with a mullet; the fourth, with a martlet; the fifth, with an annulet; and the sixth, a fleur de lis.

The martlet, annulet, and fleur de lis, the differences of the fourth, fifth, and sixth houses, are charged for distinctions similar to the mullet.

The daughters of families are permitted to bear their father's arms, with the same distinctions used by them.

The shield, or escocheon, the mantle, the helmet and crest, are the several parts of arms which compose an achievement. Accidents in the escocheon are points and abatements; the former are places in the shield named according to their position in the middle, or remote; the middle are near the centre. The fess point is the centre of the escocheon. The honour point is in a direct line above it, and the nombril is next below it. Remote points are placed at still greater distances from the fess point, some of which are superior and others inferior; the former occupy the upper part of the escocheon, and of those there are middle and extremes, the middle is the exact middle of the chief between the two extremes; the two superior extreme points occupy the corners of the chief part of the escocheon, and are termed the dexter and sinister. The inferior points are at the base, and of them there are middle and remote, (see fig. 23,) in which A is the dexter chief point; B, the precise middle chief; C, the sinister chief; D, the honour point; E, the fess point; F, the nombril point; G, the dexter base; H, the dexter middle base; I, the sinister base point. An abatement is a casual mark annexed to coat armour, which announces some dishonourable act of the bearer. Abatements consist of diminution and reversing, the first is the blemishing of some particular point of the escocheon by sanguine and tenne, which are stains; were the metals used, they would be considered additions of honour. See fig. 24.

Augmentations are additional charges borne on an escocheon, a canton, or chief, and given as particular marks of honour. See fig. 26.

Escocheons are either of one or more tinctures: of those of more than one, that is said to be predominant, when some one metal-colour or fur is supposed to be spread over the whole surface of the escocheon, which is termed the field, or shield; in such as have more than one tincture, the field and charge must be observed.

The charge is that which possesses the field, whether natural, artificial, vegetable, or sensitive, and may be placed throughout the superficies, or in some particular part of the escocheon.

Ordinaries consist of lines variously drawn. The properties of them depend upon their deviations from a right line. Those are termed engrailed, invected, waved, crenelle, or embattled, nebule, indented, and dancette. (See fig. 27.) Of these, and straight lines, honourable ordinaries, abatements, and rewards of honour, are composed.

The honourable ordinaries are, the cross, chief, fess, barr, pale, chevron, bend, saltier, and escocheon.

The cross occupies the fifth part of the escocheon; if charged, the third; and is borne engrailed, invected, wavy, &c. between a charge, and charged as the rest of the ordinaries are. (See fig. 28.) Argent a cross sable.

The chief is peculiar to those who have obtained it by extraordinary merit: it contains one third part of the escocheon in depth, and is divided into a fillet, which includes a fourth part of the chief, and is placed in the chief point. (See fig. 29.) Or, a chief gules.

The fess is situated in the centre of the shield, and contains in breadth the third part of the escocheon. (See fig. 30. Azure a fess, or.) The bar differs from the fess only as it is but the fifth part of the shield. It is divided into the closet, or a moiety of the bar; and the barulet, or half the closet.

The pale contains the third part of the escocheon, and is divided into a pallet, or one-half of the pale. An endorse is the fourth part of a pale, and is not used but when the pale is between two of them. If the pale is upon an animal, it is usual to say, he is debrused with the pale; if the beast is on the pale, he is supported of the pale. (See fig. 31.) Gules, a pale, or.

The chevron resembles the rafters of a house, and occupies the fifth part of the field, and is divided into the chevronel, which contains half the chevron; and a couple close, the fourth part of the chevron. These are not borne but in pairs, unless there is a chevron between them. (See fig. 32.) Gules, a chevron argent.

The bend contains the fifth part of the field in breadth when not charged; when charged, the third; and is divided into the bendlet, which is limited to the sixth part of the shield; into a garter, the moiety of a bend; into a cost, the fourth part of a bend; and a riband, the half of a cost. (See fig. 33.) Or, a bend azure.

There is, besides, the bend sinister, which passes obliquely across the escocheon, from the sinister chief to the dexter base. This is divided into the scrape, half the bend; and the battune, the fourth part of the bend, the most common badge of illegitimacy. (See fig. 34.) Gules, a battune argent.

The saltier contains the fifth part of the shield; if charged, the third. This object represents an ancient description of a scaling ladder; and, similar to the other ordinaries, is borne engrailed, wavy, &c. &c. (See fig. 35.) Sable, a saltire embattled, counter embattled, argent.

An inescocheon consists of the fifth part of the field, and is to be placed in the fess point. Those who marry an heiress bear her arms on an escocheon of pretence. (See fig. 36.) Ermine, an inescocheon gules.

The pile is an ordinary, in form like a wedge; is an ancient addition to armoury, and adopted from the pointed instrument used to secure foundations on marshy grounds. (See fig. 37.) Azure, a pile ermine.

Partitions are such in which there is no tincture from metal, colour, or fur, predominating in them, and are formed of various lines of partition, often causing counter-changing and transmutation. This kind of bearing may be engrailed, &c. (See fig. 38. Plate II.) Parted per pale, argent and gules.

An example of counterchanges is given in fig. 39. Or, a cross per pale, gules and sable.

Another of ordinaries joined is shown in fig. 40. Gules on a chevron argent, three bars, gemells sable.

The artificial objects used in heraldry are very numerous, and far too much so for enumeration: they express ensigns of dignity, both spiritual and temporal, the liberal and mechanical professions, and military and naval acts. See fig. 41.

Military figures are equally usual, and consist of castles, battering rams, daggers, spears, &c. &c.

Common charges are composed of objects natural or artificial; celestial are borne single, upon or between any of the honourable ordinaries, and then three are the usual number. (See fig. 42.) Diamond, a fess ermine, between three crescents topaz.

Under the article of vegetables are included trees, plants, leaves, flowers, and fruits. An illustration is given in fig. 43. Vert, five fig-leaves in saltier.

Various parts of the human body and the blood are borne in heraldry. (See fig. 44.) Argent, goutte de sang. Those are, however, seldom borne alone, but upon or with some of the ordinaries.—Goutte de sang only, always signifies gules; goutte de larmes, drops of tears, azure; goutte de eau, drops of water, argent; de poix, or sable, drops of pitch and d'or. The form of each is the same

The bloody hand is the appropriate mark of a baronet.

Of the various animals used, the lion is the most honourable; and all quadrupeds are considered more so than the bearings of fishes or fowls, particularly the males. The lion is borne rampant, (see fig. 45.) argent, a lion rampant sable; and passant, (see fig. 46.) or, a lion passant sable, in chief three piles of the second. Parts of the lion are also generally adopted, (see fig. 47.) Argent, a lion's head erazed vert. The varieties of beasts, and their parts are extremely common, and cannot possibly be specified in an article so brief as the present, (see fig. 48.) Gules, a talbot passant, or, a chief ermine. All animals, which are quadrupeds, and oviparous, may be borne. (See fig. 49.) Azure, a tortoise erect, or. Fowls of every description are to be represented in the natural acts of standing or flying; those that are either whole footed, or have their feet divided, and have no talons, should be termed membered; the cock, and all birds of prey, must be called armed, and the arming or membering of them is to be of a different colour from the fowl or bird: in the blazoning of fowls, which make much use of their wings, if they are not exhibited spread, they must be termed close. The parts and members are generally borne both couped and erazed, and that on or between any of the honourable ordinaries. Birds are considered a more noble bearing than fish. (See fig. 50.) Ermine, and eagle displayed gules.

Fishes are borne in many positions, directly upright, embowed, extended, and indorsed, and surmounting each other, fretted and triangle. (See fig. 51.) Azure, three trouts fretted in triangle argent. Those upright, with fins, were anciently termed in blazoning hauriant, signifying the act of respiration, to accomplish which fish frequently rise to the surface for fresh air; when borne transverse, or swimming, they were called in blazoning naiant. Fishes are borne in part, and on or between any of the honourable ordinaries.

There are, besides, animals or monsters, (see fig. 52.) Argent, a dragon's head erazed vert, holding in his mouth a sinister hand, couped at the wrist, gules.

Such are the peculiarities which distinguish the shield within the boundaries of its surface; we shall now proceed to treat of the helmet, and show how it is placed in various cases, on the shield, above the coronet, and in others without the latter symbol of rank, which equally marks the gradation of title with the helmet. The crown or coronet is more ancient than the helmet, and was invented as a testimony of triumph and victory; the radiated crown was assigned to Emperors; but the coronet, with pearls on the circle, and foliage intervening, was not used in heraldry more than 300 years past. (See fig. 53—56) the coronet of a Duke, Marquis, Earl, Viscount, and Baron; besides ducal, mural, naval, civic, celestial, custom, valary, &c.

The helmet was worn in battle and at tournaments, both for use and distinction. Since the invention of fire arms it has been nearly confined to heraldric purposes. The manner of placing them on shields is shewn in fig. 57, 58, 59. Those right in front, many bars, to Sovereigns; those nearly in profile, to Peers; when front and open, to Baronets and Knights; in profile close, to esquires and Gentlemen.

The wreath is a roll of silk, of two colours, blazoned on the shield, and laid on the helmet as a support to the crest. See fig. 60.

The crest is the most elevated part of the armour of the head, and is said to be derived from *crista*, or cock's-comb. The original use appears to have been a protection from the edge of the sword, when aimed at the upper part of the skull. Gwillim asserts, that the crest, or cognizance, should possess the highest place next to the mantle, yet so as to permit the interposition of a scroll, wreath, chapeau, or crown. The knights who celebrated jousts wore plumes of the heron and ostrich feathers, with crests of various materials, which were altered at pleasure. They are of great antiquity, and were of superior honour, as no person was admitted to tilt at a joust till he had given proof of his noble descent, and they were limited to those only, (see fig. 61) which exhibits a crest on the wreath.

The mantle is the drapery that is thrown around a coat of arms; it is doubled, or lined throughout by one of the furs.

Supporters are figures by the side of a shield, appearing as if they actually held it erect. (Fig. 62.) In England, supporters are confined to peers, and knights of the four orders and proxies of the Princes of the Blood Royal, at installations, except by an especial grant from the Sovereign.

Heralds. The heralds, which are six in number, are distinguished by the names of Richmond, Lancaster, Chester, Windsor, Somerset, and York, and are all equal in degree, only preceding according to the seniority of their creation, their patents being under the great seal of England.

Heraldric Achievement, in blazonry, an armorial bearing or device, formed according to the rules of heraldry, commonly called Coat of Arms. These armorial bearings appertain to families and nations. The arms belonging to the United States, adopted after the declaration of independence, and in use to the present time, were designed by William Barton, Esq. a gentleman very eminent for his heraldric knowledge and skill.

"The device for an armorial Achievement and Reverse of a great seal for the United States in Congress assembled is as follows:

"*Arms.*—Paleways of thirteen pieces, argent and gules, a chief azure; the escutcheon on the breast of the American bald eagle displayed, proper, holding in his dexter talon an olive branch, and in his sinister a bundle of thirteen arrows, all proper; and in his beak a scroll inscribed with this motto, "E pluribus unum."

"*For the Crest.*—Over the head of the eagle, which appears above the escutcheon, a glory, or, breaking through a cloud proper, and surrounding thirteen stars forming a constellation, argent, on an azure field.

"*Reverse.*— A Pyramid unfinished.

"In the zenith an eye in a triangle surrounded with a glory, proper. Over the eye these words "Annuit Cœptis."

"On the base of the pyramid, the numerical letters MDCCLXXVI, and underneath the following motto: "Novus ordo seclorum.

"*Remarks and Explanations of the Device.*—The escutcheon is composed of the chief and pale, the two most honourable ordinaries. The thirteen pieces paly represent the several states in the union, all joined in one solid compact, entire, supporting a chief which unites the whole, and represents Congress. The motto alludes to this union.

"The pales in the arms are kept closely united by the chief, and the chief depends on that union, and the strength resulting from it, for its support, to denote the confederacy of the United States, and the preservation of the Union through Congress.

"The colours of the pales are those used in the flag of the United States of America. White signifies purity and innocence, red hardiness and valour, and blue, the colour of the chief, signifies vigilance, perseverance, and justice. The olive branch and arrows denote the power of peace and war, which is exclusively vested in Congress.

"The crest or constellation denotes a new state taking its place and rank among other sovereign powers.

"The escutcheon borne on the breast of an American eagle, without any other supporters, to denote that the United States of America ought to rely on their own virtue.

"The pyramid on the reverse signifies strength and duration.

"The eye over it, and the motto ('annuit cœptis,' 'he prospers our endeavours') allude to the many signal interpositions of Providence in favour of the American cause.

"The date underneath is that of the Declaration of Independence, and the words under it signify the beginning of the New American Æra, which commences from that date."

The preceding description of arms and device is taken from a copy of the same, inclosed in a letter from Charles Thompson, Esq. formerly secretary of Congress, to William Barton, Esq. of which letter the following is a true copy:

"Sir,—I am much obliged for the perusal of the Elements of Heraldry, which I now return. I have just dipt into it so far, as to be able to be satisfied that it may afford a fund of entertainment, and may be applied by a state to useful purposes. I am much obliged for your very valuable present of Fortesque de laudibus legum Anglica, and shall be happy to have it in my power to make a suitable return.

"I enclose you a copy of the device, by which you have displayed your skill in heraldric science, and which meets with general approbation.

"I am, Sir,

Your obedient humble servant,

Charles Thompson."

To William Barton, Esq.

June 24, 1782.

The originals of the above letter and preceding "copy of the device," both in the hand writing of Charles Thompson, Esq. are now in the possession of Dr. William P. C. Barton of Philadelphia, the professor of botany in the University of Pennsylvania, and from these manuscripts we have been permitted to give the foregoing copies, and account of the arms of the United States, &c.

Dr. Barton has likewise favoured us with the following facts, relative to his father's claim to the merit of designing the device and armorial achievement of the United States, the taste, skill, and heraldric knowledge of which reflect infinite credit on the inventor.

In June, 1782, when Congress were about to form an armorial device for a great seal for the United States, Charles Thompson, Esq. then secretary, with the honourable Dr. Arthur Lee, and Elias Boudinot, members of Congress, called on Mr. William Barton, and consulted him on the occasion. The great seal, for which Mr. Barton furnished those gentlemen with devices, (as certified by Charles Thompson, Esq. in the above letter) was adopted by Congress, on the 20th of June, 1782. Mr. Thompson informed Mr. Barton four days after (see the above letter) that they met with "general approbation."

HERB, in botany, is that part of the plant which rises from the root, and is terminated by the fructification. It comprehends the trunk and stem; the leaves; the fulcra, or supports; and the buds, or, as they are sometimes denominated, the winter quarters of the future vegetable.

Herbaceous *plants*, in botany, are those which have succulent stems that die down to the ground every year; those are annual that perish stem and root every year; biennial, which subsist by the roots two years; perennial, which are perpetuated by their roots for a series of years, a new stem being produced every spring.

HERCULES, in astronomy, a constellation of the northern hemisphere. See Astronomy.

HEREDITAMENTS, all such things immoveable, whether corporeal or incorporeal, as a man may leave to him and his heirs, by way of inheritance; or which, not being otherwise devised, naturally descend to him who is next heir of blood, and not to an executor or administrator, as chattels do. It is a word of large extent, and much used in conveyances; for by the grant of hereditaments, isles, seigniories, manors, houses, and lands of all sorts, charters, rents, services, advowsons, commons, and whatever may be inherited, will pass. Hereditaments are of two kinds, corporeal and incorporeal. Corporeal hereditaments consist wholly of substantial and permanent objects, all which may be comprehended under the general denomination of land only; for land comprehends, in its legal signification, any ground, soil, or earth whatsoever, as arable, meadows, pastures, woods, moors, waters, marshes, furzes, and heath. Incorporeal hereditaments are not the object of sensation, are creatures of the mind, and exist only in contemplation. They are principally of ten sorts, *viz.* advowsons, tithes, commons, ways, offices, dignities, franchises, presents, and rents.

HERIOT, in law, signifies a tribute given to the lord for his better preparation towards war. And by the laws of Canute, it appears, that at the death of the great men of this nation, so many horses and arms were to be paid for, as they were in their respective life-times obliged to keep for the King's service. A heriot was first paid in arms and horses; it is now by some custom sometimes the best live beast which the tenant dies possessed of, sometimes the best inanimate goods, under which a jewel or piece of plate may be included. Some are due by custom, some by tenure, and by reservation on deeds executed within time of memory; those due by custom are the most frequent.

For an heriot service, or for an heriot reserved by way of tenure, the lord may either seize or distrain.

HERISSON, in fortification, a beam armed with a great number of iron spikes, with their points outwards, and supported by a pivot, on which it turns.

HERITIERA, in botany, so named in honour of Charles Louis L'Heritier, a genus of the Monoecia Monodelphia class and order. Essential character: calyx five-toothed; corolla none; male anthers ten, without filaments; female germs five; drupes with one subglobular seed. There is but one species, *viz.* H. littoralis, looking-glass plant, a native of the East Indies.

HERMANNIA, in botany. This name was given in honour of the celebrated Paul Hermann, a genus of the Monadelphia Pentandria class and order. Natural order of Columniferæ. Tiliaceæ, Jussieu. Essential character: styles five; capsule five-celled; petals semitubular at the base, oblique. There are twenty-one species. The hermannias are shrubs from two to seven feet in height. Natives of the Cape of Good Hope.

HERMAPHRODITE, a term formerly applied exclusively to signify a human creature possessed of both sexes. The term is now applied to other animals, and to plants. It is now well known there is no such thing as an hermaphrodite in the human species. In most species of animals, the production of hermaphrodites appears to be the effect of causes little understood. In the black cattle it seems to be an established principle of their propagation. It is a well known fact, and, as far as has yet been discovered, appears to be universal, that when a cow brings forth two calves, one of them a bull, and the other a cow to appearance, the cow is unfit for propagation, but the bull-calf becomes a very proper bull. They are known not to breed; they do not shew the least inclination for the bull, nor does the bull ever take the least notice of them. Among the country people in England, this kind of calf is called a free-martin; and this singularity is just as well known among the farmers as either cow or bull. When they are preserved, it is for the purposes of an ox or spayed heifer; *viz.* to yoke with the oxen, or fatten for the table. They are much larger than either the bull or cow, and the horns grow longer and bigger, being very similar to those of an ox. The bellow of a free-martin is also similar to that of an ox, and the meat is similar to that of the ox or spayed heifer, *viz.* much finer in the fibre than either the bull or cow, and they are more susceptible of growing fat with good food.

Among the reptile tribe, indeed, such as worms, snails, leeches, &c. hermaphrodites are very frequent. In the memoirs of the French Academy, we have an account of this very extraordinary kind of hermaphrodites, which not only have both sexes, but do the office of both at the same time. Such are earth-worms, round-tailed worms found in the intestines of men and horses, land-snails, and those of fresh waters, and all the sorts of leeches. The method of coupling practised in this class of hermaphrodites may be illustrated in the instance of earth-worms. These little creatures creep two by two, out of their holes of the earth, where they dispose their bodies in such a manner, as that the head of the one is turned to the tail of the other. Being thus stretched lengthwise, a little conical button, or papilla, is thrust forth by each, and received into an aperture of the other, these animals being male in one part of the body and female in another.

Among the insects of the soft or boneless kind, there are great numbers indeed, which are so far from being hermaphrodites, that they are of no sex at all. Of this kind are all the caterpillars, maggots, and worms, hatched from the eggs of flies of all kinds. But the reason of this is plain; these are not animals in a perfect state, but disguises under which animals lurk. They have no business with the propagating of their species, but are to be transformed into animals of another kind, by the putting off their several coverings; and then only they are in their perfect state, and, therefore, then only show the differences of sex, which are always in the distinct animals, each being only male or female. These copulate, and their eggs produce those creatures which show no sex till they arrive at that perfect state again.

HERMAPHRODITE *flowers*, in botany, are so called on account of their containing both the antheræ and stigma, the supposed organs of generation, within the same calyx and petals. Of this kind are the flowers of all the classes in Linnæus's method, except the classes Monoecia and Dioecia; in the former of which male and female flowers are produced on the same root; in the latter, in distinct plants from the same seed. In the class Polygamia, there are always hermaphrodite flowers mixed with male or female, or both, either on the same or distinct roots. In the plaintain-tree the flowers are all hermaphrodite; in some, however, the antheræ, or male organ, in others the stigma, or female organ, proves abortive. The flowers in the former class are styled female hermaphrodites, in the latter male hermaphrodites. Hermaphrodites are thus as frequent in the vegetable kingdom as they are rare and scarce in the animal one.

HERMAS, in botany, a genus of the Polygamia Monoecia class and order. Natural order of Umbellatæ or Umbelliferæ. Essential character: hermaphrodite, umbel terminating; involucre universal and partial; umbellets with truncate rays, the central one floriferous; petals five; stamina five, barren; seeds in pairs, suborbiculate: male, umbels lateral, with universal and partial involucres; umbellets many-flowered; petals five; stamina five, fertile. There are five species.

HERMETICAL *seal*, among chemists, a method of stopping glass vessels, used in chemical operations, so closely, that the most subtile spirit cannot escape through them. It is commonly done by heating the neck of the vessel in a flame, till ready to melt, and then twisting it closely together with a pair of pincers. Or vessels may be hermetically sealed by stopping them with a glass plug, well luted.

HERNANDIA, in botany, from Francis Hernandez, a genus of the Monoecia Triandria class and order. Natural order of Tricoccæ. Lauri, Jussieu. Essential character: male, calyx three-parted; corolla three-petalled: female, calyx truncate, quite entire; corolla six-petalled: drupe hollow, with an open mouth, and a moveable nucleus. There are two species, *viz.* H. sonora, whistling hernandia; and H. ovigera, egg-fruited hernandia. The first mentioned is un upright lofty tree, with a beautiful head; the flowers are of a pale yellow colour, in panicled racemes; the calyxes of the fruit are also yellow. It is very common in the West Indies, in gullies, near rills of water; the English there call it jack in a box. Dr. Patrick Browne attributes the whistling noise to the cups that sustain and partly envelope the nuts; these, he adds, are very large, and as they move in the wind, produce sound enough to alarm unwary travellers. The seeds are very oily.

HERNIARIA, in botany, English *rupture-wort*, a genus of the Pentandria Digynia class and order. Natural order of Holoraceæ. Amaranthi, Jussieu. Essential character: calyx five-parted; corolla none; stamina five, barren, besides the fertile ones; capsule one-seeded. There are four species; as none of these plants possess any beauty, they are rarely cultivated in gardens.

HERON, in ornithology, a bird of the ardea kind, with a hanging crest. See ARDEA.

HERRING. See CLUPEA.

HESPERIDÆ, the name of the nineteenth order of Linnæus's fragments of a natural method, consisting of five genera, among which are the caryophyllus or clove-tree: and the myrtus, myrtle; allspice or pimento. The plants of this order are of the shrub and tree-kind, and chiefly ever-green. The bark of the stalks is slender; the leaves are generally opposite, but in the myrtle, the leaves are placed opposite, at the bottom of the stalks, and alternate above. The buds are generally conical, concealed in the cavity, which is formed by the footstalk of each leaf at its origin. The flowers are commonly hermaphrodite: in a species of the myrtus, however, they are male and female upon different roots. The calyx is placed above the seed-bud: the petals are three, four or five in number; the stamina are upwards of twenty, nearly equal, and attached in several rows to the middle of the tube of the calyx. The seed-bud is large, and placed below the receptacle of the flower; the style is single, of the length of the stamina, and terminated with a single stigma. The seed vessel is sometimes a berry, sometimes a capsule, and sometimes a stone.

HESPERIS, in botany, English *rocket*, or *dames violet*, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ. Cruciformes, Tournefort. Cruciferæ, Jussieu. Essential character: petals bent obliquely: a gland within the shorter stamens; silique stiff; stigma with a forked base, and converging tip; calyx closed. There are seven species. These plants are much cultivated for the great fragrancy of the flowers: the ladies in Germany have pots of it placed in their apartments, whence it obtained the name of dames violet.

HETEROCLITE, among grammarians, one of the three variations in irregular nouns, and defined by Mr. Ruddiman, a noun that varies in declension. Other grammarians take the word heteroclite in a larger sense, applying it to all irregular nouns.

HETEROGENOUS, or HETEROGENEAL, something that consists of parts of dissimilar kinds, in opposition to homogeneous.

HETEROGENEOUS, in mechanics, such bodies whose density is unequal in different parts of their bulk; or they are such whose gravities in different parts are not proportionable to the bulks thereof; whereas bodies equally dense or solid in every part, or whose gravity is proportionable to their bulk, are said to be homogeneous.

HETEROGENEOUS *light*, is, by Sir Isaac Newton, said to be that which consists of rays of different degrees of refrangibility: thus the common light of the sun or clouds is heterogeneous; being a mixture of all sorts of rays.

HETEROGENEOUS *nouns*, one of the three variations in irregular nouns; or such as are of one gender in the singular number, and of another in the plural. Heterogenenous, under which are comprehended mixed nouns, are six-fold. 1. Those which are of the masculine gender in the singular number, and neuter in the plural. 2. Those which are masculine in the singular number, but masculine and neuter in the plural. 3. Such as are feminine in the singular number, but neuter in the plural. 4. Such nouns as are neuter in the singular number, but masculine in the plural. 5. Such as are neuter in the singular, but neuter and masculine in the plural. 6. Such as are neuter in the singular, but feminine in the plural number.

HETEROGENEOUS *numbers*, mixed numbers consisting of integers and fractions.

HETEROGENEOUS *quantities*, are those which are of such different kinds, as that one of them, taken any number of times, never equals or exceeds the other.

HETEROGENEOUS *surds*, are such as have different radical signs, as $\sqrt[2]{aa}$, $\sqrt[5]{bb}$, $\sqrt[3]{9}$, $\sqrt[7]{18}$, &c. See SURD.

If the indices of the powers of the heterogeneous surds be divided by their greatest common divisor, and the quotients be set under the dividends; and those indices be multiplied crosswise by each other's quotients; and before the products be set the common radical sign, $\sqrt{}$, with its proper index; and if the powers of the given roots be involved alternately, according to the index of each other's quotient, and the common radical sign be prefixed before those products, then will those two surds be reduced to others, having but one common radica sign.

HETEROSCII, in geography, a term of relation denoting such inhabitants of the earth as have their shadows falling but one way, as those who live between the tropics and polar circles, whose shadows at noon, in north latitude, are always to the northward; and in south latitude, to the southward. Thus we, who inhabit the northern temperate zone, are heteroscii with regard to those who inhabit the southern temperate zone, and they are heteroscii with respect to us. Hence it follows, that only the inhabitants of the two temperate zones are heteroscii, though in reality there is always one part of the torrid zone, whose inhabitants are heteroscii with respect to those of the rest, and with regard to those of one of the temperate zones, except at the time of the solstice, and even at this time all of the torrid zone are heteroscii with regard to those of one of the temperate zones; but as the people of the torrid zone have their shadows now on this, and then on that side, they are called amphiscii.

HEUCHERA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Succulentæ. Saxifragæ, Jussieu. Essential character: petals five; capsule two-beaked, two-celled. There are two species, *viz.* H. americana, American heuchera or sanicle, and H. dichotoma.

HEXACHORD, in ancient music, a concord called by the moderns a sixth. The hexachord is twofold, greater and less. The greater hexachord is composed of two greater tones, and two less, and one greater semitone, which make five intervals. The less hexachord is of two greater tones, one lesser, and two greater semitones.

HEXAEDRON, or HEXAHEDRON, one of the five regular or platonic bodies; being indeed the same as the cube; and is so called from its having six faces. The square of the side or edge of a hexaedron is one third of the square of the diameter of the circumscribing sphere; and hence the diameter of a sphere is to the side of its inscribed hexahedron, as $\sqrt{3}$ to 1. See BODY.

HEXAGON, in geometry, a figure of six sides and angles; and if these sides and angles be equal, it is called a regular hexagon. The side of every regular hexagon, inscribed in a circle, is equal in length to the radius of that circle. Hence, it is easy by laying off the radius six times upon the circumference, to inscribe an hexagon in a circle. See GEOMETRY.

To describe a regular hexagon upon a given line, describe an equilateral triangle upon it, the vertex of which will be the centre of the circumscribing circle. The side of a hexagon being s, the area will be $2.598\, s^2 = \frac{3}{2} s^2 \times \text{tang. } 60^\circ = \frac{3}{2} s^2 \sqrt{3}$.

HEXAGON, in fortification, is a place defended by six bastions.

HEXAGYNIA, in botany, the name of an order of plants, consisting of those, which, besides their classical character, have their flowers furnished with six styles.

HEXAMETER, in ancient poetry, a kind of verse consisting of six feet; the first four of which may be indifferently either spondees or dactyls; the fifth is generally a dactyl, and the sixth always a spondee. Such is the following verse of Horace:

1 2 3 4 5 6
Aut pro |desse vo| lunt, aut| dele| ctare po| etæ.

Sometimes, indeed, a spondee constitutes the fifth foot: whence such hexameter verses are called spondaic; as in this of Virgil:

1 2 3 4 5
Cara De|um sobo| les ma| gnum Jovis| incre-
6
mentum.

Epic poems, as the Iliad, Æneid, &c. consist wholly of hexameter verses; whereas elegies and epistles consist usually of hexameter and pentameter verses alternately.

HEXANDRIA, the name of the sixth class in the Linnæan system, consisting of plants with hermaphrodite flowers, which are furnished with six stamina or male organs that are of an equal length. This numerous class of plants is divided into five sections, from the number of the styles or female organs: the narcissus, snow-drop, tulip, hyacinth, &c. have one style; the rice, atraphaxis, &c. two; dock, star-flower, &c. three; guinea-hen weed, four; and water-plantain, five. The Hexandria class is distinguished from the Tetradynamia by the proportion of the stamina, which in the former are of an equal length, in the latter unequal, four stamina being long, and two short.

HIATUS, properly signifies an opening, chasm, or gap; but it is particularly applied to those verses, where one word ends with a vowel, and the following word begins with one, and thereby occasion the mouth to be more opened, and the sound to be very harsh.

The term hiatus is also used in speaking of manuscripts, to denote their defects, or the parts that have been lost or effaced.

HIBISCUS, in botany, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx double; outer many-leaved; capsule five-celled, with many seeds. There are forty-five species, most of these are perennials; several of them have shrubby stalks; and some are herbaceous; the leaves are alternate, and commonly of a soft texture. The flowers are of the mallow kind, axillary, and terminating; the bark in several is capable of being drawn into threads, and manufactured for packthread and ropes; the capsule in some is eatable; others are much esteemed for their ornamental flowers.

HIDE. See CUTIS.

HIDE. Hides are the skins of beasts: but the denomination is particularly applied to those of large cattle, as bullocks, cows, buffaloes, horses, &c. Raw hides are still a considerable object in the Egyptian trade: about 80,000 hides of buffaloes, camels, cows, and oxen, are exported yearly. Nearly 10,000 go to Marseilles, and a still greater number to Italy. The buffaloe hides, being thicker and heavier than the others, are chiefly transported to Syria. As the pastures of Lower Egypt are excellent, the hides of its cattle, in consequence of their being so well fed, are of the very best quality. Great numbers of buffaloes are also in North America. They are larger than an ox, and their head is so full of hair that it falls over their eyes, and gives them a frightful look. There is a bunch on their back, which begins at the haunches, and increasing gradually to the shoulders, reaches on to the neck. The whole body is covered with long hair, or rather wool, of a dun or mouse colour, which is exceedingly valuable, especially that on the forepart of the body, being proper for the manufacture of various articles. The hide makes a considerable article of export from America. There are hides of several denominations, according to their state and quality. Raw or green hide is that which has not undergone any preparation, being in the same condition as when taken off the carcase.—There are also hides dried in the hair. Salted hide is a green hide seasoned with sea-salt and alum, or salt-petre, to prevent its corruption. Most of the hides imported from Holland and France are so prepared. Tanned hides are further prepared by the tanner, by paring off the hair, and steeping them in pits of lime and tan. Curried hides are those, which, after tanning, have passed through the currier's hands, and have thus received their last preparation, so as to be fit for use.

Hide *of land*, was such a quantity of land as might be ploughed with one plough within the compass of a year, or so much as would maintain a family; some call it sixty, some eighty, and some an hundred acres.

The distribution of this kingdom by hides of land is very ancient, mention being made of it in the laws of King Ina. Henry I. had three shillings for every hide of land, in order to raise a dowry for his daughter: this tax was called hidage.

HIERACIUM, in botany, English *hawk weed*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx imbricate, ovate; down simple sessile; receptacle naked. There are fifty-five species: most of these plants are reputed to be weeds; few of them are cultivated except in botany gardens.

HIERARCHY, denotes the subordination of the clergy, ecclesiastical polity, or the constitution and government of the Christian Church considered as a society.

HIERO's *crown*. Under the article Archimedes we have given an account of the interesting fact to which this phrase alludes; we shall only add here an example, to shew how the fraud was detected by a simple arithmetical process: suppose each of the three masses above referred to weighed 64 ounces, and that immersing them separately in the same vessel of water, there were displaced 5*oz.* of water by the golden ball, 9*oz.* by the silver, and 6*oz.* by the compound, or the crown itself, then the respective bulks being as the quantities of water displaced, will be as 5, 9, and 6; and we say,

$$9 - 6 = 3$$
$$6 - 5 = 1$$
$$\overline{4}$$
$$4 : 64 :: 3 : 48$$
$$4 : 64 :: 1 : 16$$

And under such circumstances the crown consisted of 48*oz.* of gold and 16 of silver.

HIEROGLYPHICS, in antiquity, mystical characters, or symbols, in use among the Egyptians, and that as well in their writings as inscriptions; being the figures of various animals, the parts of human bodies, and mechanical instruments.

But besides the hieroglyphics in common use among the people, the priests had certain mystical characters, in which they wrapped up and concealed their doctrines from the vulgar. It is said that these something resembled the Chinese characters, and that they were the invention of Hermes. It has been thought that the use of these hieroglyphical figures of animals introduced the strange worship paid them by that nation: for as these figures were made choice of, according to the respective qualities of each animal, to express the qualities and dignity of the persons represented by them, who were generally their gods, princes, and great men, and being placed in their temples as the images of their deities; hence they came to pay a superstitious veneration to the animals themselves.

The meaning of a few of these hieroglyphics has been preserved by ancient writers. Thus we are told they represented the Supreme Deity by a serpent, with the head of a hawk. The hawk itself was the hieroglyphic of Osiris; the river-horse, of Typhon; the dog, of Mercury; the cat, of the moon, or Diana; the beetle, of a courageous warrior; a new born child, of the rising sun; and the like.

HIEROGLYPHICS. See WRITING, *origin of*.

HIGHWAY, a public passage for the King's people; whence it is called the king's highway. It seems that anciently there were but four highways in England which were free and common to all the king's subjects, and through which they might pass without any toll, unless there were a particular consideration for it. All others which we have at this day are supposed to have been made through the grounds of private persons, on writs of *ad quod damnum*, &c. which being an injury to the owner of the soil, it is said they may prescribe for toll without any special consideration.

There are three kinds of ways, a foot-way, a pack and prime way, which is both a horse and foot way, and cart way, which contains the other two. But notwithstanding these distinctions, it seems that any one of these ways, which is common to all the king's subjects, whether it lead directly to a market town, or only from town to town, may properly be called an highway, and that any such cart-way may be called the king's highway.—A river, common to all men, may also be called the king's highway; and that nuisances in any such ways are punishable by indictment; otherwise they would not be punished at all; for they are not actionable, unless they cause a special damage to some particular person; because if such action would lie, a multiplicity of suits would ensue.

If passengers have used, time out of mind, where the roads are bad, to go by outlets on the land adjoining to an highway in an open field, such outlets are parcels of the highway; and, therefore, if they are sown with corn, and the track is foundrous, the king's subjects may go upon the corn.

Repairing highways. By the common law, the general charge of repairing all high-ways lies on the occupiers of the lands in the parish wherein they are.—But it is said that the tenants of the lands adjoining are bound to scour their ditches.

Particular persons may be burdened with the general charge of repairing an highway in two cases; in respect of an inclosure, or by prescription. As where the owner of lands not inclosed, next adjoining to the highway, incloses his lands on both sides thereof; in which case he is bound to make a perfect good way, and shall not be excused for making it as good as it was at the time of the inclosure, if it were then any way defective; because, before the enclosure, when the way was bad, the people, for their better passage, went over the fields adjoining out of the common track, a liberty which the inclosure has deprived them of. Particular persons may be bound to repair an highway by prescription. But in all cases, whether a private person be bound to repair an highway by inclosure or prescription, the parish cannot take the advantage of it on the general issue, but must plead it specially; and, therefore, if to an indictment against the parish for not repairing an highway, they plead not guilty, this shall be intended only that the ways are in repair, or that it is not an highway, but does not go to the right of reparation.

At common law, it is said, that all the country ought to make good the reparations of an highway, where no particular persons are bound to do it; by reason the whole county have their ease and passage by the said way.

By the ancient common law, villages are to repair their highways, and may be punished for their decay; and if any do injury to, or straiten the highway, he is punishable in the King's Bench, or before the justices of peace in the court leet, &c. Destroying any public turnpike-gate, or the rails or fences thereto belonging, subjects the offender to hard labour for three months, and to be publicly whipped. 1 Geo. II. c. 19. On conviction at the assizes, the offender may be transported for seven years. And on a second offence, or on demolishing any turnpike-house, he shall be guilty of felony, and transported for seven years. But in both these cases the prosecution must be within six months, and on the convict's returning from transportation he shall suffer death. 5 Geo. II. c. 33.

Every justice of the peace by the statute, upon his own view, or on oath made to him by the surveyor, may make presentment of roads being out of repair; and, thereupon, like process shall be issued as upon indictment. For the repairing of highways, there are certain regulations by statute; and every inhabitant of a parish is bound to perform certain duties for that purpose.

HIGH *water*, that state of the tides when they have flowed to the greatest height, or have ceased to flow. It is high-water several minutes, as many as between 15 and 30, before it begins to ebb again. The mode of computing high-water is by having the moon's age given, of which take $\frac{4}{5}$, and adding it to the time of high-water on the day of full or change, and the sum is nearly equal to the time of high water. Thus, for the present day, the 29th of May, it was new moon, or change, on the 25th, of course, the moon is four days old; and on the 25th it was high-water at about two o'clock; therefore $4 \times \frac{4}{5} + 2 = 5^h\ 12^m$, or to about twelve minutes after five.

HILLIA, in botany, so named in honour of Sir John Hill, M. D. author of many works in botany, a genus of the Hexandria Monogynia class and order. Natural order of Contortæ. Rubiaceæ, Jussieu. Essential character: calyx double, lower six-leaved; corolla very long, contorted; capsule two-celled, two-valved, crowned; seeds downy. There are two species, *viz.* H. longiflora, and H. tetrandria; both natives of Jamaica.

HIN, a Hebrew measure of capacity for things liquid, containing the sixth part of an epha, or one gallon two pints, English measure.

HIND, a female stag in the third year of its age. See CERVUS.

HINGES, the joints on which gates, doors, lids, folds of tables, &c. hang, and turn in opening, shutting or folding. They are of different denominations, as butts, used by the joiners for hanging table-leaves, &c.; casement, for hanging casements upon dove-tails; and esses, for light doors and lockers; garnet-cross, for hanging large doors or heavy scuttles in ships; port, for hanging ships' ports; scuttle, particularly used for scuttles. Besides these, there are many others of different forms and uses, distinguished by different names.

HIPS, in building, those pieces of timber placed at the corner of a roof.

HIP *roof*, among carpenters, called also *Italian roof*, is a roof which has neither gable-head, shread-head, nor jerkin-head (by which is meant such heads as are both gable and hip at the same end:) for it is a gable, or upright, as high as the collar-beam, and then there are two short hips, which shut up with their tops to the tops of a pair of rafters, which country carpenters call singlars. A hip-roof has rafters as long, and with the angles of the foot, &c. at the ends of buildings, as it has at the sides; and the feet of the rafters, at the ends of such buildings as have hip-roofs, stand on the same plane, *viz.* parallel with the horizon, and at the same height from the foundation, with rafters on the sides of the roofs.

HIPPIA, in botany, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx hemispherical, subimbricate, corollets of the ray ten, obsolete, subtrifid; seeds with very broad margins, naked; down none; receptacle naked. There are three species.

HIPPOBOSCA, in natural history, a genus of insects of the order Diptera. Mouth with a short cylindrical, straight, two-valved sucker; the valves are equal; antennæ filiform; feet armed with numerous claws; body flat and hard; stemmata none. There are five species, of which the most familiar is H. equina, or horse-fly; head brown; thorax brown, varied with pale colour; wings crossing each other, hyaline with a brown spot near the outer margin; legs annulate with yellow and brown. This insect is exceedingly troublesome to horses: it hides itself under the hairs, and fixes to the skin by means of their crooked nails. It varies in size, in different districts, but is largest in the southern and warm climates. The skin of the insect is of a strong and coriaceous nature; hence it may be pressed to a considerable degree, without being apparently injured. The female of this insect deposits a single egg at distant intervals; but as the egg undergoes no further alteration of form, it has been regarded rather as a pupa than an egg; and, if opened after a certain period, it exhibits the fly in its unadvanced state, and of a white colour. It not unfrequently lies during the whole winter in this state, the fly emerging in the following summer. H. avicularia is observed on the bodies of various birds, which it infests. H. hirundinis is, as its name imports, to be found in the nests and on the bodies of swallows, swifts, and martins. H. ovina is without wings; it is known by the name of the sheep-tick, and is found imbedded in the wool of these animals; this is so tenaceous of life, that it has been found in wool that has been a long time packed up in fleeces.

HIPPOCRATEA, in botany, so named in memory of Hippocrates, the famous Greek physician; a genus of the Triandria Monogynia class and order. Natural order of Acera, Jussieu. Essential character: calyx five-parted; petals five; capsule three, obcordate or elliptic. There are two species, *viz.* H. volubilis, and H. commosa.

HIPPOCREPIS, a genus of the Diadelphia Decandria class and order, Natural order of Leguminosæ or Papilionaceæ. Essential character: legume compressed, several times emarginate along one of the sutures, curved. There are five species. These are small herbaceous plants, with unequally-pinnate leaves and small stipules; peduncles axillary, and terminating, one or many-flowered, in umbels: corollas mostly yellow. Natives of the South of Europe.

HIPPOMANE, in botany, a genus of the Monoecia Monadelphia class and order. Natural order Tricoccæ. Euphorbiæ, Jussieu. Essential character: male, ament, perianthum bifid; corolla none: female, perianthum trifid; corolla none; stigma three-parted; drupe or capsule three-grained. There are three species; of which H. mancinella, manchineel tree, is exceedingly large in the West Indies, almost equalling the oak in size. The first accounts of this tree were very much exaggerated; it was said to be dangerous to sit or lie under it, and that the rain which falls from the leaves will raise blisters in the skin. Professor Jacquin informs us, that he and his companions reposed upwards of three hours under a manchineel tree, without receiving any injury; and that he experienced rain dropping from the leaves to be perfectly innocent. It is dangerous to eat of the fruit, which resembles crab-apples; it occasions vomiting, and a burning heat in the mouth, throat, and stomach, for many hours after. The juice of the buds of the white cedar is esteemed an antidote to this poison, and is generally used with success. It is said, that goats, sheep, and macaws feed greedily on the fruit. The wood is very much esteemed, and is used for ornamental purposes.

HIPPOPHAE, in botany, a genus of the Dioecia Tetrandria class and order. Natural order of Calycifloræ. Elæagni, Jussieu. Essential character: male, calyx two-parted; corolla none: female, calyx bifid; corolla none; style one; berry one-seeded. There are two species, *viz.* H. rhamnoides, common sea-buckthorn, and H. canadensis, Canadian sea-buckthorn.

HIPPOPOTAMUS, in natural history, a genus of Mammalia, of the order Belluæ. Generic character: four front teeth in each jaw; the upper ones distant, in pairs; the lower ones prominent; the two intermediate ones longest; tusks solitary; those of the lower jaw very large, long, curved, and obliquely truncated; feet hoofed at the margin. This animal appears very naturally to have attracted the early attention of mankind, and is supposed, by most critics acquainted with natural history, to be the behemoth, so sublimely described in the book of Job. The Greek and Roman writers have also alluded to it; but their observations upon it are by no means such as could have resulted from accurate and philosophical observation; and both Aristotle and Pliny have fallen, on this subject, into the most absurd deviations from truth. Indeed, it is only recently that clear and just representations of this animal have been published, with interesting circumstances relating to its manners and habits, collected by persons who had inclination and opportunities of particularly examining it. Dr. Sparman, and Colonel Gordon, and Mr. Mason, are particularly entitled to honourable mention on this occasion. The largest female which the Colonel ever had an opportunity of observing was eleven feet in length, and the largest male nearly twelve. It is stated, however, on respectable authority, that they are frequently much larger; and Mr. Bruce reports, that they are occasionally found even of the length of twenty feet. The form of the hippopotamus is particularly awkward: its head is astonishingly large, and its body extremely fat and round; its legs are very short and thick, and its teeth are of vast strength and size: one of them is stated to weigh no less than three pounds; occasionally, each of the tusks weighs even six; the whole animal is covered with short hair; its skin is so tough, as in some parts to resist a bullet; and its colour, when dry, is an obscure brown. It inhabits the warmer latitudes, and is to be found chiefly in the interior of Africa, dwelling in the largest rivers, in which it ranges at the bottom, sometimes reaching the surface for the purpose of respiration. It sometimes quits the rivers for the sea, merely, as is supposed, for the sake of expatriating with greater freedom, as it never drinks salt water, and eats no fish, and indeed takes no animal food whatever. By night it quits the water to feed, and devours a vast quantity of grass, and the tender branches of trees. Its disposition has nothing in it sanguinary or ferocious; it never attacks other animals. It frequently commits great depredations on the plantations of corn or sugar, which are within the reach of its nocturnal progresses, and by destroying with its vast teeth the roots of trees. Its motion on land is generally not only highly inelegant, but slow; yet, if surprized and pursued, it runs with great speed till it reaches the water, into which it instantly plunges; and, though it is able to swim with great rapidity, its progress in the water is at the bottom by walking. If wounded in the water, it sometimes is highly infuriated, and has been known to attack the boats or canoes, which it supposed to contain its enemy, and overturn them by its vast strength, or sink them by making a large hole in them with its teeth. It produces but one at a birth, generally in the little rushy isles of the rivers which it frequents; and in these inlets it generally sleeps. When taken young, it is capable of being tamed. These animals are sometimes seen in considerable numbers, ranging for several miles beyond the banks of their rivers. They are often shot by the Africans, and frequently taken by the harpoon; pitfalls also are sometimes dug for them. They are valued by the natives of Africa for food, and the fat which it supplies is supposed to be equal to that of the hog. The feet are highly gelatinous, and regarded as a peculiar delicacy. With their skins the warriors of Africa are furnished with shields and bucklers. The grand motive to destroy these animals, however, is the value of their tusks, which are whiter than those of the elephant, and retain their original clearness and beauty. They are likewise of a harder consistance, and are, on both these accounts, preferred by dentists, for artificial teeth, to every other substance.

In the Ædileship of Scaurus a temporary lake was formed, into which he introduced four crocodiles and a hippopotamus, for the entertainment of the Roman people; and Augustus, in his triumph over Cleopatra, amidst many other objects characteristic of Egypt, exhibited a hippopotamus. In Upper Egypt, and in the fens of Ethiopia, traversed and inundated by the Nile, these animals are more particularly abundant. Only one species is known to exist, but the celèbrated Cuvier has discovered the fossil remains of two species, perfectly distinct from each other; but one of them was probably the same as the present African kind. For the Hippopotamus, see Mammalia, Plate X. fig. 2.

HIPPURIS, in botany, *mare's-tail,* a genus of the Monandria Monogynia class and order. Natural order of Inundatæ. Naiades, Jussieu. Essential character calyx a two-lobed rim to the germ; corolla none; stigma simple; seed one. There are three species.

HYRÆA, in botany, so named from Nicol de la Hire, a genus of the Decandria Trigynia class and order. Natural order of Trihilatæ. Malpighiæ, Jussieu. Essential character: calyx five-leaved; petals roundish, on claws; capsule three-celled, with three wings; seeds two, There is only one species, *viz.* H. reclinata, a native of Carthagena in New Spain.

HIRCUS, in anatomy, a part of the auricle or outer ear, being that eminence next the temple. See Ear.

Hircus, *a goat,* in astronomy, a star of the first magnitude, the same with Capella. See Capella.

Hircus is also a name, used by some writers, for a comet, encompassed, as it were, with a mane seemingly rough and hairy.

HIRTELLA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Rosaceæ, Jussieu. Essential character: petals five; filaments very long, permanent, spiral; style lateral; berry one-seeded. There are three species.

HIRUDO, the *leech,* in natural history, a genus of the Vermes Intestina class and order. Body truncated at both ends, oblong, unarmed, moves onward by elongating the body, and then contracting itself into an arch, adhering alternately by the head and tail. The body moves either forward or backward. There are seventeen species, principally distinguished by their colour. The most remarkable are the following:

H. medicinalis, or medicinal leech, the form of which is well known, grows to the length of two or three inches. The body is of a blackish-brown colour, marked on the back with six yellow spots, and edged with a yellow line on each side; but both the spots and the lines grow faint, and almost disappear at some seasons. The head is smaller than the tail, which fixes itself very firmly to any thing the creature pleases. It is viviparous, and produces but one young at a time, which is in the month of July. It is an inhabitant of clear running waters in Europe, and is well known for its use in bleeding. The species used in the United States is probably distinct from this.

H. muricata, or muricated leech, has a taper body, rounded at the greater extremity, and furnished with two small tentacula, or horns, strongly annulated and rugged upon the rings, the tail dilated. It inhabits the Atlantic ocean, and is by the fishermen called the sea-leech. It adheres to fish, and generally leaves a black mark on the spot.

The mouth of the leech is armed with a sharp instrument, that makes three wounds at once, and may be compared to the body of the pump, and the tongue or fleshy nipple to the sucker: by the working of this piece of mechanism, the blood is made to rise up to the conduit which conveys it to the animal's stomach, which is a membranaceous skin, divided into twenty four-cells. The blood which is sucked out is there preserved for several months, almost without coagulating, and proves a store of provision to the animal. The nutritious parts, pure and already digested by animals, have no call to be disengaged from the heterogenous substances : nor indeed is there an anus discoverable in the leech ; mere transpiration seems to be all that it performs, the matter fixing on the surface of its body, and afterwards coming off in smallthreads. Of this on experiment may be tried, by putting a leech into oil, where it keeps alive for several days : upon being taken out and put into water, there appears to loosen from its body, a kind of slough, shaped like the creature's body. The organ of respiration, though unascertained, seems to be situated in the mouth; for if, like an insect, it drew its breath through vent-holes, it would not subsist in oil, as by it they would be stopped up.

It is only the first species that is used in medicine, being applied to the skin in order to draw off blood. With this view they are employed to phlebotomise young children. If the leech does not fasten, a drop of sugared milk is put on the spot it is wished to fix on, or a little blood is drawn by means of a slight puncture, after which it immediately settles. The leech, when fixed, should be watched, lest it should find its way into the anus when used for the hemorrhoids, or penetrate into the œsophagus, if employed to draw the gums, as it would make great havoc in the stomach or intestines. In such a case, the best and quickest remedy is to swallow some salt; which is the method practised to make it loose its hold when it sucks longer than was intended.

H. sanguisuga, horse leech : elongated, olive brown, with an ochre-yellow marginal band : found in stagnant waters, ditches, and ponds : from four to six inches long : body above dull olive-black, with an ochre margin on each side ; beneath paler, with sometimes a few black spots ; tail thicker than the head. This species sucks blood with great avidity, and in large quantities. H. viridis : body depressed, oblong, green, with a transparent margin and pointed tail. This species has been described by Dr. Shaw in the "Transactions of the Linnæan Society :" it inhabits clear cold waters, is about the eighth of an inch long, and, like most of the genus, has a power of reproduction almost equal to that of the polype ; for if the animal be divided in every direction, the parts will become perfect animals, and may be again divided and again reproduced. It is of a grass-green colour, with a transparent border all round. It has since been referred to the genus Planaria. H. geometra, or geometrical leech : body filiform, greenish, spotted with white; both ends dilatable, and equally tenacious. It inhabits fresh waters : moves as if measuring like a compass, whence the name : it is found on trout and other fish, after the spawning season.

HIRUNDO, the *swallow*, in natural history, a genus of birds of the order Passeres. Generic character : bill short, depressed at the base, small at the point, and a little bending ; nostrils open ; tongue short, broad and cleft; wings long ; legs short ; tail, in general, forked. These live almost perpetually in the air, and perform in it every act of their nature. They subsist upon the insects with which that element abounds, and which they catch on the wing with the most admirable dexterity; and for this purpose they are furnished with a most extraordinary power of distending their jaws. The service they perform to man by their incessant assiduity in this work of destruction is not lightly to be appreciated, and those who observe the crowded population of the atmosphere through the beams of a summer evening will easily be led to believe, that, but for the interception of incalculable myriads of insects by these birds, the annoyance of man by these minute animals would be highly distressing, and perhaps almost intolerable. The celerity of this tribe of birds is truly astonishing, and that union of flexibility and speed which they exhibit in pursuit of their prey, or with which they elude the grasp of their enemies, is highly remarkable and interesting. Their manners are eminently entertaining and social. They fix their nests to the habitations of man, and are not only extremely useful in some respects, but perfectly inoffensive in all. Though so much within the observation of man, some circumstances of their economy have hitherto completely baffled the curiosity of the most vigilant observer. Various opinions have been formed of the state in which they exist during the time of their disappearance; some imagining them to lie torpid, in the banks of rivers, or in decayed trees, or in ruined edifices, or vaults; and others that they retire for the winter from the air to the water, lying in immense clusters, like swarms of bees, at the bottoms of rivers. But this notion can no longer deceive; its absurdity has been demonstrated by several naturalists who have observed for themselves, and not depended upon the vague accounts of the ignorant. It is indeed surprising how this story could possibly have gained belief, and a belief so general as it certainly has commanded, that the swallow, whose powers of flight are equal to those of any other bird, and whose delicate organization is so unequivocally intended for the air, should, at the approach of the rigours of winter, precipitate itself into the water, and burrow in the mud. By future naturalists it will be regarded as a proof of the credulity of the times, and will be told with as little gravity as we now observe in relation to the imputed origin of the Barnacle Goose. That nature does not in this instance deviate from her ordinary laws has been sufficiently proven, and the fact is satisfactorily established, that they regularly migrate in search of congenial climates. They have frequently been seen by mariners at a vast distance from land, and in very numerous flocks, and have occasionally converted the rigging and yards of vessels into resting places, which have most conveniently relieved their long and wearisome flight. Mr. Pearson, of London, after one unsuccessful experiment, was enabled to preserve swallows throughout the winter, taking extreme care to guard their feet from damp and cold. They were in good health, sang with vivacity, and accomplished the process of moulting soon after Christmas, without any particular inconvenience, and for three successive years exhibited the same vigour, health, and animation. From this experiment it might be presumed, that swallows experience no particular deviation in constitution and propensities from other birds, and quit this country towards winter for one where they may enjoy a milder climate, and more plentiful food. They are to be met with in every country of the world, and in all, or nearly so, are found to be migratory. There are thirty-seven species, of which we shall notice the following.

H. rustica, or the house-swallow, appears in March, in England, and leaves it in September. It generally builds in chimneys, or under the eaves of houses, and will return, unless interrupted, to its original haunt for a number of years. For three years in succession a pair of swallows built on the frame of an old picture in Camerton Hall, near Bath, having access to the apartment through a broken pane in the window. These birds breed twice a year. They are easily rendered familiar; and it has been calculated, from what occurred in a curious and extraordinary instance of the domestication of one of them, in the family of a gentleman in Northumberland, that a single swallow will devour from seven hundred to a thousand flies in one day. See Aves, Plate VIII.

H. urbica, or the martin, arrives in England rather later than the swallow, and remains longer. It builds often in the crags of rocks, near the sea; often under the eaves and cornices of houses. As soon as the young are able to fly, they are fed by the old birds upon the wing, by a process so rapid and instantaneous, as almost to be deemed incredible by those who have not actually witnessed it. Before their departure they collect in immense flocks in the small islands of the Thames, where they roost, and in their flights about which they almost obscure by their numbers the face of the sky. It is observed, that in comparison with the multitudes which depart, there are extremely few which return. See Aves, Plate VIII. fig. 3.

H. apus, or the swift, arrives in England later, and quits sooner, than any other species, and is also larger and stronger. It builds in elevated situations, particularly about churches and steeples. As these birds catch at almost every thing in the air, they are taken sometimes by a cockchaffer, or other insects, tied to a thread. In the Isle of Zante this torturing amusement is practised on them by boys, who catch them indeed often in immense numbers by a string and feathered hook only, which they suspend from some elevated situation. They retire during the heat of the day; but in the morning and evening are incessantly on the wing, taking higher and bolder flights than the swallows, and always keeping separate from them. They leave that island in August. See Aves, Plate VIII. fig. 4.

H. esculenta, or the Chinese swallow, is said to be less than the wren by some authors, while others attribute to it the size of the martin. This bird is principally remarkable for its nest, which, singular as it may appear, is not only used for food, but regarded as one of the greatest luxuries on which the genuine epicure can possibly banquet. The weight of this nest is about half an ounce: it is formed in the shape of a half of a lemon, and composed of many easily discriminated layers of a substance somewhat resembling isinglass. The materials which constitute it have been the subject of considerable diversity of opinion, and are not yet (at least in this country) ascertained. It is chiefly applied in soups and ragouts, made of chickens, and mixed with a considerable quantity of ginseng.

Mr. Wilson describes a new species, inhabiting the United States, under the name of viridis, or green-white bellied swallow: it is greenish above, with the wings and tail brownish-black, all beneath pure white. Besides this there are four other species.

H. Americana, rufus-rumped, or barn swallow, of which the rump and vent feathers are rufous

H. purpurea, entirely violet, tail-forked, attacks and drives from its haunts larger birds.

H. riparia, bank, or sand swallow, cinereous, chin and belly white: builds in holes in gravel pits and banks of rivers.

H. pelasgia, aculeated, or chimney swallow, tail feathers of equal length, naked and subulated at the end.

HISPA, in natural history, a genus of insects of the order Coleoptera. Antennæ cylindrical, approximate at the base, and seated between the eyes; feelers fusiform; thorax and shells often spinous or toothed at the tip. There have been twenty-six species enumerated and described. They are separated into three divisions: A. lip horny, entire. B. lip membranaceous, subemarginate. C. lip membranaceous, entire. H. atra is the chief species known in England, found at the roots of long grass. It is of a deep unpolished black, and has the upper part of the body entirely covered with long and strong spines, which render it similar to the bristly shell of a chesnut, or to a hedge-hog in miniature. The larva of the hispa is unknown.

HISTER, a genus of insects of the order Coleoptera. Antennæ clavate, the club solid; the last joint compressed, decurved; head retractile within the body; mouth forcipated; shells shorter than the body, truncate; fore-shanks toothed, hind-shanks spinous. There are twenty-four species, usually found in putrescent animal substances, or under the bark of decaying trees. The most common European species of the hister genus is H. unicolor, which is of a glossy coal-black colour, and of a slightly flattened shape. It is often seen in the gardens, but its larva is unknown.

HISTORIOGRAPHER, a professed historian, or writer of history. An historian, of all authors, spreads the most ample theatre; he erects the greatest tribunal on earth, for it is his office to sit supreme judge of all that passes in the world, to pronounce the destiny of the great ones of the earth, and fix their character with posterity; to do justice to virtue and worth, in bestowing eternity upon great and good actions, and fixing an everlasting mark of infamy on bad ones; to instruct all people and nations, and direct the conduct of ages; he therefore ought to be endowed with many great and uncommon qualifications. He must be a person of consummate knowlege of men and things, of sound judgment, uncommon sagacity and penetration, experienced in matters of state and war, of great integrity, firmness of mind, freedom of sentiment, and master of a pure, clear, nervous, and exalted style. An historian, whose province it is to speak to kings and princes, to the great men of all ages and countries, and to be the common master and instructor of mankind, must not only write with purity, simplicity, and manly sense, but with dignity and elegance; he must reject all that is vulgar and low in style; make the majesty and sublimity of his expression comport with the dignity of his subject; must, by an exact choice and propriety of words, a natural disposition of phrases, and a prudent moderate use of figures, give weight to his thoughts, force to his language, and imprint a character of greatness on all that he says. He must at the same time represent things with an air of gravity and prudence, and not give a loose to the heat of imagination, or vivacity of wit; but discreetly suppress every thing that shall seem idle, languid and unprofitable, and give every thing that just figure and proportion which is consistent with propriety and decorum. He must endeavour at a noble simplicity of thought, language, design, and ordinance, and carefully avoid all profuseness of false conceit, strained expression, and affected pompousness, so inconsistent with the gravity, dignity, and noble character of history. In a word, he must write so as to be intelligible to the ignorant, and yet charm the wise; form and express such ideas as are great, and yet shall appear very common, and intermix no other ornament with his narration than what the modesty of truth can bear. He should be above the reach and power of hopes and fears, and all kinds of interest, that he may always dare to speak the truth, and write of all without prejudice; religiously observing never to abuse the public faith, nor to advance any thing upon common fame, which is always uncertain, but upon undoubted memoirs and faithful relations of such persons as have had a hand in affairs. He must always be upon his guard against the bias and affections of those who supply him with matter, and must not credulously give his assent to the historians that went before him, without inquiring narrowly into their character, and what influence they may have been under when they wrote, in order to make a just estimate of their weight and credit.

An historian, as to his matter, should choose subjects great in themselves, and such as are worthy of public fame and remembrance; and should make himself so far master of his matter, as to be able to cast it into what form he pleases, and to strike upon all his subjects the colours they are naturally disposed to bear, in order to make his lessons profitable to posterity, by regulating the heart and spirits of men, animating them to great and virtuous actions by illustrious examples, and cautioning them against vice, folly, cruelty, and injustice, by laying open the fatal consequences resulting from them, The course of his narration must proceed in the order of time in which the facts happened, in a pure, grave, uninterrupted series, such as may not improperly be compared to a great river flowing with composed majesty and stately smoothness; and when it falls in his way to introduce little occurrences, they must be so artfully interwoven with the great, in the thread of the narration, as to offer a seasonable entertainment and relief to the reader, from the fatigue that too sedulous an attention to the great requireth. He must also observe great judgment in the ordinance and disposition of events and their circumstances, so as to interest the reader, and let him into all his thoughts and views, by making his persons act as their character and temper inclined them; discovering their manners, sentiments, designs, motives, and operations, as they really stand in a nenessary dependence upon each other, and with so natural a connection, as to show nothing out of its place. His transitions, in which consists the great art of narration, and one of its principal beauties, must be natural and easy, arising from the difference of subject rather than expression. He must make a wise and judicious choice of circumstances, such as are proper to enlarge and improve the ideas of things, and to strike that light and colour upon them, which most easily attracts belief and engages the mind; and must for that purpose always observe a due mixture of great and little circumstances, neither of which must be carried beyond nature, or be so minute, low, or frivolous, as to debase his subject. He must not only recite the bare events and actions of men, but also lay open the motives and principles from which they took their rise, and upon which they proceeded to their final issues. He must lay open the hearts of the actors, let his reader into the most important secrets of their councils and designs, and oblige him with a sight of those secret springs which moved them to enterprises, and of the causes of their success or miscarriage. He must be very sparing and cautious in the use of descriptions, which are to be introduced so far only as they serve to illustrate things that are essential to the main subject, and to enliven the narration: and even in that case they must be succinct and elegant. The frequent use of harangues are disapproved of by many judicious persons; for these long formal harangues of generals to their soldiers, when in the presence of the enemy, and ready to enter upon action, which we find in many historians, are undoubtedly not only unnatural and improbable, but contrary to the truth of history. Nevertheless, a short speech, suited to the subject, made by a person of eminent character, has its proper beauty, and animates a narration. A judicious historian ought not to admit any portraits into his work but those of the greatest persons, and such as are principally interested, and have the chief hand in affairs; and these must be real, natural, and truly resembling their originals; expressive of their genius, the qualities of the head and heart, rather than descriptive of the external form of his personages. When such are finished with a masterly hand, with true judgment and success, they are not only great ornaments and embellishments in history, but of use to strip the hearts of men of their disguises, to lay open all their secret folds, and disclose the real springs of actions. It is a great fault in an historiographer to abound too much in reflections of his own;

he therefore must not turn philosopher or moralist indifferently upon all occasions; for every man desires to be free in his judgment of the facts represented to him, and the consequences he is to draw from them, in which consists the greatest pleasure of the reader. But if an author should throw in or mingle reflections of his own with his story, they must be such as arise naturally from the subject, and contain a great and noble sense in a few words; they must not be too fine spun or studied, nor have more brightness than solidity, but appear rather to be the reasoning of a wise statesman than the affectation of a declaimer; nor must they be too frequent, or too loose and disjointed, but be enamelled in the body of the work. Digressions, if made with judgment, and not too wide and foreign from the subject, have also their proper grace and ornament in history; as they give an agreeable variety to the narration, and relieve the mind of the reader; but they must be introduced by the historian with an artful hand and great address; they must bear an alliance and connection with the purport of the history; and their length must be proportionably greater or less, as they are more nearly or remotely allied to the capital point of the story.

HISTORY is a connected recital of past or present events.

If the value of each department of knowledge is to be ascertained by the esteem in which it is held by the generality of readers, a place of distinguished honour must be assigned to history. Gratifying that curiosity, which is innate in the mind of man, it is equally delightful to those whose intellect is just dawning, and to those whose faculties are matured by the lapse of time and the process of cultivation. Comparateively, few have a relish for abstract speculations; but almost all are delighted by the display of facts. By the pictures which are exhibited in a faithful narration, the fancy is gently excited, and the feelings are interested, without being agitated to a degree inconsistent with pleasure. If then we consider history only as a source of elegant amusement, it is an object of no inconsiderable importance in a course of liberal education.

But this is in fact the lowest commendation to which history is entitled. It is eminently productive of signal utility. The poet has justly remarked, that "the proper study of mankind is man;" and it is the office of history to trace the progress of man from the savage state, and through the intermediate degrees of civilization, to the nearest approach to perfection of which social institutions are capable. It falls within its province to note the effects of laws and political regulations, and to record the wondrous revolutions which have been produced in states by external violence, and the no less astonishing changes which have been occasioned by the gradual corruption of ancient systems of government. The record of past transactions, when diligently and minutely examined, will present to the politician matter of warning and matter of instruction. It will point out the sources of the errors of former days, and will also lead him to a discernment of the means which have crowned with success such plans as have been productive of benefit to the public. Knowledge which is thus gained is obtained at the cheapest possible price. Happy are the directors of political affairs, who learn, in the philosophy of history, those lessons which their predecessors have learnt by the process of painful experience. It has been well observed by Voltaire, that the history of the sanguinary Chrstiern will deter those, whose influence may happen to sway the destiny of nations, from investing a tyrant with absolute power; and that the disaster of Charles XII. before Pultowa affords a lesson of admonition to a general, not to penetrate without provision into a country like the Ukraine; whilst the powerful and popular administration of Elizabeth of England demonstrates the mighty effects of extended commerce, and prudent economy. In a political point of view, the general influence of historical knowledge, is, indeed, of the highest importance; it tends to prevent the recurrence, and to diminish the remaining influence, of superstition and religious persecution, and of the long train of calamities with which those direst enemies of human happiness are accompanied. For who can read the memorials of the papal usurpations in the dark ages, and of the melancholy consequences by which they were followed, without imbibing a spirit of tolerance, and a determined disposition to discountenance any claims which may revive the unjust assumptions of inordinate spiritual power. In short, history, whilst it details the miseries and misfortunes which have upon various occasions befallen civilized man, instructs him how these miseries and misfortunes may hereafter be avoided.

In a moral point of view, history is extremely useful, as it points out the issues of things, and exhibits, as its general result, the reprobation consequent upon vice, and the glory which awaits virtue. In his days of nature, the oppressor may be applauded by the venal, whilst he lords it over his fellow men, and the wanton destroyer of the human race may be hailed as a hero by the obsequious or mistaken crowd. But when his dust is mingled with that of the victims of his cruelty and ambition, history summons him to her tribunal: she scrutinizes his deeds with impartial strictness, and passes sentence upon him according to his deserts. The prejudices and errors of time present will hereafter be done away and corrected by history, which redresses the wrongs of the injured, and treats with just contempt the insolent assumption of the undeserving. Thus, by the record of crimes, no less than by the display of illustrious examples of virtue, does history inculcate good principles, and enforce upon the reflecting mind a belief in a superintending Providence.

The early annals of all countries are considerably debased by an intermixture of fables. In fact, the first historians were universally poets, whose metaphors, amplifications, and allegories, necessarily obscured facts, or heightened them beyond the standard of probability. To explain their legends is the province of the mythologist, whose labours, however curious and interesting to those who have time and inclination for such pursuits, afford very little assistance to the historian.

But the mythologic age being thus consigned to the examination of those whom they may concern, however rude may be the style of ancient chronicles, or however simple and puerile the observations and reflections with which they may be interspersed, he who wishes to imbibe the true spirit of history will diligently peruse them, when they become the repositories of facts. Such documents alone will give him an idea of the genius of the times concerning which they treat. He who wishes to become acquainted with the principles and manners which predominated in France, in the reign of St. Louis or of John, will read the lively and simple, but minutely particular, narratives of Joinville and of Froissart, rather than the dull details of a Daniel, or the hasty and imperfect sketch of a Millot. In all cases, indeed, he who wishes to see past events in their true light will refer as much as possible to original authorities. The farther the stream of history flows from its source, the more it is polluted by foreign mixtures. And besides this, however skilful, or however faithful, a compiler may be, his particular views lead him to pass unnoticed a variety of facts, which are in themselves valuable, and indeed necessary to the perfect understanding of the real nature and bearings of events.

This maxim of having recourse to authentic documents will furnish a canon for the most profitable mode of studying ancient history. It will instruct the student to pass lightly over those periods of the Greek and Roman annals, the transactions of which were handed down by tradition to authors, who, instead of scrutinizing their credibility, have amplified and embellished them by the charms of style; and to direct his attention to the records which have been written by those who lived at the time when the actions which they commemorate took place, and more especially to the memoirs of illustrious warriors and statesmen, who have left behind them the detail of transactions in which they have been personally concerned. Guided by this principle, he will not dwell upon the marvellous tales of an Herodotus or a Quintus Curtius; but he will study with diligence the narratives of a Thucydides or a Xenophon, of a Sallust, a Cicero, a Cæsar, or a Tacitus; and whilst the legend of Curtius, as recorded by Livy, only demonstrates to him the posthumous glory, which, in the happier times of the Roman republic, awaited him who was ready to sacrifice his life for the good of his country, he will peruse, with more interest, the later periods of that writer's history, in which he treats of events which happened nearer to his own time, and the genuine records of which were, in all probability, furnished to him by the public offices of the state.

In regard to the earlier periods of modern history, authentic documents are scanty and obscure, and the investigator of the truth of facts is frequently obliged, as it were, to proceed with cautious steps through a dark and doubtful way; but, in process of time, they multiply to such an extent, that the student is embarrassed by their number. The archives of the different states of Europe contain vast masses of materials, which occasional liberality has opened to the curious inquirer. On the important topic of ecclesiastical proceedings, the printed reports of the decrees of councils and synods throw the most satisfactory light. Voluminous collections of treatises, which have been compiled for the benefit of after times, open the policy of different states and empires; and in various cases, those documents are themselves illustrated by the comments and memoirs of the negociators, by whom they were discussed and finally arranged. The confidential correspondence which took place between scholars, at the revival of letters, frequently contains political details which are highly instructive and interesting. In later days, the publication of the various memoirs and state papers of ministers, to whom the conduct of the affairs of nations has been entrusted, reveal all the springs of their policy, and enable the reader of research to follow them through all the windings of the labyrinth of intrigue.—The acts of the British parliament, in themselves, contain a record of the political changes which have taken place in this country, of our progress in commerce, of the gradual amelioration of our constitution, amidst the struggles of party and the contentions of faction. The recorded proceedings of our courts of law, also, supply the means of judging of the public conduct of our statesmen. It may be with truth asserted, that the perusal of the state trials can alone give an adequate idea of the horrible crimes, which, under the colour of justice, were perpetrated by the different parties which divided this kingdom in the reign of Charles II. In short, there hardly exists in any country a public office, or a private collection of papers, which does not contain documents that are calculated to throw light upon history.

The student, who wishes to pursue his historical inquiries with becoming accuracy, must make himself master of the details of geography, and of the principles of statisticial calculations; must moreover be versed in all the minutiæ of chronological researches. In the settling of dates, he will at once evince his labour and his ingenuity. For the correct arrangement of the order of events, he will not shrink from the task of poring over pedigrees, or examining coins.

It has been well observed, by the profound Pinkerton, that, by the study of medals alone, Vaillant "was enabled to ascertain, in a very grear degree, the chronology of three important kingdoms of the ancient world, namely, those of Egypt, of Syria, and of Parthia."

Such are the principal sources from which may be derived a knowledge of historic truth. To enumerate all the materials of history would be an almost endless task; but in order to make due profit of these materials, wherever they may occur, the student ought to be animated by the spirit of philosophical inquiry.—"Incredulity," says Aristotle, "is the foundation of all wisdom." Without the gift of discrimination, the historian degenerates into a chronicler of fables; without the faculty of deducing useful consequences, he is degraded into a registrar of barren facts. To distinguish truth from falsehood in the obscure records of former times, or amidst the misrepresentations of factious malignity in more modern periods, requires no small degree of sagacity. Voltaire has justly observed, that in order to be qualified to seize the proper objects of history, a man must not be acquainted with books alone. He must have a minute knowledge of the human heart, and be qualified to analyze the prejudices and the passions of men. He will give due weight to circumstances and situations. He will not estimate the character of a despot by the panegyric of a courtier; nor will he pass sentence of condemnation on a prince, who has resisted ecclesiastical claims and restrained the power of the clergy, because he is vilified in the chronicles of a monk.

The enlightened student of history will not direct his chief attention to the frivolous anecdotes of a court, but to the circumstances which stamp the character and decide the destiny of a nation. He will inquire what has been its radical vice or its predominant virtue; why it has been powerful or weak by sea or land; what has been the improvement or the deterioration of its trade and commerce; wherein consist the excellencies and the defects of its civil and municipal institutions; what have been the constitution, and what the influence of its ecclesiastical establishments. He will trace the introduction of arts and manufactures, and observe the changes which have taken place in manners and in laws.

Such are the materials and such the objects of history, than which, next to our relation to the deity, no more important topic of inquiry can be presented to the human intellect.

HITCH, in the sea language, is to catch hold of any thing with a hook or rope, and by this means to hold it fast: thus, when a boat is to be hoisted in, the sailors say, "Hitch the takles into the ring-bolts of the boat;" and when they are about to weigh anchor, "Hitch the fish-hook to the fluke of the anchor."

HIVE, in country affairs, a convenient receptacle for bees. See Bee.

HOD, an instrument used to carry bricks and mortar in, up ladders, &c. to build or repair houses, &c. with.

HODMAN, an appellation given to a young student admitted into Christ's

College, in Oxford, from Westminster school.

HOE, in country affairs, a tool made like a cooper's adze, to cut upwards in gardens, fields, &c. This tool is commonly called the hand-hoe.

HOFFMANNIA, in botany, so named in memory of Maurice Hoffman, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: calyx four-toothed; corolla salver-shaped, four-parted; filaments none; berry two-celled, many-seeded. There is only one species, *viz.* H. pedunculata, a native of Jamaica.

HOG. See Sus.

Hog, *hedge*. See Erinaceus.

HOKE, *day*, the Tuesday after Easter week, which was the day on which the English conquered and expelled the Danes; this was therefore kept as a day of rejoicing, and a duty, called Hoke Tuesday money, was paid to the landlord, for giving his tenants and bondmen leave to celebrate it.

HOLCUS, in botany, a genus of the Polygamia Monoecia class and order. Natural order of Gramina or Grasses. Essential character: hermaphrodite, calyx glume, one or two-flowered: corolla glume, awned; stamina three; styles two: seed one: male, calyx glume, two-valved; corolla none; stamina three.—There are fifteen species. One of these, the Holcus bicolor, is cultivated in some parts of the United States, for making a kind of beverage as a substitute for chocolate. The following account of this species we take from a paper written by the Professor of Botany in the University of Pennsylvania, and published by order of the Philadelphia Linnæan Society:

Some account of the Holcus Bicolor, read to the Philadelphia Linnæan Society, by the president, Professor Barton.

During a late visit to Lancastsr, I learned that the German inhabitants of the Manor, in the county of Lancaster, near the Susquehanna, cultivated a plant, from the seeds of which they made a kind of beverage, resembling, in colour, taste, and nutritious qualities, common chocolate. The first accounts I had of this beverage were received from Dr. Eberle, and William Barton, esquire, of Lancaster. The latter informed me, he had drank it once or twice, and that a member of his family had breakfasted on it, supposing it to be chocolate, without perceiving the deception.

From the information I received, respecting the stature, growth, and habit, of the plant, I supposed that it was a species of Sorghum. Learning, however, that a quantity of the plant was growing in a neighbouring garden, I procured a few specimens of it, together with a quantity of the seeds, then sufficiently ripe for use. I found the plant belonging to the genus *Holcus*, but having no books with me by which I could ascertain the precise species, I brought the specimens to Philadelphia, and after carefully comparing them with the descriptions of the different species of *Holcus* in Willdenow's work, I find that it is the *Holcus bicolor* of that author, and was known to Linnæus.—(Vide *Mantissa*, 301.)

The generic character of Holcus, according to the Gen. Plant. is as follows:—Holcus. Hermaph. *Cal. Gluma* 1-sive 2-flora. *Cor. Gluma* sub apice aristata. *Stam.* 3. *Styli* 2. *Sem.* 1.

Masculi. *Cal. Gluma* 2-valvis. *Cor.* 0-s. 2-valvis. *Stam.* 3.

And, according to Pursh:

Holcus. *Cal.* 2-valvis. *Cor.* minor: valv. altera aristata. *Nectar.* 2-partitum. *Polygamum.*

Linnæus, Willdenow, Muhlenberg, and others, have thrown the genus Holcus into *Polygamia Monœcia;* but Michaux and Pursh have referred it to *Triandria Digynia,* where it truly belongs, and also to Jussieu's "*Gramineæ.*"

The following is Willdenow's description of that species of Holcus, which is the subject of this paper:

Holcus bicolor.

H. glumis glabris nigris, seminibus globosis albis aristatis. Man. 301.

H. glumis glabris; Hort. Cliffort. 468.

H. (Sorghum) panicula coarctata ovali erecta, locustis hermaphroditis obovatis, pene glabris, subaristatis. Mieg. Act. helv. tom 8. p. 129. t. 4. f. 4.

Milium arundinaceum, subrotundo semine, sorgho nominatum. Bauhin. pin. 26. Morris. hist. 3. p. 196. s. 8. t. 5. f. 7.

Habitat in Persia. D. Lerche. ⊙. H. V. Zweyfarbiges Pferdegras W.

Similimus *Holco Sorgho,* distinctissimus calycibus atris et seminibus niveis.

The method of making the beverage, which has a real or a fancied resemblance to chocolate, is this:—The seeds, which are farinaceous, together with the glumes, or, as they are commonly called, husks, which are persistent and black—are ground in a common coffee-mill, into grains somewhat smaller than ground coffee. This coarse farina is then boiled over a slow fire, with the addition of a sufficient quantity of milk, and a small piece of butter, until the beverage assumes a chocolate colour, which it receives from the colouring matter of the husks. The liquor should be then strained through gauze, sweetened till palatable, and brought to table for use. I have drank it thus made, except that it was unstrained; and though I could perceive no taste resembling chocolate, yet it was a beverage quite savoury and pleasant.

To make *four pints* of a pleasant, nutritious, and, I presume, a wholesome beverage, to serve as an economical article of diet, in lieu of chocolate, tea, or coffee,—the expense may be calculated as follows, viz.

	cents.
For 4 oz. of the *chocolate-meal* (or flour made from the seed of the *Holcus bicolor*, at 5 cts. per lb.)	$1\frac{1}{4}$
$2\frac{1}{2}$ ditto of sugar, at 16 cts. per lb.	$2\frac{1}{2}$
1 ditto of butter, at 20 cts. per lb.	$1\frac{1}{4}$
1 pint of milk, at	3
3 pints of water	0
	8

The proportions of the several articles here mentioned are to be boiled together, and in such quantities as may be required. When sufficiently boiled, and just before it is taken from the fire, the butter is to be well stirred up with the boiling liquor—it is then fit for use. The proportions of the materials may be varied, so as to suit different palates; but the above are agreeable to the directions given to Mr. William Barton, by the person who furnished him with the seed.—"In makin the experiment with the *Holcus* in my family," says Mr. Barton; "the seed were ground in a common coffee-mill; but as they could not be ground fine enough in this way, nor their *farina* be sufficiently disengaged from its integument or husk, too much of a coarse bran was deposited in the liquor, after boiling. The kind of grinding performed by the trituration of mill-stones would make a better meal; and I should much prefer bolting it, after being ground in a proper corn-mill, to straining the liquor when boiled, in order to separate the coarsest of the bran from the *farina* of the seed."

The plant in question resembles common *broom corn* very much. It is eight or ten feet in height—is an annual, of rapid growth—and requires no particular care in its cultivation. The leaves are long, channelled, nerved, and sheathing the stem. The fruit, and, of course, the inflorescence, which I have not seen, is borne in a terminal, close and compact panicle, of an oblong-ovate form; in this respect differing widely from sorghum saccharatum, or common broom, the pannicle of which is diffuse and spreading. It differs also from the broom in the colour of the husks, they being in the *chocolate broom* (for so I shall call the plant in question in want of a better name) of a deep shining black colour, and glabrous; and in the common broom of a reddish-brown hue, and pubescent, sometimes even hairy. The seeds are white, roundish, and hard, enclosed in shining black husks.

Holcus bicolor is a native of Persia. It is unqestionably not a native of any part of the United States, or even of North America; though Prush says, that *sorghum saccharatum*, which is nearly allied to it, is sometimes found wild in our country.

This plant thrives perfectly well in Lancaster county; and will, probably, grow equally well in most parts of the United States. I conjecture, from its appearance, that, when mature, a single stalk will yield about a pint of seed. I will attempt an estimate, then, of the quantity of seed that may be procured from one acre of ground, planted with the *Holcus;* by which it will appear, that it is not an unprofitable product.

Supposing an acre planted in rows or lines, three feet apart, so as to produce one stalk only in a hill,—and at the same distance from one another, along each row;—the number of plants will, in this case, be 4840: and calculating that each plant will yield a pint of seed, the product of an acre will be $75\frac{5}{8}$ bushels. I have no means of ascertaining, just now, what quantity of meal (or flour) could be made from a bushel of seed, on separating the farinaceous parts from the rest, by grinding and bolting in the common mode: but I will suppose, that not less than 15lbs. of meal, sufficiently bolted from the bran, would be obtained, clear of the toll,—from a bushel of the seed. At this rate, an acre would yield $1134\frac{3}{8}$lbs. of the flour or meal, which, if valued at only 5 cents per lb. would produce $56.72. There can be little doubt that the trouble and expense of cultivating an acre of the *Holcus* would be amply compensated by the value of the plant as fodder for cattle, when stripped of its seed, dried, and housed; and, perhaps, some useful vegetable might, besides, be planted or sown between the rows. The net profit, therefore, of cultivating this plant would be not less than $56.72 per acre.

The seeds which produced the specimens, now before the society, were procured from the Manor, in Lancaster county, where the plant is said to be much cultivated, and the beverage a good deal in use. How the Germans of that settlement became acquainted with the plant, or from whence they received the original seeds, I had no opportunity of learning. Should I visit Lancaster in the course of the next summer, I will endeavour, by personal inquiries at the Manor, to become possessed of the knowledge of these interesting particulars.

At present I have given all the facts concerning this vegetable, with which I became acquainted. It appears to me, first:—That as the plant is readily cultivated, is hardy, and produces plentifully, it is worthy of some attention, on account of the farina yielded by its seed. This is sensibly mild and mucilaginous, upon mastication, and may consequently prove extremely nutritious. Secondly: That, as it is proved to yield a pleasant beverage, with the addition only of a little butter to those articles which are necessary to render coffee, tea, and chocolate palatable—it might, from the ease with which it is propagated, be rendered, by being well known, a cheap and nutritious substitute for tea, coffee, or chocolate, at the tables of the country-poor, and those residing in country towns and villages, where each hut, however miserable, is generally furnished with a tolerable-sized garden plot.

I believe that a single plant will yield seed enough to produce, by the second year's crop, a sufficiency of flour to furnish a poor family, of six or eight persons, one entire year, with a good and nourishing substitute for the meagre and unhealthful liquors used by them, under the names of tea and coffee.

For 8 cents, as much of the liquor, here described, may be prepared from them, as, with a due proportion of bread—to the value, perhaps, of twelve cents—will constitute a good and nutritive breakfast, or supper, for four grown persons; being at the rate of five cents for each person.

I do not, however, profess myself competent, at this time, to offer more than conjecture on these points. I have made no experiments with the plant as yet, to ascertain the proportions of mucilage and farina contained in the seeds; but have merely thrown thus hastily together, a few facts and hints, which may perhaps prove indirectly serviceable to the poor and the peasantry.

I take the liberty of recommending the plant to the attention of surgeons, and commanders of navy-yards, forts, or barracks, for to all such posts a sufficiency of ground generally appertains to admit the cultivation of enough to supply the sailors, marines, or soldiers, with an occasional meal of a grateful, and, I believe, a healthful beverage. My experience, both in the navy and army practice, induces me to believe, that the diet of seamen, marines, and soldiers, cannot be too strictly attended to, in order to preserve their health and vigour; and when an opportunity is presented of furnishing all those on shore stations, and in barracks or garrisons, with a comfortable vegetable diet like the one above-mentioned, and that too without any cost, it should certainly not be suffered to pass without at least a trial.

P. S. The calculations in the preceding paper, as to the quantity of meal a bushel of the seed would produce, is probably 100 per cent. lower than they should be.

HOLD, that part of a ship which lies between the keelson and the lower deck; in which, divided by bulk heads, are the steward's-room, powder-room, bread-room, and the boatswain's and carpenter's store-rooms. In a merchantman, all the goods and lading in general are stowed in the hold.

HOLD-*fast*, a large piece of iron, in the shape of the letter S, fixed into a wall to strengthen it. Also a tool used by joiners, carvers, &c. which goes through their benches, to hold fast such work as cannot be finished by its being held in the hand.

HOLLAND, in commerce, a fine and close kind of linen, so called from its being first manufactured in Holland.

HOLLOA, in sea language, an exclamation of answer to any person who calls to another to ask some question, or to give a particular order: thus, when the master means to give any order to the people in the main top, he previously calls "Main-top hoay," to which they answer, "Holloa," to show that they hear him and are ready. It is also the answer in hailing a ship at a distance. See HAILING.

HOLLOW *square*, in the military art, a body of foot drawn up, with an empty space in the middle for colours, drums, and baggage.

HOLLY. See ILEX.

HOLOMETER, a mathematical instrument that serves universally for taking all measures, both on the earth and in the heavens.

HOLORACEÆ, in botany, the name of the twelfth order in Linnæus's "Fragments of a Natural Method," consisting of pot-herbs, or plants used for the table, and entering into the economy of domestic affairs. This order is separated into two divisions. 1. Hermaphrodite plants. 2. Male, female, androgynous, and polygamous plants. This order contains trees, shrubs, and perennial and annual herbs; some of the woody vegetables, as the bay, retain their green leaves during the winter; the roots are long; the stems and young branches are cylindric. In the greatest part of the aquatic plants of this order, the stalks are hollow within; the buds are of a conical form; the leaves are generally simple, alternate, entire, and attached to the branches by a cylindric foot-stalk, which is sometimes very long, but generally short.

HOLOSTEUM, in botany, a genus of the Triandria Trigynia class and order. Natural order of Caryophyllei. Essential character: calyx five-leaved; petals five; capsule one-celled, subcylindrical, opening at top. There are five species.

HOLOTHURIA, in natural history, a genus of the Vermes Mollusca class and order. Body detached, cylindrical, thick, naked, and open at the extremity; mouth surrounded by fleshy branched tentacula or feelers. These are all inhabitants of the sea, and expand or contract themselves at pleasure; the anterior aperture serves them both as a mouth and vent, and from the hinder one they reject waters which had been previously drawn in; the tentacula are retractile. There are twenty-three species. H. pentactes, or five-rowed Holothuria is noticed by Pennant. It has an incurvated cylindric body, marked with longitudinal rows of papillæ; out of the centre of each issue at pleasure, slender feelers like the horns of snails; the upper extremity retractile; when exerted it assumes a cordated form, surrounded at the apex with eight tentacula, elegantly ramified, of a yellow and silver colour. It is found on the shores near Penzance. H. tremula is a foot long, inhabits the Mediterranean and Adriatic seas; the body is cylindrical when extended, and oblong when contracted; it is various in colour, but generally of a beautiful mixture of red and white; the cylindrical tubes beneath the body act as so many suckers, by which the animal fixes itself firmly to the bottom of the sea. Another curious species noticed by Gmelin is H. denudata, is oblong, with interrupted lateral lines, and without a crest or tail, inhabits the American ocean. It is three or four inches long, with a body slowly tapering at both ends, transparent, of a firm gelatinous consistence and hollow, opening by a small triangular aperture next the crest, and a narrow round one at the other extremity; they have a spiral milky line down the back, under this another larger opaque one, and on each side below these another smaller purple one. They are sometimes found single, and frequently sticking lengthways together. The word holothuria is used by Pliny and Aristotle; but Mr. Pennant supposes they both intended, under this name, to describe those marine bodies now denominated zoophyta. Aristotle, however, seems to have admitted that they possessed animal life, a circumstance that has in modern times been completely ascertained.

HOMALIUM, in botany, a genus of the Polyandria Trigynia class and order. Natural order of Rosaceæ, Jussieu. Essential character: calyx six or seven parted; corolla six or seven petalled; stamens twenty-one, in three bodies; pericarpium one-celled, many seeded. There are two species.

HOMER, Omer, Corus, or Chomer, in Jewish antiquities, a measure containing ten baths, or seventy-five gallons and five pints, as a measure for things liquid; and thirty-two pecks and one pint, as a measure for things dry. The homer was most commonly a measure for things dry, and the greatest that was used among the Jews: it contained, according to the Rabbins, ten ephas, or thirty fata or seahs. Corus is the most usual term in the historical writers, and homer, omer, or chomer, among the prophets.

HOMICIDE, in law, is the killing of a man by a man. Of this there are several species, as homicide by self-defence, homicide by misadventure, justifiable homicide, man-slaughter, chance-medley, and murder. Homicide by self-defence, *se defendendo*, or in a man's own defence, is where one has no other possible means of preserving his life from one who combats with him on a sudden quarrel, and kills the person by whom he is reduced to such inevitable necessity. And not only he, who on assault retreats to a wall, or some such strait, beyond which he can go no farther, before he kills the other, is judged by the law to act upon unavoidable necessity; but also he, who being assaulted in such a manner, and in such a place, that he cannot go back without manifestly endangering his life, kills the other without retreating at all. And though a person who retreats from an assault to the wall should give the other wounds in his retreat, yet, if he give him no mortal wound till he get thither, and then kill him, he is guilty of homicide *se defendendo* only. But if the mortal wound were given first, then it is manslaughter.

Homicide by misadventure, is where a man is doing a lawful act, without any intent of hurt, unfortunately chances to kill another; as where a labourer being at work with an hatchet, the head thereof flies off, and kills one who stands by. It seems clear, that neither homicide by misadventure, nor homicide *se defendendo*, are felonious, because they are not accompanied with a felonious intent, which is necessary in every felony.

Homicide, *justifiable*. To make homicide justifiable, it must be owing to some unavoidable necessity, to which a person who kills another must be reduced, without any manner of fault in himself. And there must be no malice coloured under pretence of necessity; for wherever a person who kills another acts in truth upon malice, and takes occasion upon the appearance of necessity to execute his own private revenge, he is guilty of murder. But if a woman kill him who assaulteth to ravish her, it is no felony: or if a man come to burn my house, and I go out and kill him, it is no felony. So "if any evil disposed person shall attempt feloniously to rob or murder any person in any dwelling house, or highway, or feloniously attempt to break any dwelling-house in the night-time, and shall happen to be slain in such felonious attempt, the slayer shall be discharged, and shall forfeit no lands nor goods." 24 Hen. VIII. c. 5. Justifiable homicide of a public nature is such as is occasioned by the due execution or advancement of public justice; with regard to which it must be observed, 1. That the judgment, by virtue whereof any person is put to death, must be given by one who has jurisdiction in the cause; for otherwise both judge and officer may be guilty of felony. 2. The execution must be pursuant to, and warranted by, the judgment, otherwise it is without authority; and consequently, if a sheriff shall behead a man, when it is no part of the sentence to cut off the head, he is guilty of felony.

Homicide, *manslaughter*, against the life of another, is either with or without malice; that which is without malice is called manslaughter, or sometimes chance-medley, or chaud-medly, by which is understood such killing as happens either on a sudden quarrel, or in the commission of an unlawful act, without any deliberate intention of doing any mischief at all. Hence it follows, that there can be no accessaries to this offence before the fact, because it must be done without premeditation; but there may be accessaries after the fact. The only difference between murder and manslaughter is, that murder is upon malice aforethought, and manslaughter upon a sudden occasion, as if two meet together, and striving for the wall, the one kills the other, this is manslaughter and felony. And if they had, on that sudden occasion, gone into the field and fought, and the one had killed the other, this had been but manslaughter, and no murder; because all that followed was but a continuance of the first sudden occasion, and the blood was never cooled till the blow was given.

Chance, or chaud-medley. Authors of the first authority disagree about the application of this word. By some it is applied to homicide by misadventure, by others to manslaughter. The original meaning of the word seems to favour the former opinion, as it signifies a sudden or casual meddling or contention; but homicide by misadventnre supposes no previous meddling or falling out.

Murder is the highest crime against the law of nature that a man is capable of committing. It is when a man of sound memory, and at the age of discretion, unlawfully kills another person under the king's peace with malice aforethought, either expressed by the party, or implied by the law, so as the party wounded or hurt die of the wound or hurt within a year and a day, the whole day on which the hurt was done being reckoned the first.

By malice express, is meant a deliberate intention of doing any bodily harm to another, to do which, by law, a person is not authorized. And the evidences of such malice must arise from external circumstances discovering that inward intention; as lying in wait, menacings antecedent, former grudges, deliberate compassings, and the like, which are various, according to the variety of circumstances. Malice implied, is where a person voluntarily kills another without any provocation. For in this case the law presumes the act to be malicious.

If a man kill another, it should be intended, *prima facie*, that he did it maliciously, unless he can make the contrary appear, by shewing that he did it on a sudden provocation, or the like. And when the law makes use of the term man-lice aforethought, as descriptive of the crime of murder, it must not be understood in that narrow restrained sense, to which the modern use of the word malice is apt to lead one, a principle of malevolence to particulars; for the law, by the term malice, in this instance, means, that the fact has been attended with such circumstances, as are the ordinary symptoms of a wicked heart, regardless of social duty, and fatally bent upon mischief.

The law so far abhors all duelling in cold blood, that not only the principal who actually kills the other, but also his seconds are guilty of murder, whether they fought or not; and it is holden that the seconds of the person killed are also equally guilty, in respect to the countenance which they give to their principals in the execution of their purpose, by accompanying them therein, and being ready to bear a part with them. Also it seems agreed, that no breach of a man's word or promise, no trespass either to land or goods, no affront by bare words or gestures, however false or malicious it may be, and aggravated with the most provoking circumstances, will excuse him from being guilty of murder, who is so far transported thereby, as immediately to attack the person who offend, in such a manner as manifestly endangers his life, without giving him time to put himself upon his guard, if he kill him in pursuance of such assault, whether the person slain did at all fight in his defence or not.

HOMINE, *replegiando*, a writ to bail a man out of prison, now disused on account of the superior advantage of the habeas corpus.

HOMO, *man*, in natural history, is reckoned by Linnæus under the order Primates, which is characterised by having four cutting teeth in the upper and lower jaw, and two mammæ in the breast. There are two species, 1. H. sapiens, including six varieties, *viz.* the wildman, four-footed, mute, hairy. 2. American, copper-coloured, choleric, erect. 3. European, fair, sanguine, brawny. 4. Asiatic, sooty, melancholy, rigid. 5. African, black, phlegmatic, relaxed. II. H. monstrosus, including 1. The mountaineer, small, active, timid, 2. Patagonian, large, indolent. 3. Hottentot, less fertile. 4. American, beardless. 5. Chinese, head conic. 6. Canadian, head flattened. See Man.

HOMOGENEOUS, or Homogeneal, an appellation given to things, the parts of which are similar, or of the same nature and properties.

Homogeneous *light*, that whose rays are all of one colour and degree of refrangibility, without any mixture of others. See the article Colour.

Homogeneous *surds*, those which have the same radical character, or signs, as $\sqrt[2]{a}$, and $\sqrt[2]{b}$. See the article Surd.

HOMOLOGOUS, in geometry, an appellation given to the corresponding sides and angles of similar figures, as being proportional to each other.

All similar figures have their like sides homologous, or proportional to one another: their areas also are homologous, or proportional to the squares of the like sides, and their solid contents are homologous, or proportional to the cubes of the same.

HONE, a fine kind of whetstone, used for setting razors, pen-knives, and the like.

HONEY, a vegetable product, very similar in its properties to sugar. It is found in large quantities in a number of vegetables, is collected by the bee, and is fed upon by many insects. It is always formed in the flower, chiefly at the base of the pistil, and it seems designed to receive and retain the fecundating pollen. Honey differs much in colour and in consistence; it contains much saccharine matter, and probably some mucilage, from which it derives its softness and viscosity. Honey very readily enters into the vinous fermentation, and yields a strong liquor called mead. There are two species of honey, the one is yellow, transparent, and of the consistence of turpentine; the other white, and capable of assuming a solid form, and of concreting into regular spheres. These two species are often united; they may be separated by means of alcohol, which dissolves the liquid honey much more readily than the solid. Honey has never been accurately analyzed, but some late experiments go to prove it is composed of sugar, mucilage, and an acid.

In France, a good swarm of bees, in two years, will yield near thirty pounds of honey; and they are still more profitable in countries that are covered with flowers the greatest part of the year. There are two sorts of honey, the white and the yellow. The white or virgin honey trickles out spontaneously from the combs. These they break, soon after they are made, and lay them upon hurdles or mats of osier or on linen cloth, fastened at the four corners to as many posts, and then an excellent white honey will fall from the combs, and grow hard in a short time. Afterwards they put it into glazed earthen pots. Some press this honey out, but then it is not so agreeable, for it will taste of the wax. The best sort of French virgin honey is that of Languedoc, called honey of Narbonne. It should be new, thick, granulated, of a clear transparent white colour, of a soft and somewhat aromatic smell, and of a sweet and lively taste. If it is very pure, it is almost as hard as sugar-candy; and what renders it so superior, are the many aromatic flowers which grow in those parts, and from which the bees gather their honey. It is always observable that the honey made in mountainous countries is more highly flavoured than that of low grounds. The honey made in the spring is more esteemed than that gathered in the summer; that of the summer more than that of the autumn. There is also a preference given to that of young swarms. Yellow honey is obtained by pressure from all sorts of honey-combs, old as well as new; and even of those from whence the virgin honey has been extracted. They break the combs, and heat them with a little water in basins or pots, keeping them constantly stirring; they then put them into bags of thin linen cloth, and these they put in a press, to squeeze out the honey. The wax stays behind in the bag, though always some particles of it pass through with the honey. Honey is the production of most countries; yet more abundant in the island of Candia, and in the greater part of the islands of the Archipelago, than any where else. The Sicilian honey seems to be particularly high flavoured, and in some parts of the island even to surpass that of Minorca; which no doubt is owing to the quantity of aromatic plants with which that country is overspread. This honey is gathered three times in the year, in July, August, and October. It is found by the peasants in the hollow of trees and rocks. The country of the lesser Hybla is still, as formerly, the part of the island that is most celebrated for this article. Considerable quantities of honey are produced by the wild bees in the woods of North America.

Honey *comb*, a waxen structure full of cells, framed by the bees, to deposit their honey and eggs in. The construction of the honey-comb seems one of the most surprising part of the works of insects, and the materials of which it is composed, which, though evidently collected from the flowers of plants, yet do not, that we know of, exist in them in that form, has given great cause of speculation to the curious. The origin and formation of the wax has been lately discovered. It is secreted by the peculiar organization of the insect, in the form of small and thin oval scales, in the incisures or folds of the abdomen. The regular structure of the comb is also equally wonderful. When the several cells in it are examined, it should seem that the nicest rules of geometry had been consulted for its composition, and all the advantages that could be wished or desired in a thing of that kind are evidently found in it. Each cell consists of six plane sides, which are all trapeziums, but equal to each other: the bottom of the cell is contrived with three rhombuses, so disposed as to constitute a solid angle under three equal angles, and each of which is double the maximum angle of 54° 44′. Hence it comes to pass, that a less quantity of surface is sufficient to contain a given quantity of honey than if the bottom had been flat, in the proportion of 4,658 to 5,50 as has been found by calculation; that is, nearly a fifth of the whole, so far as the figure in the end of the cells extends in each: which fifth part of wax and labour saved amounts to a vast deal in the whole comb. And if these admirable insects knew their advantage, they could not more nicely observe the rules of modern geometry.

The method of making two sorts of cells in each comb is also admirably contrived to save the expense of wax; since, had they been made single, every comb must have had its peculiar base, and every set of cells their bottom of wax, whereas one bottom serves now for two cells; and there is but one plate of wax in the centre of a double comb. This structure occasions a very great sparing of the wax, or matter of the comb; but besides this, there is another great advantage resulting from this structure, which is, that the angles arising from the forementioned combination of the bases greatly strengthen the whole work.

The sides of the cells are all much thinner than the finest paper, and yet they are so strengthened by their disposition, that they are able to resist all the motions of the bee within them, as they are frequently obliged to be. The effect of their thrusting their bodies into the cells would be the bursting of those cells at the top, were not these well guarded against. But to prevent this, the creatures extend a cord, or roll of wax, round the verge of every cell, in such a manner, that it is scarce possible they should split in that particular part. This cord or roll is at least three times as thick as the sides of the cell, and is even much thicker and stronger at the angles of the cells than elsewhere, so that the aperture of each cell is not regularly hexagonal, though its inner cavity be perfectly so. The several combs are all placed parallel to one another, and there is such a space left between them, that the bees can easily pass; and often they place a part of the comb in a contrary direction to the rest, so that while the others are placed horizontally, these stand perpendicularly. The cells which have served, or are to serve, for the habitation of the worms of the common and of the male bees, are often made also at other times the receptacles of honey; but though these are indifferently made to serve either use, there are others destined only to receive honey. The celerity with which a swarm of bees, received into a hive where they find themselves lodged to their minds, bring their works of the comb to perfection, is amazing. There are vast numbers at work all at once; and that they may not incommode one another, they do not work upon the first comb till it is finished, but when the foundation of that is laid, they go to work upon another, so that there are often the beginnings of three or four stories made at once, and so many swarms allotted to the carrying on the work of each.

Honey *stone.* See Mellite.

HONOUR, in law, is used especially for the more noble sort of seigniories on which other inferior lordships or manors depend, by performance of some customs or services to those who are lords of them. Before the statute 18 Edward I. the King's greater barons, who had a large extent of territory holden under the crown, frequently granted out smaller manors to inferior persons, to be holden of themselves; which therefore now continue to be held under a superior lord, who is called in such cases the lord paramount over all these manors; and his seigniory is frequently termed an honour, not a manor, especially if it has belonged to an ancient feudal baron, or been at any time in the hands of the crown. When the King grants an honour with appurtenances, it is superior to a manor with appurtenances; for to an honour, by common intendment, appertain franchises, and by reason of those liberties and franchises, it is called an honour.

Honour, *courts of.* There is a court of honour of earl marshal of England, &c. which determines disputes concerning precedency and points of honour.

Honours, *military;* all armies salute crowned heads in the most respectful manner, colours and standards dropping, and officers saluting. Different ranks of officers are saluted in a different mode.

Honours of war, are stipulated terms which are granted to a vanquished enemy, and by which he is permitted to march out of a town, from a camp, or line of entrenchments, with all the insignia of military etiquette. In another sense, they signify the compliments which are paid to great personages, military characters, when they appear before an armed body of men, or such as are given to the remains of a deceased officer. The particular circumstances attending the latter depend greatly upon the usages of different countries.

HOOK, a piece of iron or brass wire bent, and turned up at one end.

Hook *pins,* are bolts made with a shoulder at one end, and used by carpenters in framing: these are drove through the mortices and tenons of the work prepared for building or wharfing.

HOOPOE, *upupa,* in ornithology. See Upupa.

HOPEA, in botany, so named in honour of Dr. Hope, professor of botany at Edinburgh, a genus of the Polyadelphia Polyandria class and order. Natural order of Guaiacanæ, Jussieu. Essential character: calyx five-cleft, superior; corolla five-petalled; stamens many, connected in five bodies; style one; drupe with a three-celled nut. There is only one species, *viz.* H. tinctoria, a native of Carolina.

HOP, in botany. See Humulus. Hops are said to have been first brought into England from the Netherlands, in the year 1524. They are first mentioned in the English statute-book in the year 1552, *viz.* in the 5th and 6th Edw. VI. cap. 5, and by an act of parliament of the first year of King James I. anno 1603, cap. 18, it appears that hops were then produced in abundance in England. The hop being a plant of great importance in this country, we shall briefly consider what relates to the culture and management of it under distinct heads. As for the choice of soil, the hop-planters esteem the richest and strongest ground the most proper; and if it is rocky within two or three feet of the surface, the hops will prosper well; but they will by no means thrive on a stiff clay or spongy wet land. Hops require to be planted in a situation so open, as that the air may freely pass round and between them, to dry up and dissipate the moisture, whereby they will not be so subject to fire-blasts, which often destroy the middle of large plantations, while the outsides remain unhurt. The hills should be eight or nine feet asunder, that the air may freely pass between them. If the ground is intended to be ploughed with horses between the hills, it will be best to plant them in squares, chequerwise; but if the ground is so small that it may be done with the breast-plough or spade, the holes should be ranged in a quincunx form. Which way soever you make use of, a stake should be stuck down at all the places where the hills are to be made. Persons ought to be very curious in the choice of the plants as to the kind of hop; for if the hop-garden is planted with a mixture of several sorts of hops that ripen at several times, it will cause a great deal of trouble, and be a great detriment to the owner.

The two best sorts are the white and the grey bind; the latter is a large square hop, more hardy, and is the more plentiful bearer, and ripens later than the former. There is another sort of the white bind, which ripens a week or ten days before the common; but this is tenderer, and a less plentiful bearer; but it has this advantage, that it comes first to market. If there is a sort of hop you value, and would increase plants and sets from, the superfluous binds may be laid down when the hops are tied, cutting off the tops, and burying them in the hill; or, when the hops are dressed, all the cuttings may be saved, for almost every part will grow and become a good set the next spring. As to the manner of planting the sets, there should be fine good sets planted in every hill, one in the middle, and the rest round about, sloping. Let them be pressed close with the hand, and covered with fine earth, and the stick should be placed on each side the hill to secure it. When the hop ground is dug in January or February, the earth about the hills, and very near them, ought to be taken away with a spade, that you may come the more conveniently at the stock to cut it. About the end of February, if the hops were planted the spring before, or if the ground is weak, they ought to be dressed in dry weather; but else, if the ground is strong and in perfection, the middle of March will be a good time; and the latter end of March, if it is apt to produce over rank binds, or the beginning of April, may be soon enough. Then having, with an iron picker, cleared away all the earth out of the hills, so as to clear the stock to the principal roots, with a sharp knife you must cut off all the shoots which grew up with the binds the last year; and also all the young suckers, that none be left to run in the alley, and weaken the hill. It will be proper to cut one part of the stock lower than the other, and also to cut that part low that was left highest the preceding year. In dressing those hops that have been planted the year before, you ought to cut off both the dead tops and the young suckers which have sprung up from the sets, and also to cover the stocks with fine earth a finger's length in thickness. About the middle of April the hops are to be poled, when the shoots begin to sprout up; the poles must be set to the hills deep into the ground, with a square iron picker or crow, that they may the better endure the winds: three poles are sufficient for one hill. These should be placed as near the hill as may be, with their bending tops turned outwards from the hill, to prevent the binds from entangling; and a space between two poles ought to be left open to the south, to admit the sun beams. As to the tying of hops, the buds that do not clasp of themselves to the nearest pole, when they are grown to three or four feet high, must be guided to it by the hand, turning them to the sun, whose course they will always follow. They must be bound with withered rushes, but not so close as to prevent them from climbing up the pole. This you must continue to do till all the poles are furnished with binds, of which two or three are enough for a pole, and all the sprouts and binds that you have no occasion for are to be plucked up; but if the ground is young, then none of these useless binds should be plucked up, but should be wrapped up together in the middle of the hill. About the beginning of July the hops begin to blow, and will be ready to gather about Bartholomew tide. A judgment may be made of their ripeness by their strong scent, their hardness, and the brownish colour of their seed. When by these tokens they appear to be ripe, they must be picked with all the expedition possible; for if at this time a storm of wind should come, it would do them great damage, by breaking the branches, and bruising and discolouring the hops; and it is well known that hops, being picked green and bright, will sell for a third more than those which are discoloured and brown.

The most convenient way of picking them is into a long square frame of wood, called a binn, with a cloth hanging on tenter hooks within it, to receive the hops as they are picked. The best method of drying hops is with charcoal on an oast, or kiln, covered with hair cloth, of the same form and fashion that is used for drying malt. The hops must be spread even upon the oast, a foot thick or more, if the depth of the curb will allow it; but care is to be taken not to overload the oast, if the hops are green or wet. The oast ought to be first warmed with a fire before the hops are laid on, and then an even steady fire must be kept under them; it must not be too fierce at first, lest it scorch the hops; nor must it be suffered to sink or slacken, but rather be increased till the hops are nearly dried, lest the moisture or sweat, which the fire has raised, fall back or discolour them. When they have lain about nine hours they must be turned, and in two or three hours more they may be taken off the oast. It may be known when they are well dried by the brittleness of the stalks, and the easy falling off of the hop leaves. As soon as the hops are taken off the kiln, lay them in a room for three weeks or a month, to cool, give, and toughen; for if they are bagged immediately, they will powder, but if they lie a while (and the longer they lie the better, provided they are covered close with blankets to secure them from the air) they may be bagged with more safety, as not being liable to be broken to powder in treading; and this will make them bear treading the better, and the harder they are trodden, the better they will keep.

Hops. By several statutes, regulations are made for the curing of hops, &c. which are placed under the inspection of the officers of excise.

HOPPER, a kind of basket, wherein the seed-corn is carried at the time of sowing. It is also used for the wooden trough in a mill, into which the corn is put to be ground. See Mill.

HORARY, or Hour Circle *of a globe*, is a small brazen circle, fixed upon the brazen meridian, divided into twenty-four hours, having an index moveable round the axis of the globe, which, upon turning the globe fifteen degrees, will show what places have the sun an hour before or after us; for instance, if the index of the hour circle be set at the upper XII. when the globe is rectified for London, and the globe turned fifteen degrees from east to west, the index will point at the hour of 1; which shews that all places under that meridian, and particularly Naples, have the sun an hour sooner than London has it: on the contrary, let the index be set at the upper XII. again, and the globe be turned fifteen degrees from west to east, the index will point at XI. because all places under that meridian, particularly the Madeira islands, have the sun an hour after London has it. For the several problems performable on the globes, by means of the horary circle, see Globes, *use of.*

Horary *circles* or *lines*, in dialling, are the lines or circles which mark the hours on sun-dials. See Dialling.

Horary *motion of the earth*, the arch it describes in the space of an hour, which is nearly fifteen degrees, though not accurately so, as the earth moves with different velocities, according to its greater or lesser distance from the sun. Hence we see the method of reducing motion into time, and *vice versa;* since $15° = 60'$, or one hour, $1° = 4'$: therefore the clocks at places 15° east of London are one hour faster than those at London; and the clocks at places 15° west of London are one hour later than those at London, and so in proportion. Thus, if I wish to know what o'clock it is at Constantinople, and also at Boston in North America, now it is eight o'clock, A. M. here, I look to the gazetteer, and find Constantinople to be 29° east of London, and Boston is 70° 30′ west: to reduce these degrees to time, I divide each by 15, and I find $\frac{29}{15} = 1^h\ 56^m$, and $\frac{70°\ 30'}{15} = 4^h\ 42^m$; accordingly the time at Constantinople is $1^h\ 56^m$ before our time, and at Boston it is $4^h\ 42^m$ behind it: that is, at eight o'clock in London it will be 56 minutes after nine at Constantinople, and at Boston it will be only 18 minutes past three o'clock.

HORD, in geography, is used for a company of wandering people, which have no settled habitation, but stroll about, dwelling in waggons or under tents, to be ready to shift as soon as the herbage, fruit, and the present province, is eaten bare; such are several tribes of the Tartars, particularly those who inhabit beyond the Wolga, in the kingdoms of Astracan and Bulgaria. A hord consists of fifty or sixty tents, ranged in a circle, leaving an open place in the middle. The inhabitants of each hord usually form a military company or troop, the eldest whereof is commonly the captain, and depends on the general or prince of the whole nation.

HORDEUM, in botany, *barley*, a genus of the Triandria Digynia class and order. Natural order of Grasses. Essential character: calyx lateral, two-valved, one-flowered, by threes, at each toothlet of the rachis. There are nine species.

HORIZON, in astronomy and geography, that great circle which divides the heavens and the earth into two equal parts, or hemispheres, distinguishing the upper from the lower. The horizon is either sensible or rational: the sensible horizon is that circle, which, being discovered by our senses, limits our prospect.

When we are on terra firma, this circle commonly seems rugged and irregular, occasioned by the unevenness of the ground; but at sea, there are no such irregularities. The semi-diameter of this circle varieth according to the height of the eye of the observer. If a man, six feet high stood upon a large plain, or the surface of the sea, he could not see quite three miles round. To find the distance to which a person can see, at any given height of the eye, or the extent of the visible horizon, is a problem of some utility, particularly to mariners: the rule is, "multiply the square root of the height of the eye in feet, by 1.225, and the product is the distance in miles to which we can see from that height;" thus a sailor, standing at the top-mast of a ship 120 feet high, can see a distance in miles $= \sqrt{120} \times 1.225 = 13.45 =$ to thirteen miles and a half nearly.

The rational, or true horizon, is a great circle of the apparent celestial sphere, dividing it into two equal hemispheres, and serving as the limits of elevation or depression of celestial objects. This horizon being parallel to the sensible horizon, is distant from it by the semi-diameter of the earth, through whose centre it passes: for the astronomers reduce the appearance of the heavens to a spherical surface, which is not concentrical to the eye, but to the earth. It divides the heaven and earth into two parts, the one light, and the other dark, which are greater or lesser, according to the condition of the place, &c. It determines the rising and setting of the sun, moon, or stars, in any particular latitude; for, when any of these appear just at the eastern part of the horizon, we say it rises; and when it does so at the western part, we say it sets. And from hence also the altitude of the sun or stars is accounted, which is their height above the horizon. This circle is divided by astronomers into four quadrants, or cardinal points The poles of this horizon are the zenith and the nadir: and the innumerable circles drawn through these poles to the horizon are called the vertical circles, or azimuths. These two horizons produced to the fixed stars will appear to coincide into one, since the earth compared to the sphere in which the fixed stars appear is but a point; therefore the two circles, which are but a point distant from each other, may be well considered as coinciding into one.

HORIZON *of a globe*. See GLOBE.

HORIZONTAL, something relating to the horizon; or that is taken in, or on a level with the horizon: thus we say, an horizontal plane, &c.

It frequently happens at sea, that the atmosphere is so hazy as to prevent a distinct view of the horizon, which is a great hindrance to accurate observations. This inconvenience is remedied by an

HORIZONTAL *speculum*, which consists in a well polished metal speculum, about three or four inches in diameter, inclosed within a rim of brass; so fitted, that the centre of gravity of the whole shall fall near the point on which it turns. This is the end of a steel axis running through the centre of the speculum, above which it finishes in a square, for the convenience of fitting a roller on it, by which it is set in motion by means of a piece of tape wound round the roller. The cup in which it turns is made of agate, flint, or other hard substance, and a cover to the whole may be made of glass; by this means an observation may be taken with it as well covered as open, which will prevent injury from the spray of the sea. These specula are as useful by night as by day; for as the images of the stars may be seen in the speculum, consequently any object that can be seen reflected upon the glasses of the quadrants may be observed by the speculum, and these are all the stars of the first magnitude, the planets Venus, Mars, Jupiter, Saturn, and the Moon; so that by having the declinations of these bodies in the Nautical Almanack, or indeed in any ephemeris, they may be used in observations as well as the sun.

HORIZONTAL *dial*, that drawn on a plane parallel to the horizon, having its style elevated according to the altitude of the poll, in the place it is designed for. See DIAL.

HORIZONTAL *line*, in perspective, a right line drawn through the principal point parallel to the horizon; or it is in the intersection of the horizontal and perspective planes. See PERSPECTIVE.

Horizontal *parallax*. See Parallax.

Horizontal *plane*, that which is parallel to the horizon of the place, or nothing inclined thereto. The business of levelling is to find whether two points be in the horizontal plane, or how much the deviation is.

Horizontal *plane*, in perspective, is a plane parallel to the horizon, passing through the eye, and cutting the perspective plane at right angles.

Horizontal *range*, of a piece of ordnance, is the distance at which a ball falls on, or strikes a horizontal plane, whatever be the angle of elevation or direction of the piece. When the piece is pointed parallel to the horizon, the range is then called the point-blank, or point-blank range. The greatest horizontal range, in the parabolic theory, or in a vacuum, is that made with the piece elevated to 45 degrees, and is equal to double the height from which a heavy body must freely fall, to acquire the velocity with which the shot is discharged. Thus, a shot being discharged with the velocity of v feet per second; because gravity generates the velocity $2g$, or $32\frac{1}{6}$ feet, in the first second of time, by falling $16\frac{1}{12}$ or g feet, and because the spaces descended are as the squares of the velocities, therefore as $4g^2 : v^2 :: g : \frac{v^2}{4g}$ the space a body must descend to acquire the velocity v of the shot, or the space due to the velocity v; consequently the double of this, or $\frac{v^2}{2g} = \frac{v^2}{32\frac{1}{6}}$ is the greatest horizontal range with the velocity v, or at an elevation of 45 degrees, which is nearly half the square of a quarter of the velocity. In other elevations, the horizontal range is as the sine of double the angle of elevation: so that, any other elevation being e, it will be,

As radius $1 : \sin. 2e :: \frac{v^2}{32\frac{1}{6}} : \frac{v^2}{32\frac{1}{6}} \times \sin. 2e$,

the range at the elevation e, with the velocity v. But in a resisting medium, like the atmosphere, the actual ranges fall far short of the above theorems, in so much that with the great velocities the actual or real ranges may be less than the tenth part of the potential ranges; so that some balls, which actually range but a mile or two, would in vacuo range twenty or thirty miles. And hence also it happens, that the elevation of the piece, to shoot farthest in the resisting medium, is always below 45°, and gradually the more below it as the velocity is greater, so that the greater velocities with which balls are discharged from cannon with gunpowder require an elevation of the gun equal to but about 30°, or even less. And the less the size of the balls is too, the less must this angle of elevation be, to shoot the farthest with a given velocity. See Gunnery and Projectiles.

HORN, in physiology, a tough, flexible, semitransparent substance, intended for the defence or covering of animals. The hollow horns of the ox, goat, &c.; the hoof, the horny claw and nail, and the scale of certain insects, as the shell of the tortoise, resemble each other in chemical characters; but they differ very widely from stag's horn, ivory, &c. Horn is distinguished from bone, in being softened very completely by heat, either naked, or through the medium of water, so as to be readily bent to any shape, and to adhere to other pieces of horn in the same state. Horn contains but a small portion of gelatine, and in this it differs from bone, which contains a great deal. Horn consists chiefly of condensed albumen, combined with a small and varying portion of gelatine, with a small part of phosphate of lime. The fixed alkalies readily and totally dissolve horn into a yellow saponaceous liquor.

Horn and tortoise-shell are applied to mechanical purposes, which require them to be bent and united in various ways; this is performed by the aid of heat, applied either dry, with warmed irons or burning charcoal; or by softening the horn in boiling water, or in a weak solution of alkali: when thus softened, they will easily adhere. Mr. Aiken gives the following process for making the horn-ring that surrounds a common opera-glass: "A flat piece of horn is cut out, of the requisite shape, the ends to be joined are thinned down by a file, the piece is then put into boiling water till sufficiently supple, and is then rolled round a warm iron cylinder, and held in that position by a vice, so that the ends over-lap each other: another piece of iron, heated and grooved, is then laid upon the seam of the joined ends, and pressed upon the cylinder, and there confined by an iron wire; and the heat of the two partially melts that portion of the horn, and cements the ends so completely, that no seam or joining can be observed when cold." For the manner of making horn to imitate tortoise-shell, see COMB.

HORN is also a musical instrument of the wind kind, chiefly used in hunting, to animate the hunters and the dogs, and to call the latter together.

The French horn is bent into a circle, and goes two or three times round, growing gradually bigger and wider towards the end, which in some horns is nine or ten inches over.

HORNS *of insects*, the slender oblong bodies projected from the heads of those animals, and otherwise called antennæ, or feelers. The horns of insects are extremely various; some being forked, others plumose or feathered, cylindrical, tapering, articulated, &c. As to the use of these parts, some have imagined that they served as feelers, lest the creature should run against any thing that might hurt it; and others there are, who think them the organs of hearing. See ENTOMOLOGY.

HORN *ore*, in mineralogy, is one of the species of silver ore; its most frequent colour is pearl-gray, of all degrees of intensity, which borders sometimes on milk-white, and sometimes approaches to lavender and violet-blue. It passes also, though but rarely, into green. It is found massive, disseminated in thick membranes, in roundish hollow balls; also crystallized: specific gravity 4.8. When heated on charcoal before the blow-pipe, it melts quickly, and leaves a globule of silver; it is even fusible by the flame of a candle; it takes a polish by friction; and its constituent parts, according to Klaproth, are

Silver - - - -	67.75
Muriatic acid - - -	21.
Sulphuric acid - -	0.25
Oxide of iron - -	6.0
Alumina - - -	1.75
Lime - - -	0.25
	97.00
Loss - - - -	3.00
	100,00

It occurs in veins, and generally in their upper parts, and is usually accompanied with brown iron ocre, and with silver glance, but seldom with native silver and red silver ore. It occurs in considerable abundance in the mines of South America, in some parts of France, and in Hungary. It derives its name from its property of cutting like horn; and is, of course, soft, flexible, and ductile, when obtained in thin plates.

HORN *stone*, or HORN *steen*, in mineralogy, a species of the flint genus, divided by Werner into three sub-species: the splintery, the conchoidal, and the woodstone. The most common colour of the splintery horn stone is gray; it is found in veins, in the shape of balls, in limestone, and forming the basis of porphyry, in several parts of Germany, and also in the Shetland islands. It appears to differ from quartz in containing a greater proportion of alumina; when it contains a very large quantity, it passes into jasper. It sometimes borders on chalcedony and flint. The best millstone, called French burr, is cellular-splinter hornstone. Conchoidal hornstone occurs in beds, accompanied with agate; and is distinguished from the splintery by the lightness of its colours, its fracture, and its inferior translucency and hardness.

In the woodstone several colours occur together, and it commonly exhibits coloured delineations, as clouded and striped, and these arrange themselves in the direction of the original woody texture. Its shape is exactly conformable to its former woody shape, so that it occurs in the form of trunk, branches, and roots. It is found in sandy loam, in Germany, and in Ireland. It receives a good polish, and serves the purpose of agate.

Mr. Jameson observes, on this mineral, that, "at first sight it may appear inconsistent, to consider a petrifaction as a particular fossil species; when we reflect, however, that woodstone differs in its external characters from all other fossils, the justness of the Wernerian method will become evident. Many other fossils occur in the shape of petrifactions, but they are almost always identical with some known species, and therefore are to be considered only as varieties of the external shape of the particular fossil to which they belong."

HORN *work*, in fortification, an out-work composed of two demi-bastions, joined by a curtin.

HORN *geld*, a tax paid for feeding of horned beasts in the forest. See FOREST.

HORNBLENDE, in mineralogy, a species of the clay genus, of which there are four sub-species; *viz.* the common the Labrador, the basaltic, and the hornblende slate. The common hornblende is of a greenish black, or raven-black, which in some varieties approaches to a greyish and even velvet black. It occurs in mass, disseminated and crystallized. Its specific gravity is from 3.6 to 3.8. It is opaque, gives a greyish streak, is moderately hard, and easily frangible; it exhales an argillaceous odour. It melts before the blow-pipe into a greyish black glass; the constituent parts, according to Kirwan, are,

Silica	37.0
Alumina . . .	22.0
Magnesia . . .	16.0
Lime	2.0
Oxide of iron .	23.0
	100.0

The common hornblende forms one of the essential ingredients of several mountain rocks; is sometimes accidentally disseminated in others, and occurs in beds. When in beds, it is frequently accompanied with ores, as magnetic iron-stone, iron pyrites, &c. It is found in all the northern parts of Europe; and when pure is a capital flux for iron ores, to which purpose it is applied in Sweden, where it is obtained in large quantities.

The Labrador hornblende is found in the island of St Paul, on the coast of Labrador, is usually of a brownish black, and its specific gravity is 3.38. The hornblende slate is of a colour intermediate between greenish and raven black; it is massive, and is generally mixed with mica and felspar. It occurs in beds of primitive rocks, particularly in clay slate; also in gneiss and mica slate, and is found principally in the northern parts of Europe.—The basaltic hornblende is of a velvet black, occurs almost always in single imbedded crystals, which are small and middle sized. The surface is smooth and shining, except where it happens to be covered by a thin ochery crust. The specific gravity is rather less than that of the hornblende slate. It melts before the blow-pipe into a brownish black glass. Bergman has analyzed it, and found it contained.

Silica	58.0
Alumina . . .	27.0
Iron	9.0
Lime	4.0
Magnesia . . .	1.0
	99.0
Loss . . .	1.0
	100.0

It is found in Saxony, Bohemia, Scotland, Italy, &c. It resists decomposition longer than basalt, hence crystals of it are found in clay, formed by the decomposition of basaltic rock. Common hornblende is difficultly frangible, but the basaltic is very easily frangible.

HORNET. See Vespa

HOROLOGY. Horology is that branch of science which enables us to measure the portions of time. We judge of the lapse of time by the succession of sensible events; and the most convenient and accurate measures of its quantity are derived from motions, either uniform, or else repeated at equal intervals. Of the former kind, the rotation of the earth on its axis is the most exact, and the situation of its surface with regard to the fixed stars, or, less simple, with regard to the sun, constitutes the means for determining the parts of time as they follow each other. See Astronomy and Dialling.—Of the latter kind, the rotation of machinery, consisting of wheel-work, moved by a weight or spring, and regulated by a pendulum or balance, affords instruments of which the utility is well known. The term horology is at present more particularly confined to the principles upon which the art of making clocks and watches is established. A considerable portion of this extended subject of research has been given under the articles Clock and Chronometer. In the present, we shall chiefly attend to the means by which the train of wheel-work is made to make a number of successive advances, all so very nearly equal in the measurement of time, that a surprising degree of precision is obtained in ascertaining the intended object.

The machines which, for centuries, have been commonly used to measure time, consist of a movement, or train of wheels, drawn by a weight or spring, and a regulator, the object of which is to keep the motion of the train within the required degree of uniformity. A continual rotatory motion, which constantly tends to accelerate, is thus corrected by means of an alternate motion; while the power which carries round the movement restores also, to the regulator, the action lost by friction and other causes. The mechanism, by which the two principal parts act on one another, is called the escapement; and this most admirable contrivance may be reckoned the distinguishing characteristic of the modern art of time-piece making.

One of the most ancient escapements is that which is now applied in almost all common pocket watches. It is represented in fig. 1. Plate Horology, and is best suited to the long vibrations of the balance, which was invented earlier than the pendulum. A B denotes the rim of a contrate wheel, called a crown wheel, having its teeth pointed and sloped on one side only, so that the points advance before any other part of the teeth during the motion. C and D are two pallets or flaps proceeding downwards from the verge E F. The pallets are nearly at right angles to each other; and when the balance F G, fixed to the verge, is at rest, the pallets remain inclined to the plane of the wheel, in an angle of about forty-five degrees; but when it is made to vibrate, one of the pallets is brought nearer to the perpendicular position, while the other becomes more nearly parallel. The wheel must be supposed to have one of its teeth resting against a pallet, by virtue of the maintaining power. This tooth will slip off or escape, as the pallet rises towards the horizontal position, at which instant a tooth on the opposite side of the wheel will strike against the other pallet which is down.—The returning vibration, by raising this last pallet, will suffer that tooth to escape, and another tooth will apply itself to the first-mentioned pallet. By this alternation, the crown-wheel will advance the quantity of half a tooth each vibration, and the balance or pendulum will be prevented from coming to rest, because the impulse of the teeth against the pallets will be equal to the resistances from friction and the re-action of the air.

The common escapement here described was well known to Leonardo de Vinci, who describes an instrument acting by an escapement of this kind, similar, as he says, to the verge of the balance in watches, which he does not seem to mention as a new thing: he died about 1513. The isochronism of the pendulum was known to Galileo, in 1600, who, before his death, namely, about 1633, proposed to apply it to clocks. The actual application by Huygens was made before 1658, when he published his "Horologium Oscillatorium." He applied it by means of the common escapement already in use with the balance, and still retained in our table-clocks. Sanctorius had made the same application about forty years before that time, as appears by his "Commentarii in Avicennam," (quest. 56,) printed in 1625, in which several instruments are described as having been publicly exhibited and explained to his auditors, at his lectures in Padua, for thirteen years previous to that time.

This escapement not being adapted to such vibrations as are performed through arcs of a few degrees only, another construction has been made, which has been in constant use in clocks for this century past, with a long pendulum beating seconds. (Fig. 2.), A B represents a vertical wheel, called the swing wheel, having thirty teeth. C D represents a pair of pallets connected together, and moveable in conjunction with the pendulum, on the centre of axis F. One tooth of the wheel, in the present position, rests on the inclined surface of the inner part of the pallet C, upon which its disposition to slide tends to throw the point of the pallet further from the centre of the wheel, and consequently assists the vibration in that direction. While the pallet C moves outwards, and the wheel advances, the point of the pallet D, of course, approaches towards the centre, in the opening between the two nearest teeth; and when the acting tooth of the wheel slips off, or escapes from the pallet C, another tooth on the opposite side immediately falls on the exterior inclined face of D, and, by a similar operation, tends to push that pallet from the centre. The returning vibration is thus assisted by the wheel, while the pallet C moves towards the centre, and receives the succeeding tooth of the wheel after the escape from the point of D. In this manner the alternation may be conceived to go on, without limit.

The celebrated George Graham improved this escapement very much, by taking off part of the slope furthest from the points of the pallets; instead of which part, he formed a circular or cylindrical face, having its axis in the centre of motion. Pallets of this kind are seen on the opposite side of the wheel at E and G, having H for their centre or axis. A tooth of the wheel is seen resting upon the circular inner surface of the pallet G, which is not therefore affected by the wheel, excepting so far as its motion, arising from any other cause, may be affected by the friction of the tooth. If the vibration of the pendulum be supposed to carry G outwards, the slope surface will be brought to the point of the tooth, which will slide along it, and urge the pallet outwards during this sliding action. When the tooth has fallen from the point of this pallet, an opposite tooth will be received on the circular surface of E, and will not affect the vibration, excepting when the slope surface of E is carried out so as to suffer the tooth to slide along it. In the two former escapements, there is always a certain portion of vibration takes place after the drop which drives the pallets back, and causes the index also to recede through a small arc: this has been distinguished by the name of a recoil. Other considerable objections, besides that of the continued action of the maintaining power, have been made against escapements with a recoil; but it would lead us too far into the minute departments of this subject to discuss them. The escapement of Graham, and all such as have no recoil, have been called dead beat escapements, because the index for seconds falls directly through its arc, and remains motionless on the line of division till the next vibration. It may be observed, that the maintaining power in Graham's escapement may be applied during a small portion only of the vibration; and that an increase of the maintaining power tends to enlarge the arc of vibration, but scarcely interferes with its velocity.

The effect of the escapement which has been termed horizontal, because the last wheel in watches of this construction has its plane parallel to the rest of the system, is similar to that of the dead beat escapement of Graham. In fig. 3, the horizontal wheel is seen with twelve teeth, upon each of which is fixed a small wedge supported above the plane of the wheel, as may be seen at the letters A and B. On the verge of the balance there is fixed part of a hollow cylinder of steel, or other hard material, the imaginary axis of which passes through the pivots of the verge. C. represents this cylindrical piece, into which the wedge D. may be supposed to have fallen. While the vibration causes the cylindrical piece to revolve in the direction which carries its anterior edge towards the axis of the wheel, the point of the wedge will merely rub the internal surface, and no otherwise affect the vibration of the balance than by retarding its motion. But when the return of the vibration clears the cylinder of the point of the wedge D, the wheel will advance, and the slope surface of the wedge, acting against the edge of the cylinder, will assist the vibration of the balance. When the edge of the cylinder arrives at the outer point of the wedge D, its posterior edge must arrive at the position denoted by the dotted lines of continuation; immediately after which the wedge or tooth E will arrive at the position *e*, and rest on the outer surface of the cylinder, where it will produce no other effect than that of retardation from friction, as was remarked with regard to the wedge D, until the course of the vibration shall bring the posterior edge of the cylinder clear of the point of the wedge. In this last situation the wedge will act on the edge of the cylinder, and assist the vibration, as in the former case, until that edge shall arrive at the outer or posterior point of the wedge; immediately after which the leading point will fall on the inner surface of the cylinder in the first position, as was shewn in the wedge D.

Time-pieces, with a pendulum regulator, are certainly the most perfect, when they are kept in a fixed situation; and, for that reason, these are the only sort used in astronomical observatories. But external motion is so contrary to the regularity of their performance, that no sea chronometer has been since attempted to be constructed upon that principle. The balance regulator remained, as affording the only method by which the desired uniformity might be obtained in portable machines; and the great improvement made in that regulator, by the addition of a spiral spring, may be considered as one principal cause of the perfection which has been since attained in them. The first invention of attaching a spring, to give to the balance, by its elasticity, a power which renders the action of this sort of regulator similar to that of gravity in the pendulum, is undoubtedly due to Dr. Hooke, though it is not so clear whether he ever applied it in the shape of a spiral, as has been so long practised since. F. Berthoud, in his "Histoire de la Mesure du Temps," (vol. i. pp. 134 to 141,) gives a body of extracts from several works relative to this subject; and concludes, that Dr. Hooke only applied a straight spring to the balance, and that M. Huygens improved upon that idea, and contrived the spiral spring, which is more favourable to the vibrations of the balance. M. Huygens, indeed, applied in France a balance spring, the account of which has been published in the Philosophical Transactions for 1675, No. 112; but Dr. Hooke, in the Postscript to his Description of Helioscopes, asserts, that the hint was taken from the experiments he had made in 1664, in Gresham College, where he explained above twenty several ways, by which springs might be applied to do the same thing.

In relating the progress of time-piece making, we must not omit mentioning the use of precious stones, particularly rubies, to form the holes in which the pivots of the wheels turn, and the pallets upon which the action of the teeth is exercised. These jewels, by the high polish given to them, reduce the quantity of friction; and, not being liable to the wear which takes place in metal rubbing upon metal, the machine, with that addition, not only becomes more durable, but acquires a degree of uniformity in the motion of the pieces, which is very favourable to the regularity of its going.

That extraordinary man John Harrison having produced the first portable machines, which, upon repeated trials, met with success, to the extent required for the great reward offered by the British parliament, must be reckoned the father of modern chronometry; and his long and active career has proved extremely useful, by stimulating with so bright an example other artists to similar endeavours The principles of Mr. Harrison's watches are well known; and, as most parts of his construction have been superseded by more simple contrivances, we shall only mention the principal inventions of which he appears to be the author, and which are still used by the watchmakers of the present day.

The going fusee is one among those inventions which have proved the most generally useful in practice. By this simple mechanism, the main spring, while the watch is going, acts on an intermediate short spring, which Harrison calls the secondary spring, and is constantly kept bent to a certain tension by the former; and when the watch is winding up, and the principal spring ceases to act, the secondary spring being placed in a ratchet wheel, which is hindered from retrograding by a click, continues the motion without alteration. Other contrivances have been proposed, and executed, to make time-pieces go while winding up; but none which, like this, combines the advantage of simplicity, and the property of providing a supplementary power, which is equal to that of the main spring when its action ceases. And it is to be observed, that the utility of the going fusee, which has induced manufacturers to introduce it into all good watches, is peculiarly important in those time-pieces which have not the power of setting themselves in motion, as is the case with the best modern escapements.

Harrison invented also a compensation for the effects of heat and cold; which at the time was perfectly new, and has led to the improvements made afterwards in that essential requisite of time-keepers.

The alterations to which the length of the pendulum is liable, by the different degrees of heat and cold, affect the going of clocks with that sort of regulator, (see PENDULUM); and watches, with a balance, are still more subject to irregularity from that source; because not only the balance expands or contracts, according to the rise or fall of the thermometer, but the regulating spring itself, while it suffers similar changes, becomes weaker or stronger; so that, from these causes, a time-piece must go slower or faster in too great a proportion to be overlooked or neglected. Graham (Philosophical Transactions, 1726) is the first who thought of applying two metals, of different expansibility, to correct the errors proceeding from the variation of temperature in a pendulum; but as he seemed to have had in view to effect it immediately, without the aid of mechanism, he was obliged to fix on steel and mercury, these being the metals which offered to him the greatest difference of dilatation and contraction. Harrison, by multiplying the bars, increased the total length of the two metals acting on one another, without exceeding the limits of the pendulum; and thereby produced a sufficient compensation with brass and steel, in the compound or gridiron pendulum, which has been almost universally adopted ever since. This contrivance could not be easily applied to balances; but Harrison, following still the principle of the different expansibility of metals, applied it in a manner which had not been thought of before, and made it act on the spiral spring, in order to produce the desired compensation in the regulator. This method is described as follows: (Principles of Mr. Harrison's Time-keeper, p. xii. notes.) "The thermometer kirb is composed of two thin plates of brass and steel riveted together in several places, which, by the greater expansion of brass than steel by heat, and contraction by cold, becomes convex on the brass side in hot weather, and convex on the steel side in cold weather; whence, one end being fixed, the other end obtains a motion corresponding with the changes of heat and cold, and the two pins at the end, between which the balance spring passes, and which it touches alternately as the spring bends and unbends itself, will shorten or lengthen the spring, as the change of heat and cold would otherwise require to be done by the hand, in the manner used for regulating a common watch."

This kind of compensation has been since applied in other ways; but the method, in general, is liable to some material objections, on account of its altering the length of the balance spring, and the difficulty, perhaps impossiblity, of effecting with it an accurate adjustment.

Pierre le Roy, eldest son and successor to Julien le Roy, the companion and friend of H. Sully, had the merit of accomplishing the great desideratum of making the compensation on the balance itself. In the chronometer, which was presented to the king of France the 5th August, 1766, and obtained the prize of the Academy of Sciences of Paris the 31st of the same month, that author executed a compensation in the balance, which he has fully explained in his description of that machine. ("Mémoires sur la meilleure Manière de mesurer le Temps en Mer, qui a remporté le Prix double au judgement de l'Academie Royale des Sciences. Contenant la Description de la Montre à Longitudes, presentée à sa Majesté le 5 Aout, 1766." Par M. le Roy, Horloger du Roi, pp. 41 to 44.) This memoir accompanies the account of Cassini's voyage in 1668, published in 1770. This compensation is composed (fig. 4.) of two thermometers, *t* K *t* A K, of mercury and spirits of wine, made each in the form of a parallelgogram, except in the upper branch, which bears the ball containing the spirits of wine, and is a little bent downwards; the mercury is in the lower part, and the vertical branch of the tube, A K, is open at the upper end. These two thermometers are placed opposite one another, the axis of the balance being in the same plane with the centrical lines of the tubes; and the thermometers and balance are solidly attached together, and form a well poised and steady regulator. At the middle temperature of the atmosphere, the quicksilver stands at K A *t* K; but, when an increase of heat occurs, the alcohol, by its expansion, forces the mercury from the exterior branch, *t* K *t*, towards A K, and a portion of the mass of the regulator contracts by approaching the centre. On the contrary, if the variation consist of an additional degree of cold, the mercury moves towards the exterior branch, and the weight towards the circumference of the balance becomes greater. Thus, if the thermometers are well adjusted, the effects of all the changes of temperature in the balance will be compensated, and the regulator will act with the same uniformity as if its figure were not liable to such alterations.

Peter le Roy mentions his knowledge of Harrison's expansion curb, acquired soon after he made his thermometrical balance; and he constructed a balance accordingly on the principle of Harrison's curb, the arms or arcs of which act by flexure, and are adjusted by moveable weights. He proved the effect of such arms by experiment; but gave the preference to his own mercurial compensation. Peter le Roy's second invention is the same as is now used: but though so publicly declared in the face of the French government and academy in 1766, Arnold took an English patent for it in 1782.

We have not yet taken any notice of improvements made in the escapement, because after all the plans proposed for this most essential part of chronometers, the principle of what is called the detached escapement is the only one now used; and, being established upon long experience, seems to merit the preference given to it over all the constructions proposed till now. We shall content ourselves with stating in a general manner the beginning and progress of that escapement.

In all the escapements known till the middle of the last century, the escape wheel was in continual contact with the pallets belonging to the axis of the balance wheel; and the friction proceeding from this circumstance may be considered as a principal source of irregularity in the going of the watches. Suppose that a regulator should be made so perfect as to be exactly isochronal, while vibrating in a free situation, that advantage would be diminished or lost as soon as it was placed in connection with a train of wheels; and the errors would be more or less, according to the nature and quantity of friction in the escapement. It would be, therefore, extremely useful to secure to the regulator a perfect liberty of vibration, except during the short intervals of time which may be necessary for the action of the escape wheel, to give it a new impulse. This ingenious idea was also started by P. le Roy, and carried into execution by the same artist, in a model which he presented in 1748 to the Academy of Sciences of Paris, and is described in the collection of machines approved by that society for the same year, vol. vii. p. 385.

The effect or action of le Roy's escapement in few words is this: An escape wheel is kept in repose by a lever detent. The balance unlocks the detent, and receives an impulse or stroke on a pallet through a part of every second vibration; and during great part of its course it is free and detached.

About the year 1755, according to Count de Bruhl, the late Mr. Thomas Mudge invented a detached escapement, and applied it to a watch which he made for the king of Spain, Ferdinand VI. This is the same escapement that was used by the late Josiah Emery, in his chronometers, some of which have gone very well. It differs from the constructions which we have already explained, both in the detent and in the communication of the impulse, which in this mechanism takes place at every vibration: but the date will not suffer us to consider it as the first invention of the detached escapement.

This justly celebrated artist afterwards made a chronometer, in which the vibrations of balance were kept up by secondary springs attached to two pallets, each of which was wound up by the last wheel of the train during the time employed by the balance in its vibration, unconnected with that pallet. Though this invention is highly ingenious, and was rewarded by parliament, it is now generally considered as unsafe in the locking of the hooks, or detent parts, which terminate the pallets. Mr. Alexander Cumming executed a similar escapement for clocks long before Mudge actually carried his idea into effect, though it has been contended that Mudge had the mere notion much earlier. But Mr. Cumming, to whom our art and the other branches of mechanics are highly indebted for his labours, and his Treatise on Clock and Watch Making, made his detents separate from his pallets, and by that means avoided the chief defect of the construction afterwards adopted by Mudge. Our limits will not, however, allow us to pursue these and other improvements and variations, adopted by our own and by foreign artists.

We must confine ourselves to the construction used at present by the English watchmakers; and shall begin with that of the late Mr. Anold, as described in his statement, presented by his son to the board of longitude.

The teeth of the escape wheel (fig. 5.) are of a cycloidal shape, in the face part, which is intended for action, the section of which, with those of the two other sides, form a sort of mixed triangle. B B *d* represents the detent, which is formed of a flexible piece or spring, bending between C and N; and in the part N B *d*, which is stronger than the other, is fixed the locking pallet, *a*, opposite an adjusting screw F. The pallet, projecting below the spring detent, locks upon the interior angle of the tooth; suspending the motion of the escape wheel, and leaving the balance to vibrate free, as pointed out in the preceding escapements. The action of the spring detent (for the joint of the detent is itself a spring) presses the locking pallet against the screw, F, except at the time of unlocking the wheel. A very delicate spring N *e*, called the discharging or unlocking spring (and also the tender spring,) is attached by one end, N, to the spring detent, C B N B *a*; and, passing under the adjusting screw, F, extends a little beyond the extremity, *d*, of the detent itself. H H H is a circular piece attached to the axis of the balance, and, *o*, the discharging pallet. This pallet, when the balance is in motion from *e* to *d*, presses against the end of the discharging spring, *n e*; and carrying it, together with the locking spring, B B *d*, disengages the locking piece, *a*, out of the internal angle of the tooth, with which it was in contact; and the escape wheel then communicates a new power to the balance, by its impulse on a pallet, *m*, which is fixed or set in the aperture of the circular piece. As soon as this is done, the spring detent, or locking spring, falls back to its position against the adjusting screw, F; and the pallet, by receiving or intercepting the next tooth, stops the motion of the escape wheel. When the balance returns from *d* to *e*, the unlocking pallet acts again on the extremity of the discharging spring; but this, being very delicate, gives way without disturbing the detent or locking spring; and the balance, after suffering a trifling degree of resistance by that contact, continues its free vibrations. At the next vibration the unlocking takes place; and the action of the escapement proceeds successively, as explained before.

The detached escapement used by Mr. Earnshaw, is represented in fig. 6, which is taken from his statement presented to the board of longitude. This escapement is similar to that of Arnold's, already described, except in small variations, which will be easily perceived on a comparison of the two figures. It is besides asserted, and it appears probable from every circumstance relative to these constructions, that the late Mr. Arnold had made use of this form of escapement long before Mr. Earnshaw, but that he had laid it aside, in order to adopt the escapement with cycloidal teeth, which he esteemed far preferable. In the escapement we are now considering, the escape wheel is shaped as appears in the figure; and, on the inspection of this representation, it will be easily observed, that the teeth presenting a right line, and escaping by a sharp point, their action cannot be so smooth, and the wear of the whole must be greater, than in the construction with protuberant cycloidal teeth. The detent is of the same kind as the other, and only differs from it, in being stopped by the inside of the head of the adjusting screw, instead of the extremity of the screw itself, and unlocking outwards and not towards the centre.

The two constructions, which may be considered as the same, differ from the French detached escapements, such as those of F. Berthoud, which we have already explained in the detent. In the new detent, the pivots are abolished, and the centre of motion is established in the locking piece itself; which, for that purpose, is made flexible near the extremity by which it is fixed. The elasticity of the detent, or locking piece, supplies also the office of a strait auxiliary spring, placed behind the lever of the detent, or a spiral spring, which has been sometimes applied to the axis of the pivots, to keep the detent in the proper situation.

The pivots of the old detent are so slender, that its performance cannot be supposed subject to any considerable degree of friction; and watches, with that kind of detent, have been known to go very well. Some able artists, upon that account, think that the new detent is only preferable to the other, because it saves work and is less expensive; but while the spring detent is allowed to perform as well, if not better, than the detent with pivots, which its universal use in this country seems to prove, that property, combined with the economy in the manufactory, must secure to the mechanism in question the character of an improvement in the construction of time-keepers.

To whom are we indebted for the invention of the spring detent? The general opinion attributes it to the late Mr. Arnold; and we do not see any reason of sufficient weight to refuse him that merit. Mr. Earnshaw has claimed it in his own favour; but Mr Arnold's labours have, at least, the advantage of priority; and the strength of this advantage not having been done away by any proofs, which in our opinion can be esteemed satisfactory, must decide our judgment in the present case, as in the like controversies upon other points, which have been considered in the course of this inquiry. The contrivance of the locking spring, or spring detent, therefore, appears to us to be due to the late Mr. Arnold. With regard to this mechanism, it is also worthy of remark, that the invention is entirely English, not a single passage existing in the writings of the French authors, by which any one of them might claim it with reason, or even plausibility. The first mention of any thing like the locking spring, to be found in foreign publications, is the detent without pivots, given by F. Berthoud in his "Supplément au Traité des Horloges Marines;" but that book was published in 1787, that is, five years after Mr. Arnold had taken out his patent, and when many watches upon that construction had been in circulation. We cannot, therefore, allow him the credit of this thought; nor do we find that other French artists have availed themselves of that hint, to carry the spring detent to the great degree of simplicity which it has attained in this country.

A little after the invention of the detached escapement, the isochronism of the vibrations of the balance, by means of the spiral spring, was, if not newly discovered, at least perfected and brought into general notice, and that principle added a great value to the detached escapement, while this mechanism secured the utility of the principle, by offering the species of insulated balance which it required. From some theories and experiments long known to the world, it would appear that the vibration of a spring might be always supposed of equal duration; and that advantage Dr. Hooke asserted himself to have attained with his invention in watches, which had been shown to several persons. The principle, however, could not be generally trusted, according to Dr. Hooke himself, who, in the postscript to his description of Helioscopes, (p. 29,) declares, that he had explained how the vibrations might be so regulated, as to make their durations, either all equal, or the greater, slower, or quicker, than the less, and that in any proportion assigned. We must suspect that these ideas were not properly digested, or regret that their communication by the author, in his lectures in Gresham College, was not sufficiently explicit to give precise rules for practice, and fix the attention of watch-makers upon the subject. After those hints, the principle seems to have been very little attended to for many years, and the isochronism was frequently attempted to be effected by means of mechanical contrivances in the escapement. Harrison endeavoured to accomplish that important object, by the form of the back of the pallets; and on the return of the voyage to Jamaica, added for the same purpose the cycloidal pin, to regulate the balance spring; but this method of adjustment never appeared satisfactory or certain. P. le Roy, in his "Mémoire sur la meillure Manière de mesurer le Temps en Mer," rewarded in 1766, first announced distinctly the discovery of a general principle, proper to produce the isochronism, by means of the balance spring, which is expressed as follows: that in every spring sufficiently long, a certain portion of it will be isochronal, whether long or short; that the length of this portion being found, if it be lessened, the long vibrations will be quicker than the short ones; and that, on the contrary, if the length be increased, the small arcs will be performed in less time than the great arcs." This important property of the spring enabled P. le Roy to bring to a happy issue his labours for the improvement of chronometry: and the art is indebted to him for the practical utility of that discovery, as much as for the invention of the detached escapement.

Berthoud found that the spiral spring, in order to be isochronal, must have an ascending force in arithemetical progression, and that this property may be affected, not only by the length of the spring, but by the number of coils, and the tapering or decreasing thickness from the centre to the extremity, &c. He adds, besides, the proportions of the tapering in many springs, which he had actually tried, and gives minute accounts of the experiments made with them in several time-keepers.

The late Mr. Arnold applied to the balance the cylindrical or helical spring, which had been employed long before to a variety of purposes instead of the spiral, which had been constantly used in watches since the time of Dr. Hooke and M. Huygens. This is one of the articles of his patent of 1782, whence it would appear, that provided the spring be made of that form, the vibrations cannot fail to be isochronal; but experience is contrary to that, notion, and artists are obliged to attend to a variety of circumstances in the application of the helical, as well as that of the spiral spring. At present, some watchmakers think that the helical spring does not possess any advantage with regard to that property; but as the opinion of other persons is in the affirmative, while all the manufacturers, as far as our knowledge goes, agree in considering the cylindrical form as more easily managed than the other, its application seems entitled to the merit of a practical improvement.

Mr. Earnshaw, in the explanation of his time-keepers presented to the board of longitude, after noticing the insufficieny of the cylindrical spring, states, that he had, by long preseverance, found how to make springs increasing in thickness to the outer end, in order to effect the isochronism of the vibrations. This method of obtaining isochronal vibrations had been long before explained by Berthoud, with regard to the spiral spring, in that part of his treatise on marine time-pieces which we have already quoted.

This artist states as a considerable discovery, that the balance spring falls off or tires in its strength, and he gives an allowance for it; but the fact is neither so constant nor so equable as to admit of his general remedy.

Fig. 7. represents the balance of a chronometer, or time-piece, as usually made by our artists. A circular groove is turned in the flat face of a piece of steel, and into this groove a piece of good brass is driven, and a little of the solution of borax is applied, to prevent oxydation. This compound piece being then put into a crucible, is made sufficently hot to melt the brass; which in these circumstances adheres firmly to the steel without requiring any solder. The face of the steel is then cleaned, and by proper application of the mechanical means of turning, boring, and filing, the superfluous steel is taken away, and the balance is left, consisting of two or sometimes three radii, and a rim, the external part of which is brass, and the internal part steel, the former metal being about twice the thickness of the latter. Some artists solder the metals together; and others plunge the steel balance into melted brass, and suffer them to cool together, but the method we have described appears to be the best. In this state the arcs of the rim are then cut through and diminished in their length as in the figure; and near that extremity of each arc which is farthest from its radius, a piece or weight is put on, which can be slided along the arm so as to be adjusted at that distance, which upon trial shall be found to produce a good performance, under the different changes of temperature. For it scarcely need be observed, that the flexure of these arms, by change of temperature, will carry the weights nearer to the centre in hot than in cold weather; and the more, the greater the distance of the weights from the radius. The small screws near the ends of the radii afford an adjustment for time, as the balance will vibrate more quickly, the further these are screwed in; and the contrary will be the case, if they be unscrewed or drawn further out.

Fig. 8. shews a balance according to a construction used by Arnold, and specified by him to the commissioners of longitude. The expansion weights are cylindrical, and are adjusted upon the arm by screwing: and there is an inner rim upon which three weights are adjusted by sliding. These serve to regulate the going of the time-piece in different positions.

If an uniform ring, with two or more radii placed at equal regular distances, and in all other respects alike, were to be poised on its axis, as a balance, no part would preponderate; but it would remain at rest in any position; and if we suppose the axis itself to be a spring, such as a piece of stretched wire, and we overlook the difference of tension in the wire, which might arise from the weight of the balance itself, in different positions, it is obvious that all the vibrations of that balance, through equal arcs, would be performed in equal times, whether the balance were made to vibrate parallel to the horizon, or in any other position. But in the balance of a time-piece, the pivots of its axis bear very differently, according to the position of the chronometer; and it requires some management to make the frictions the same, whether the axis be turning on one of its ends, or upon the two cylindrical faces of the pivots. And still more than this, since the balance itself has a permanent figure, compared with the spring, which in every part of the vibration alters its distance from the axis, and in every part of its length has a different degree of rotatory motion, it cannot be expected, nor does it happen, that a balance, which is found to be in poize, along with its spring, when out of the chronometer, will make equal vibration, as to time, in all positions when in its place. And in addition to these difficulties, there is one part of the arc of vibration, where the force of the spring, and the inertia of the balance, are not simply in opposition to each other, but are combined with the maintaining power: namely, during the action of escape. The remedy for all these difficulties, which is happily adopted in chronometers for use at sea, is to place the axis in a vertical position; by which means the balance itself is not affected by gravity; but for pocket time-pieces, the ingenuity of the artist is called upon for expedients, of which it would be not easy to exhibit a complete theory. The general principle commonly used, and also adopted by Arnold and Earnshaw, as far as can be gathered from the little they say in their specifications to the commissioners of longitude, is to consider the balance, when out of adjustment for position, as a pendulum weight above and below the centre of suspension, acted upon by gravity,—and at the same time urged to a quiescent point by the force of elasticity. In these circumstances the vibrations will be quickest when the point of stable equilibrium is downwards, and they will be slowest in the opposite position of the machine. This leads to the remedy of diminishing either the weight of the radius, or that side which is lowest when the rate is most quick. Thus, if one of the two adjusting screws, in fig. 7, were downwards, in the position of quickest rate, that screw would require to be screwed a very little quantity inwards, and the opposite screw to be screwed a like quantity outwards, in order to remedy this imperfection without much change in the other adjustments And if a like imperfection were found in the vibrations of the balance, when tried in a vertical position, having the lowest point at rest, in a line at right angles to the line passing through the radii, a similar alteration must be made in the expansion weights, either by a careful flexure of the circular arcs, or by altering the quantities of those weights; or else by means of small screws tapped into the weights themselves, and directed towards the centre, like the weights at the extremities of the radii.

By these, and other correspondent means, the balance may be made to keep time, in all those positions wherein its plane shall be perpendicular to that of the horizon; but even in these trials, very great pains and labour may be required to produce a high degree of accuracy; and in this course of operation, the skilful workman may be under the necessity of preparing a great number of expansion weights and regulating screws, to be applied in trial, whenever the course of adjustment in one part shall carry him beyond the general conditions of the whole machine. And after all, as the quantity of action, in the spring, must alter the quantity of pendulous effect, in this curious and delicate time-measurer, it may be doubted, whether the adjustments for position in the vertical balance can be effectual any longer than while the arcs of vibration continue permanent. This consideration leads us to the necessity of an adjustment in the maintaining power, in order that the vibrations shall not fall off;

at the same time that it affords one of the strongest arguments in favour of a remontoire, notwithstanding the experiment of Arnold, which showed that a sea-chronometer (face up) kept the same rate, when those arcs were greatly varied.

When the balance has been adjusted for position in the vertical situation, it does not follow, as a matter of course, that it will keep the same time with its plane horizontal, or face up and face down. In the former cases, the effect of gravity still appears to be combined with that of elasticity, though under circumstances of adjustment; in the latter, gravity seems to be out of the question. If the rate should demand adjustment with the axis vertical, in order to make it agree with that which obtains when the balance is vertical, it appears necessary, that either the inertia or the elastic force should be altered. The former seems to demand such changes of the screws or weights, as may alter the effective radius of the balance; the latter requires a change of the spring itself. The artists, with whom the writer of this article has conferred, did not seem to have clear notions of any direct method for effecting the purpose here pointed out. It appeared, that they have recourse to several expedients; but that, in general, the rate, face up, of a timepiece, which has been well adjusted in other respects, does not require much additional adjustment.

From all these considerations, with others, into which brevity forbids us to enter, together with those which relate to the choice and preparation of materials, and the delicacy and truth of workmanship, the reader will be able to form some judgment of the intelligence and skill, with which, chiefly under the sanction of the British government, this important manufacture has been pursued, and likewise of the ample field for improvement, which remains for the exertions of future artists. See Pendulum, Clock, Train, and Watch-work.

HOROPTER, in optics, a right line drawn through the point where the two optic axes meet, parallel to that which joins the centres of the two eyes, or the two pupils.

HOROSCOPE, in astrology, is the degree of the ascendant, or the star that rises above the horizon at a certain moment, which is observed in order to predict some future event, as the success of a design, the fortune of a person who was at that instant born, &c. The same name is also given to a scheme or figure containing the twelve houses, in which are marked the situation of the heavens and stars, in order to form predictions. See House.

Horoscope *lunar*, the point from whence the moon proceeds when the sun is in the ascending point of the east.

HORS, *de son fee*, an exception, to avoid an action brought for rent issuing out of certain lands, by him that pretends to be the lord, or from some customs and services; for if the defendant can prove the land to be within the compass of his fee, the action fails.

HORSE. See Equus.

Horse *dealers*. Every person, exercising the trade or business of an horse-dealer, must take out a licence from the Stamp Office, for which he shall pay annually, if within London, Westminster, the bills of mortality, the parish of St. Pancras, or the borough of Southwark, twenty pounds; elsewhere, ten pounds.

Horse-dealers, who shall, after January 1, 1796, carry on the said business without having obtained a licence under the act of 36 George III. c. 17, shall be liable to be assessed the duties on riding-horses, and shall deliver lists thereof as other persons.

Horses. It shall be lawful for any person, native or foreigner, at any time, to ship, lade, and transport, by way of merchandize, horses into any parts beyond the seas, in amity with his majesty, paying for each horse, mare, or gelding, 5*s*. and no more.

No person convicted for feloniously stealing a horse, gelding, or mare, shall have the privilege of clergy. 1 Ed. VI. c. 12. And not only all accessaries before such felony done, but also all accessaries after such felony, shall be deprived and put from all benefit of their clergy, as the principal, by statute heretofore made, is or ought to be.

If an horse be stolen out of the stable, or other curtilage of a dwelling-house, in the night time, it falls under the denomination of burglary; if in the day-time, it falls under the denomination of larceny from the house; and in either case there is a reward of 40*l*. for convicting an offender, and the prosecutor is entitled to a certificate, which will exempt him from all parish and ward offices, in the parish and ward where the burglary, or larceny, is committed, and which may be once assigned over, and will give the same exemption to the assignee as to the original proprietor.

Great abuses having arisen, and many horses having been stolen, from the facility and safety of disposing of them to those who keep slaughter-houses for horses, some regulations and restrictions seemed absolutely necessary. It was no uncommon thing for horses of great value to be sold for the purpose of making food for dogs, the thief rather choosing to receive twenty shillings for a stolen horse, without fear or danger of detection, than venture to dispose of him publicly, though he might possibly have found a purchaser who would have given as many pounds for him. These considerations induced the legislature to pass the act of 26 Geo. III. c. 71, for regulating these slaughter-houses.

Killing or maiming horses. Where any person shall, in the night-time, maliciously, unlawfully, and wilfully, kill or destroy any horses, sheep, or other cattle, of any person, every such offence shall be adjudged felony, and the offender shall suffer as in the case of felony. 22 and 23 Car. II. c. 7.

Offenders may be transported for seven years, either at the assizes, or at the sessions, by three justices of the peace; one to be of the quorum.

By the 9 Geo. I. c. 22. commonly called the black act, it is enacted, that if any person shall unlawfully and maliciously kill, maim, or wound, any cattle, every person so offending, being thereof lawfully convicted in any county of England, shall be adjudged guilty of felony, and shall suffer death, as in cases of felony, without benefit of clergy. But not to work corruption of blood, loss of dower, nor forfeiture of lands or goods.

Prosecution upon this statute shall, or may, be commenced within three years from the time of the offence committed, but not after.

If a horse, or other goods, be delivered to an innkeeper, or his servants, he is bound to keep them safely, and restore them when his guest leaves the house.

If a horse be delivered to an agisting farmer, for the purpose of depasturing in his meadows, he is answerable for the loss of the horse, if it be occasioned by the ordinary neglect of himself or his servants. If a man ride to an inn, where his horse has eat, the host may detain the horse till he be satisfied for the eating, and without making any demand. But a horse committed to an inn-keeper can only be detained for his own meat, and not for that of his guest, or any other horse; for the chattels, in such case, are only in the custody of the law for the debt which arises from the thing itself, and not for any other debt due from the same party. By the custom of London and Exeter, if a man commit a horse to an inn-keeper, if he eat out his price, the inn-keeper may take him as his own, upon the reasonable appraisement of four of his neighbours; which was it seems a custom, arising from the abundance of traffic with strangers, that could not be known so as to be charged with an action. But it hath been holden, though an inn-keeper in London may, after long keeping, have the horse appraised and sell him, yet, when he has in such case had him appraised, he cannot justify the taking him to himself at the price he was appraised at. And this cannot be done at any other place by the common law, unless there is some special custom.

Horse, in naval affairs, a rope reaching from the middle of a yard to its extremities, and depending about two or three feet under the yard, for the sailors to tread on while they are loosings, reefing, or furling the sails, rigging out the studding sail-booms, &c. The same word is used for a thick rope extending in a perpendicular direction near the fore or aft-side of a mast, for the purpose of hoisting some yard or extending a sail upon it: when before the mast, it is used for the square sail, whose yard is attached to the horse by means of a traveller which slides up and down When it is abaft the mast, it is intended for the try-sail of a snow, but it is seldom used in this position, except in sloops of war that occasionally assume the appearance of snows to deceive the enemy.

Horse *leech.* See **Hirudo.**

HORTUS *siccus*, a *dry garden*, an appellation given to a collection of specimens of plants, carefully dried and preserved. The value of such a collection is very evident, since a thousand minutiæ may be preserved in the well-dried specimens of plants, which the most accurate engraver would have omitted. We shall, therefore, give some methods of drying and preserving an hortus siccus. Specimens ought to be collected when dry, and carried home in a tin box. Plants may be dried by pressing in a box of sand, or with a hot smoothing iron. Each of these has its advantages. If pressure be employed, a botanical press may be procured. The press is made of two smooth boards of hard wood, eighteen inches long, twelve broad, and two thick. Screws must be fixed in each corner with nuts. If a press cannot easily be had, books may be employed. Next some quires of unsized blotting paper must be provided. The specimens, when taken out of the tin box, must be carefully spread on a piece of pasteboard, covered with a single sheet of the paper quite dry; then place three or four sheets of the same paper above the plant, to imbibe the moisture as it is pressed out; it is then to be put into the press. As many plants as the press will hold may be piled up in this manner. At first they ought to be pressed gently. After being pressed for twenty-four hours or so, the plants ought to be examined, that any leaves or petals which have been folded may be spread out, and dry sheets of paper laid over them. They may now be replaced in the press, and a greater degree of pressure applied. The press ought to stand near a fire, or in the sunshine. After remaining two days in this situation, they should be again examined, and dry sheets of paper be laid over them. The pressure then ought to be considerably increased. After remaining three days longer in the press, the plants may be taken out, and such as are sufficiently dry may be put in a dry sheet of writing paper. Those plants which are succulent may require more pressure, and the blossom paper again renewed. Plants which dry very quickly, ought to be pressed with considerable force when first put into the press; and if delicate, the blossom paper should be changed every day. When the stem is woody, it may be thinned with a knife, and if the flower be thick or globular, as the thistle, one side of it may be cut away, as all that is necessary, in a specimen, is to preserve the character of the class, order, genus, and species. Plants may be dried in a box of sand in a more expeditious manner, and this method preserves the colour of some plants better. The specimens, after being pressed for ten or twelve hours, must be laid within a sheet of blossom paper. The box must contain an inch deep of fine dry sand, on which the sheet is to be placed, and then covered with sand an inch thick; another sheet may then be deposited in the same manner, and so on, till the box be full. The box must be placed near a fire for two or three days. Then the sand must be carefully removed, and the plants examined. If not sufficiently dried, they may again be replaced in the same manner for a day or two. In drying plants with a hot smoothing iron, they must be placed within several sheets of blotting paper, and ironed till they become sufficiently dry. This method answers best for drying succulent and mucilaginous plants. When properly dried, the specimens should be placed in sheets of writing-paper, and may be slightly fastened by making the top and bottom of the stalk pass through a slip of the paper, cut nearly for the purpose.—Then the name of the genus and species should be written down, the place where it was found, nature of the soil, and the season of the year. These specimens may be collected into genera, orders, and classes, and titled and preserved in a portfolio or cabinet. The method of preserving many of the cryptogamous plants is more difficult, on account of the greater quantity of moisture which they contain, and the greater delicacy of their texture.

HOSPITALS, are institutions founded for the relief of the sick and miserable.

Hospital, *Pennsylvania.* This is one of the best organized institutions in the United States. The following account of it, together with hints for amending its police, is extracted from a work, entitled "A Treatise, containing a plan for the internal organization and government of Marine Hospitals, in the United States," &c. by Dr. Wm. P. C. Barton, professor of botany in the university of Pennsylvania:—

An account of the Pennsylvania Hospital, and its internal police

It is obvious, that in proposing regulations and arrangements for the internal administration of hospitals, whether naval, military, or civil, or in suggesting plans for the structure of wards, and other domestic contrivances, but little can be offered that is new. In both cases, the best we can do is, to take a view of some of the similar institutions in highest repute, and cull from their various and well-devised plans, such as are most useful, and consistent with the principles of economy and neatness.

With this view, I deem it far from irrelevant to the object of this work, to present some account of an institution, with the internal police of which I have long been familiarized; and which I believe, from a comparative view with the first hospitals of England, to be one of the best conducted institutions of the kind, perhaps, in any country. The hospitals of London are, it is true, conducted on a much more extensive plan: St. Thomas's, Guy's, and St. Bartholomew's, being perhaps twice as large as the one of which I am speaking—the Pennsylvania Hospital. But I think I can with truth assert, that the regularity, neatness, and regard to comfort, which characterize this noble institution, eminently entitles it to a preference to any of these, at least so far as it goes. The architectural plan of the building, its beautiful and healthy situation, surrounded as it is by a constant current of fresh air, unimpeded by any buildings, or other hindrances, render this institution one of the most salubrious resorts for the sick or afflicted, that could possibly be contrived in the midst of a large and populous city.

The hospital presents a south front; the wings which intersect the long buildings, that join them to the main edifice, at right angles, present the one an east, and the other a west, front. The centre building, or main edifice, is sixty-four feet in front, elevated above all the adjoining buildings, (being three stories high) and projecting beyond them both front and back. On the summit of the roof is a sky-light, forming the apex of the operating theatre, which receives its light entirely from this. Two large staircases, leading to the several wards and apartments up stairs, are constructed in this building, running from the main hall.

Adjoining this centre edifice, on the east, is a building 80 feet front, and 27 feet deep, two stories high, from the surface of the ground, and three, including the range of windows in the area below. This building is divided, in its upper stories, into two wards, extending nearly to its entire length and breadth; and the lower or basement story is subdivided into a row of cells on the south side, and a lobby on the north. The two long wards are ventilated by openings into the chimnies, of which there are four in each ward, near the ceiling. At the east end of these wards, two small apartments are partitioned off, about 10 feet square, the one intended for a pantry, and the other for a lodging-room for the assistant nurses of the ward. At the other, or west termination of the upper ward, two small rooms, of the same size, are partitioned off, for patients who may require a separate room. The lower ward extends in length to the centre building.

Intersecting this long building, at right angles, and adjoining it, facing the east, is a wing two stories high, running north and south, extending in length 110 feet. In the middle of this wing, opposite to and communicating with the long ward, is an hall, 28 feet square, including the stair-case, projecting beyond the line of the wing sufficiently to cover the cornice, and raised one story above it, with a cupola. In the north and south ends of this wing are two sick wards, and between them and the hall, on each side of it, are two lodging-rooms for the nurses. The arrangement in the second story is the same.

Adjoining the centre edifice, on the west, is a long building, 34 feet deep, divided into 42 cells, for lunatics, with a window in each. These cells front north and south, and are separated in the middle by a long lobby, about 12 feet wide, which is lighted from the cells, by the small windows over each door. The west wing, which intersects this long building at right angles, is in all respects subdivided like the east. The structure upstairs is the same as that of the first story, being divided into wards, and a double row of cells.

In the basement story, there is likewise a double row of cells, all round the wing and long building, the windows of which open into the area. All the cells are warmed by flues in their partition walls, communicating with the chimney, and opening into wall stoves, the doors of which are in the lobbies—one stove warms two rooms. The whole extent of the buildings, from east to west, is 278 feet. In consequence of the length of the wings crossing the long wards, and rows of cells, the east and west fronts present a finished and agreeable appearance.

Detached from the main building, and at a convenient distance from it, near the east wall, is a two story building: divided into a kitchen, pantry, lodging-room for a nurse, and four small wards for venereal patients.

Near the west wall are two buildings, two stories high, the one containing washing, ironing, and drying rooms; the other stables, &c.

The different apartments in this hospital are as follow:

Centre building.

Kitchen, scullery, steward's dining room, maid's lodging-room, in the basement story.	4
A library-room, on the first floor, an apothecary's shop, ditto, manager's room, ditto, steward's room, ditto,	4
The contributors' room, in the second story, chambers for the resident physician, pupils, and steward, ditto	3

Operation-room, in the third story, museum, ditto, small apartments near the operation-room, for the patients operated on, ditto	4
Baking-rooms and larders, in the cellar	3
Bathing-rooms in the basement story of the west wing	2
Room for deputy-steward and his wife, in ditto	1
Cells for lunatics in the west wing	70
Ditto, in the east	16
Wards for sick and wounded in the whole building	23
In all, wards and rooms,	130

The square ground plot, on which the hospital stands, is 396 feet in width, and 468 feet in length, containing about four acres. It is enclosed by a brick wall, with an iron palisade in its front. It is surrounded by fine rows of lofty sycamore trees, and the grounds are well laid out in a beautiful garden behind, and grass plots and hedges in front. There is a vacant square to the east, and half a square on the west, making together above six acres. These squares lay across eighth-street on the east, and ninth-street on the west, parallel to the lines of the hospital-enclosure. Besides these, there are three vacant squares on the south side of pine-street, opposite the hospital, which belong to this institution; so that every benefit that arises from airiness of situation is insured to this hospital. The other half square, on the west, belongs to the Alms-House, and it is intended to be kept open; so that the Pennsylvania hospital may be said to stand in the middle of several great squares, which, without including the open streets, contain more than thirteen acres.

This institution was founded by the contributors in the year 1752, for the relief of lunatics, and the sick poor of Pennsylvania. These contributors are such persons as have paid into the hospital fund the sum of 10 pounds, or upwards. "They have perpetual succession, with the power to elect twelve managers, a treasurer, and all other officers of the institution, and to make rules and regulations for the government of the household. They may receive and take the lands, hereditaments, and tenements, not exceeding the yearly value of one thousand pounds, of the gift, alienation, bequest, or devise, of any person or persons whomsoever, and of any goods and chattels whatsoever: Provided, that no general meeting of the contributors, or persons acting under them, shall employ any money or other estate, expressly given to the capital stock of the hospital, in any other way than by applying its annual interest or rent toward the entertainment and care of the sick and distempered poor, that shall from time to time be brought and placed therein, for the cure of their diseases, from any part of the state, without partiality or preference."

The contributors have vested the managers with the authority to establish the mode of admitting and discharging patients, and the terms upon which they are to continue in the hospital; also to elect the medical and other officers of the institution.

They admit as many other poor patients (after the established number of paupers, supported by the capital stock, are admitted) as they can agree to take upon reasonable rates. The fund arising from the profits of the board and nursing of such patients is appropriated to the same uses as the interest money of the public stock. The overseers of the poor of Pennsylvania, and its religious societies, pay three dollars per week for each patient. Those of other states pay four dollars; private patients, residents of Pennsylvania, from three and a half to six dollars; those of other states, from four and an half to eight dollars.

The anatomical museum contains a collection of dried preparations—castings in plaster of Paris of the gravid uterus—two wax models of the human body—pictures representing the blood vessels, the fœtus in utero, &c. &c. in crayons, the gift of Dr. John Fothergill, of London; together with many valuable preparations in spirits. Every stranger, or visitor, pays one dollar for admission into this museum. Students, who have taken a ticket to attend the practice of the house, are, however, admitted without any extra charge.

The medical library consists of about 3000 volumes of well chosen books. To this number has lately been added, the whole of the botanical, natural, and historical works, from the library of the late Professor Barton.

The library and museum are supported and enlarged by the fund accruing from the money paid by students to attend the hospital, which is 10 dollars per annum each. This fund amounts to a yearly income of above two thousand dollars, the number of students who take tickets being usually between two and three hundred.

The managers, the physicians, the surgeons, and the contributors, serve the institution gratuitously. Persons, however, who are able to do it, are at liberty to remunerate the attending physicians and surgeons as they would in private houses.

Every private patient has the liberty of choosing any one of the physicians of the hospital to attend him, whom he prefers.

The amputation of a limb cannot be performed, without a consultation and agreement of the three surgeons of the house; and in no case without the consent of the patient.

No medical man can be elected a physician or surgeon of the hospital, who is under twenty-seven years of age.

The sitting managers meet on Wednesday and Saturday mornings of every week, to admit and discharge patients.

Between these periods, the patient desiring admittance must apply to the attending physician or surgeon, and obtain his certificate that he is a proper subject for admission. This is carried to one of the sitting managers, who takes the usual security, and orders his admission.

Overseers from the country, who bring a patient for admission, are obliged to have a certificate, signed by two magistrates, signifying that they are in office, and that the pauper belongs to their district.

Persons, with infectious diseases, are not admitted. Incurables are not admitted, except lunatics. All cases of sudden accident are admitted without form or charge, if brought within 24 hours after they have happened.

The capital stock of this hospital amounts to 124.854 dollars. The real estate consists of vacant lots surrounding the hospital area, &c. &c.

The officers of the institution are as follow:—

12 Managers, who serve gratis.	
3 Physicians, who also give their attendance gratis.	
3 Surgeons, ditto.	
A physician to the lying-in department, ditto.	
A physician to the out-patients, per annum - - - - -	$300.00
A resident physician, who serves gratis.	
A dresssr, and an apothecary, (pupils of the house, who serve 5 years) ditto.	
A steward, and a matron - -	600.00
Deputy-steward, or superintendant of the west building, and deputy-matron of the same	350.00
A gardener - - - - - -	$216.00
An assistant ditto - - -	144.00
Four cell-keepers, each, - -	144.00
A carter - - - - - -	144.00
A labourer - - - -	144.00
A watchman - - - -	144.00
A baker - - - - - -	144.00
A porter - - - - -	96.00
Four nurses, each $1.33 per week,	276.64
Five assistants ditto, each $1.25 per week, - - - - -	325.00
Cook, $1.30 per week, -	69.16
Four chambermaids, each $1.25 per week, - - - - -	320.00
Three laundresses, hired 5 or 6 days in each week, at 62½ cents per day, - - - - -	487.50
A sufficient number of women are hired every spring, to white-wash and thoroughly clean every part of the house. Their wages and materials employed amount to - - - -	167.50

Hints and Propositions suggested to the Managers of that Institution, for the better ventilation of the Wards, and improving some of the internal arrangements.

Ably conducted as is this institution, systematic as is its internal police, and salutary as are its general regulations, there is, nevertheless, room for amendment and reform. It may not be amiss to suggest a few improvements, which I think would render this hospital more complete. I would propose,

1st. That all the wards in the east and west wings (I mean the buildings which front east and west) should be ventilated by means of air-ducts in some one corner of each ward, communicating externally. These wards have no contrivance for ventilation.

2d. That the long wards of the building that joins the centre to the east wing should be furnished with four or six ventilators in the window sashes, to render the ventilation of those wards more perfect.

3d. That an air-duct should be introduced into the entry of each story of the west building, that contains the cells for lunatics, which air-ducts should be ten or twelve feet in length, so as to pass through the corner cells of each story, and communicate with the external air; these air-ducts should be introduced alternately in the north and south walls, from the lower story.

4th. That a communication should be made between the lower entry and that of the ground-floor, by gratings similar to those in the entries of the second and third stories. This could easily be done, by removing the boards covering the openings that appear to have been originally left. Though I have before remarked that this part of the hospital is uncommonly well ventilated, yet these alterations and additions would, I think, render the ventilation quite perfect.

5th. I would recommend that warm, cold, and vapour baths be constructed in some convenient part of the east building, on the first floor, to be appropriated exclusively to the use of the patients of that part of the hospital, and such private patients (not maniacs) as inhabit the large rooms in the west building. (These are now erected.)

6th. That two small buildings be erected, about twelve or fourteen feet square, and 2 stories high, at the distance of about fifteen feet from the north end of the east and west wings, and communicating with each story of these wings by means of a covered corridor. Or, should this plan be found inconvenient, such buildings might be erected on any part of the north side of the hospital, that an architect should deem most proper.

7th. That a building, containing convenient dissecting rooms, be erected in some part of the area of the hospital, remote as possible from the main buildings, for the purpose of examining and dissecting dead bodies. No hospital is complete without such a building.

8th. That the American chimney-place stove be erected in the managers' room, the library-room, and as many of the wards as convenient. The first cost of these stoves would be considerable, but their erection would result in an annual saving of three-fourths of the quantity of fuel usually consumed in open fire-places.

9th. That a concise and well written account of the hospital be printed in small pamphlets of four or five pages, and be sold by the gate-keeper for three-pence each, to such strangers as visit the hospital, who may be disposed to purchase them. Scarcely any person visits an institution of this kind, who would not willingly give three-pence for an account of it; and the annual amount of the sale of such pamphlets at the gate would, I am persuaded, be considerable. The perquisite for showing the great hall of Greenwich hospital to strangers is one shilling, three-pence of which goes to the person who exhibits it. The remaining nine-pences make an annual revenue, which supports, clothes, and educates, twenty boys, the sons of distressed seamen. I would propose that the fund arising from the sale of such description of the hospital be appropriated toward the support of an additional number of paupers in the institution.

10th. That at some future day, when the finances of the hospital will admit of it, and their vacant lots shall be exempted from the present unjust taxes to which they are subjected, a lunatic asylum be erected on such one of the vacant lots as may be deemed best situated for the purpose; and that all that portion of the present building now divided into cells be converted into wards for the sick. In fact, the legislature of this state should grant an adequate sum of money for this purpose, and enable the contributors to the institution to commence such an asylum immediately.

11th. That the resident physician be invested with more authority and control over the general economy of the household than he now has. His consequence in that institution, considering the important station he fills, is much too inconsiderable.

12th. That as the attending physicians and surgeons of the hospital serve gratuitously, the hard duty they are now obliged to perform, in visiting all patients previously to their being admitted into the house, who are not able to call on them, be, under certain circumstances, dispensed with; and that in such cases the resident physician's certificate for admission shall be deemed sufficient and satisfactory.

13th. That the bedsteads be all raised at least six or eight inches, and that only twenty-four be arranged in each long ward; and six in each of the wards of the east and west wings.

HOT-*house*. This convenience is productive of many articles at the tables of the rich and luxurious, and may be said to constitute the chief pride of many gardeners, and indeed of many persons in the highest circles of society. Illiberal persons are, however, prone to decry those productions, which do not ordinarily enter within their own use and consumption, and it is not unusual to hear many execrations uttered against hot-houses, temples, &c. and other edifices, which ornament the gardens and pleasure grounds of the affluent, under the idea that the money so expended is thrown away. But when we consider how many families are maintained by the labour required, either in manufacturing, or in appropriating the several materials, we certainly may consider hot-houses in particular as claiming an exemption from such indiscriminate censure.

In truth, hot-houses are highly useful; they not only serve to give a stimulus to common gardeners, of whom many affect to vie in early productions, but they serve as the receptacles for those exotics, which could not be reared, nor even preserved, were it not for the similarity thus artificially produced with their native climates. We have various instances of the naturalization of foreign shrubs, &c. which in time became nearly as hardy as our indigenous plants of the tender class; but which could never have been propagated, if exposed to the severity of our winter months.

The site of a hot-house is extremely important, as on this much will depend. A south-south-west aspect is to be preferred, as greatly inducive to economy during the summer time, which, in some seasons, are warm enough to obviate the necessity for many expenses, that in an unsettled year become indispensable; this, in places where fuel is scarce, and consequently dear, is a matter of serious consideration.

The best plan for a hot-house we consider to be a parallelogram, of whatever length may be thought proper; the front wall to be about a foot high, so as to rise above the level of the adjacent surface in such manner as may exclude heavy rain, &c. and to bring the plants to such a level as may give them a full exposure to the sun. On the front wall a perpendicular glass frame, of about two feet and a half, should be raised, so that its upper ledge should stand at full three feet and a half above the ground. This is necessary, for the purpose of allowing the sliding frames to be drawn out on occasion, and to give height within for the gardener's operations. The breadth of the interior ought not to exceed fourteen feet, and the back wall should be high enough to give the top or sliding frames an angle of thirty-five degrees from the horizon. The tan-binns should be excavated in a diagonal manner; shallow in front, but at their back to the depth of six feet, and divided off into compartments, so that each portion, say six feet square, might be supplied, as occasion should demand, with fresh tan, without causing the adjoining parts to be disturbed, or, as is too often the case, to fall in.

The surface of the tan-binns should partially correspond with the angle made by the upper glass frames, or at least it should stand at an angle of full twenty degrees from the horizon; so that the plants should not lay on a flat bed, but rise like a flight of steps towards the back of the tan-binns. By this means, when the excavation, which in this mode need scarcely be a foot in depth, is filled with tan. It will give various degrees of heat, according to the depth, in each part respectively, as it may be more or less removed from the front of the hot-house. We, however, rather recommend, that only half should consist of hot-beds, and that the front part be built up with benches of masonry, perfectly air tight, through which flues should be made, whereby such pots as might stand on them would receive a degree of warmth sufficient to preserve many of the more hardy exotics. We likewise are disposed to consider sliding frames to be far inferior, both in regard to their safety, and as relating to the closeness of shutting, to such as are made to rise on hinges at their upper ends, and which, having projecting battens to throw off the wet, into the centre of their supporting rafters (which should be grooved to receive the wet, and to conduct it downwards) effectually exclude exterior moisture, and, by being listed within, debar the access of frost. We have, in Plate VII. Miscel. given some idea of this arrangement, wherein fig. 1. shows the internal section of the hot-house, with the binns for receiving the tan; also the angles of the surfaces, both of the tan-binns and of the glass frames; the latter, being divided into two or more parts, may be opened at pleasure, by means of the racks, to any height. The benches in front are all flued, and rise *en escalier*, *i. e.* by regular steps, for the purpose of displaying all the plants standing on them, and to give them a proper portion of the sun's influence, without which no plant will thrive, or be either so well flavoured, or so highly coloured. In fact, warmth without light will produce no good effect on the vegetable world.

Fig. 2. displays the manner in which the flues are made to meander through the several benches, between which the intervals should be filled up, to within two feet of their tops; thereby to allow the means of shifting, watering, or the whole may be built up as in fig. 3. provided their joint breadths do not exceed three, or three and a half feet; if more, they would preclude the possibility of giving the due attention to each individually. The square

black spaces, under each bench, shows the passages of the flues, the sides being half a brick in thickness, and the tops covered only with a strong tile, well cemented down, and plastered over. By this means any part of the flues can be easily cleaned or repaired. Our readers will of course understand, that where any part of the hot-house is thus benched, it need not be excavated, that mode being only requisite for the lodgment of the tan in the parts intended for keeping up the heat by immersion of the pots in the hot-beds.

The average heat of the interior should be from about 75 to 80 degrees; but at particular critical times, when pines, &c. require much forcing, it may be carried up to full 85, or even to 90 degrees, so as to correspond with the temperature of their natural climate. It is remarkable, that in those places where pines grow wild, they possess the highest flavour, far exceeding that of the domesticated fruit, and that they ordinarily undergo a change of about 12 or 15 degrees between the average heats in the shady parts, where they grow, at mid-day, and at mid-night. Yet our gardeners keep them full as warm during the night, as during the day. Perhaps some assiduous and curious speculator in this branch of horticulture may deem the above hint worthy of notice. The entrance into a hot-house should always be by means of a small anti-chamber, shutting very close; for when a door opens abruptly, so as to admit the external air, those plants which are contiguous thereto will receive a shock from the cold air, thus inevitably allowed to reach them, and will be far less luxuriant than others of the same kind, which, by a more fortunate locality, escape the baneful influence. We would recommend the sketch given in fig. 4, to the attention of our readers; in it A is the anti-chamber to the hot-house B, and C is the fire-place, whence the chimney forms the several flues that pass under the benches, and through the back wall D, C ending in the chimney E.

It will be found most convenient to have the door in the centre of one end of the hot-house, and as that part will necessarily be raised by the slope of the surface of the beds and benches, four or five steps may be made, either in the anti-chamber, or in the hot-house. It will also be found useful to make in the back wall various small apertures, one for each binn, that the old tan, which has lost its heat, may be removed from below by means of scoops and hoes; the surface of the binn being, in the meanwhile, covered with bass-mats, straw, &c., to exclude the external air. When the old tan has all been removed, the aperture should be closed, and the fresh tan be filled into the binn by two men, with a long narrow basket, which might be advantageously rolled up the path-way or alley, between the binns and the benches, on a small truck frame.

In small hot-houses, such as we sometimes see in the gardens attached to little country-boxes, the heat might be circulated from a kitchen fire, provided the benches were raised sufficiently high to receive that benefit without affecting the draught. This would, in many instances, be found convenient and economical. In such the air might be admitted, merely by having one or two panes of glass set in metal frames, to be opened on hinges, as we often see in places where sash windows would not answer, or where only a slight change of air is needful.

We shall conclude this article with remarking that hot-houses require considerable attention, and are extremely expensive, both in their construction and in their support. A thermometer should always be suspended in some shady part; and, in warm weather especially, it will be found extremely convenient to have tin ventilators set in the sides, near the tops, as shown in the figure; their action might at any time be stopped, by putting on a tin cap or cover, or by a sliding board; the latter would prove most convenient.

During the day time, in the summer season, the fires may frequently be allowed to go out; but so soon as the evening chill is felt, the glasses ought to be closed, and the flues to be heated. As, however, some plants require more air than others, we offer to the consideration of our horticultural readers, whether a perpendicular glazed frame, dividing the hot-house longitudinally into two distinct parts, the front one to be kept partially opened, and the back one completely closed, would not be an improvement in the construction of this species of buildings. This might be so contrived as more effectually to guard against the sudden access of cold air, and serve as an auxiliary to the precaution already suggested, of having the entrance guarded by means of an antichamber. The manner of attending to the plants in hot-houses will be seen under the head of GARDENING, where we have endeavoured to furnish a complete, but concise essay and calendar, and in which every matter of utility, of ornament, and of luxury, has been allowed its due notice.

HOTTONIA, in botany, *water-violet*, so named in honour of Peter Hotton, professor of botany at Leyden, a genus of the Pentandria Monogynia class and order. Natural order of Palmæ. Lysimachiæ, Jussieu. Essential character: corolla salver shaped; stamina placed on the tube of the corolla; capsule one-celled. There are four species.

HOVENIA, in botany, so named in honour of M. Hoven, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: petals five, convoluted; stigma trifid; capsule three-celled, three-valved. There is but one species, *viz.* H. dulcis, a native of Japan, near Nagasaki.

HOVERING, in law: ships of fifty tons, laden with customable or prohibited goods, hovering on the coasts of this kingdom, within the limits of any port (and not proceeding from foreign parts) may be entered by officers of the customs, who are to take an account of the lading, and to demand and take a security from the master, by his bond to his majesty, in such sums of money as shall be treble the value of such foreign goods then on board, that such ship shall proceed, as soon as wind and weather, and the condition of the ship, will permit, on her voyage to foreign parts, and shall land the goods in some foreign port; the master refusing to enter into such bond or demand, or who, having given bond, shall not proceed on such voyage (unless otherwise suffered to make a longer stay, by the collector or other principal officer of such port where the vessel shall be, not exceeding twenty days;) in either of the said cases, all the foreign goods on board may be taken out by the custom-house officers, by direction of the collector, and properly secured; and if they are customable, the duties shall be paid, and if prohibited, they shall be forfeited. The officers of the customs may prosecute the same, as also the ship, if liable to condemnation, 3 Geo. III. c. 21. Commanders of men of war, and custom-house officers, may compel ships of fifty tons, or under, hovering within two leagues of shore, to come into port. 6 Geo. I. c. 21. If any ship or vessel shall be found at anchor, or hovering within eight leagues of the coast, (except between the North Foreland and Beachy Head) unless by distress of weather, having on board foreign spirits, in any vessel or cask which shall not contain sixty gallons at least, or any wine in casks (provided such vessel have wine on board) shall not exceed sixty tons burthen, or six pounds weight of tea, or twenty pounds weight of coffee, or any goods whatever liable to forfeiture upon importation, that such goods, with the ship and furniture, shall be forfeited; spirits for the use of seamen, not exceeding two gallons per man, excepted. 42 Geo. III. c. 82.

HOUND, a hunting dog, of which there are several sorts, as the grey-hound, gaze-hound, &c. See CANIS.

HOUNDS, in naval language, a name given to those parts of a mast-head, which gradually project on the right and left side beyond the cylindrical or conical surface, which it preserves from the partners upwards.

HOUR, *hora*, in chronology, an aliquot part of a natural day, usually a twenty-fourth, sometimes a twelfth. But the word hour has not always been of the same signification; for in ancient times an hour did indefinitely express a short space of time. It is thought too, that anciently the four seasons of the year, wherein the sun finishes its annual course, had the name of hours, because Horus instituted a certain year, consisting of three months; and for this reason the ancients called spring, summer, autumn, and winter, hours, and the year itself hours: of which some footsteps appear in this, that the Greeks called their annals *Hori*; and the writers of them *horographi*. However it be, the division of the day into hours is very ancient, though the most ancient hour is that of the twelfth part of the day.

An hour, with us, is a measure or quantity of time, equal to a twenty-fourth part of the natural day, or nychthemeron; or it is the duration of the twenty-fourth part of the earth's diurnal rotation. Fifteen degrees of the equator answer to an hour; though not precisely, yet near enough for common use.

The hour is divided into sixty minutes; the minute into sixty seconds; the seconds into sixty thirds, &c.

There are divers kinds of hours, used by chronologers, astronomers, dialists, &c. Sometimes hours are divided into equal and unequal. Equal hours are the twenty-fourth part of a day and night precisely; that is, the time wherein fifteen degrees of the equator mount above the horizon. These are also called equinoctial hours, because they are measured on the equinoctial: and astronomical, because used by astronomers. They are also differently denominated, according to the manner of accounting them in different countries. Astronomical hours are equal hours, reckoned from noon, or mid-day, in a continued series of twenty-four. Babylonish hours are equal hours, reckoned in the same manner from sun-rise. The Italian hours are also equal hours, reckoned in the same manner too, from sun setting. European hours are also equal hours, reckoned from mid-night; twelve from thence too noon, and twelve more from noon to mid-night. Jewish, or planetary or ancient hours are the twelfth part of the artificial day and night, each being divided into twelve equal parts. Hence, as it is only in the time of the equinoxes that the artificial day is equal to the night, it is then only that the hours of the day are equal to those of the night: at other times they will be always either increasing or de-creasing. And they will be the more or less unequal according to the obliquity of the sphere.

HOUR *glass*, a popular kind of chronometer, which serves to measure the flux of time by the running of sand from one vessel into another. Glasses of this kind for half and quarter hours, and for less divisions of time, are much used at sea.

HOUSE, in astrology, denotes the twelfth part of the heavens. The division of the heavens into houses is founded upon the pretended influence of the stars, when meeting in them, on all sublunary bodies. These influences are supposed to be good or bad, and to each of these houses particular virtues are assigned, on which astrologers prepare and form a judgment of their horoscopes. The horizon and meridian are two circles of the celestial houses, which divide the heavens into four equal parts, each containing three houses; six of which are above the horizon, and six below it: and six of these are called eastern, and six western houses. A scheme or figure of the heavens is composed of twelve triangles, also called houses, in which is marked the stars, signs and planets, so included in each of these circles. Every planet has likewise two particular houses, in which it is pretended that they exert their influence in the strongest manner; but the sun and moon have each of them only one, the house of the former being Leo, and that of the latter Cancer. The houses in astrology have also names given them according to their qualities; the first is the house of life; this is the ascendant, which extends five degrees above the horizon, and the rest below it: the second is the house of riches; the third the house of brothers: the fourth, in the lowest part of the heavens, is the house of relations, and the angle of the earth: the fifth, the house of children: the sixth, the house of health; the seventh, the house of marriage, and the angle of the west: the eighth, the house of death: the ninth, the house of piety: the tenth, the house of offices: the eleventh, the house of friends: and the twelfth, the house of enemies.

We have given this and other brief accounts of the most absurd of all pretended sciences, in order to shew the folly of those, who were, in former times, weak enough to give any degree of credit to it.

HOUSED, in sea language, the situation of the guns, upon the middle and lower gun-decks, when they are run in, and the breech being let down, the muzzle gets against the side above port. They are there secured.

HOUSTONIA, in botany, so named, from William Houston, M. D. a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla one-petalled, funnel form; capsule superior, two-celled, two-seeded. There are two species, *viz.* H. cœrulea, blue-flowered Houstonia, and H. purpurea, purple-flowered Houstonia, natives of Virginia and Maryland.

HOUTTUYNIA, in botany, so called in honour of Mart. Houttuyn, M. D. a genus of the Monoecia Monandria class and order. Natural order of Peperitæ. Aroideæ, Jussieu. Essential character: calyx four-leaved; corolla none; stamens mixed with the pistils. There is only one species, *viz.* H. cordata; it was discovered in Japan, between Miaco and Jeddo.

HOY, in naval architecture, a small vessel fitted only with one mast.

HUDSON'S *bay company*. See COMPANY.

HUDSONIA, in botany, from William Hudson, a genus of the Dodecandria Monogynia class and order. Natural order of Bicornes. Ericæ, Jussieu. Essential character: calyx five leaved, tubular; corolla none; stamens fifteen; capsule one celled, three valved, three seeded. There is only one species, *viz.* H. ericoides, a native of different parts of the United States.

HUE and CRY, is the ancient common law process after felons, and such as have dangerously wounded any person, or assaulted any one with intent to rob him. And it has received great countenance and authority by several acts of parliament. In any of these cases, the party grieved, or any other, may resort to the constable of the vill; and, 1st, give him such reasonable assurance of the fact as the nature of the case will bear: 2. If he know the name of him that did it, he must tell the constable; 3. If he know it not, but can describe him, he must describe him, his person, or his habit, or his house, or such circumstances as he knows, which may conduce to the discovery; 4. If the thing be done in the night, so that he knows none of these circumstances, he must mention the number of persons, or the way they took: 5. If none of all these can be discovered, as where a robbery, or burglary, or other felony, is committed in the night, yet they are to acquaint the constable with the fact, and desire him to search his town for suspected persons, and to make hue and cry after such as may probably be suspected, as being persons vagrant in the same night; for many circumstances may happen to be useful for discovering a malefactor, which cannot at first be found out. For the levying of hue and cry, although it is a good course to have a justice's warrant, where time will permit, in order to prevent causeless hue and cry, yet it is not necessary, nor always convenient; for the felon may escape before the warrant be obtained. And upon hue and cry, levied against any person, or where any hue and cry comes to a constable, whether the person be certain or uncertain, the constable may search suspected places within his vill, for the apprehending of the felon. And if the person, against whom the hue and cry is raised, be not found in the constablewick, then the constable, and also every officer to whom the hue and cry shall afterwards come, ought to give notice to every town round about him, and not to one next town only; and so from one constable to another, until the offender be found, or till they come to the sea-side: and this was the law before the conquest. Hue and cry also is good, and must be pursued, though no person certain can be named or described.

HUER, or Hver, the Icelandic name for streams of heated water, which are forced with great violence through apertures in the earth by internal causes, to a great height, in that wretched Island. Numerous as are the phenomena of nature, there is none more capable of exciting astonishment and admiration than the huer. These grand fountains far exceed the most celebrated attempts to rival them by many, very many fathoms, exclusive of possessing the property of increasing their beautiful effect by the discharge of steam in vast volumes, almost resembling fleecy clouds. The heat of the water of the different fountains varies considerably, the fluid flowing gently from some, and spouting upwards from others in an actual state of boiling. Those which have the properties of common springs, except in their heat, are called laug, or a bath; the heat, though unequal, was never known to be less than 188 of Fahrenheit's thermometer, and Dr. Von Troil found the water at Laugarnas 188, 191, and 193. At Geyser, Reykum, and Laugarvatn, 212.

It is not unusual to find the springs closed in some places, with others opened near them; and there are traces of huers without a drop of water in their vicinity. Olafsen asserts, that a huer burst forth at Reikakio, in 1753, forty-two feet in breadth, eighteen in depth, and at three hundred in distance from a spring, which had been overwhelmed by a fall of the adjoining soil. The water, thus impeded in its progress, occasioned convulsive motions in the earth, and loud explosions were heard by the inhabitants before the imprisoned stream obtained a vent.

The apertures, through which the water passes, are lined with an incrustation, which is most pure in those that emit it perpendicularly. This substance is said to resemble chased work, is of a very fine grain, and will not effervesce with acids; unfortunately, the circumstances that excite curiosity to examine these springs prevent its gratification, as it is impossible to explore their depths, or dig round them, without danger; an opportunity occurred, however, at Laugarnas, where Dr. Von Troil had the satisfaction of observing the course of a spring through a bright gray clay, "the surface of which was covered with a white rind; but was on the side nearest the clay quite smooth, and crisped on the upper side. The vein flowed a good way under this crust, through a canal, formed of a similar matter, and the whole canal was filled with crystals, which had a very pleasing effect." He was interrupted in his attempts to trace the further progress of the water by its retirement to subterraneous passages, where, compressed by exhalations, and acquiring greater heat, it has forced a new course, and gushes out at an opening some distance from the first mentioned.

The water has a sulphurous taste, in some instances, when hot, but is exactly similar to common boiled water when cold. It is used by the inhabitants for dying, and might be applied to many purposes with great advantage, as victuals may be dressed by its heat, merely by placing the meat in a covered vessel, immersed in common water, and that in the boiling fluid; they have indeed evaporated sea water over it, and made excellent fine salt; and the cows which drink from the stream after it has cooled are said to give great quantities of good milk. Olafsen says, that syrup of violets will not change its colour, and that alkali has no effect when thrown into it. There cannot be a doubt, that the heat of these springs and fountains is derived from the volcanoes of the island, but for obvious reasons they are seldom found very near them; they are common throughout the country, in the vallies between mountains, and even the summits of the ice mountains have their huers, particularly Torfa Jockul, which abounds with hot springs, and two send their water to a great height; besides those, there is a lukewarm spring near Haadegis Hunk, on Gueland's Jockul, at the base of the mountain, with numerous marks of closed huers. The influence which urges this heated water upwards is so considerable, as to force it in that state through the cold medium of the sea, the steam accompanying it floating from the place, and pointing out the situation of the spring. Dr. Von Troil enumerates many separate huers and fountains, which he visited in different parts of the island; amongst those the valley of Reykholts contains the greatest number. This vale is two miles and a half in breadth, and the steam arising from it is conspicuous for several miles, producing an appearance exactly similar to the smoke ascending from a volcano. The huers at Oelves are supposed to be the largest in Iceland; and the most remarkable are Geyser and Badstofn; there is one at this place which emits vapour only, but so very hot, that water may be boiled by holding it above the steam a few minutes.

Geyser is situated about two days journey from Mount Hecla, near a farm called Haukadal. Here, says Dr. Von Troil, a poet would have an opportunity of painting a picture of whatever nature has of beautiful and terrible united, by delineating one of its most uncommon phenomena; it would be a subject worthy the pen of a Thomson, to transport the reader, by poetical imagery, to the spot which is here presented to the eye. A spacious plain, bounded on one side by very distant mountains, covered with ice, and their summits enveloped in clouds, which frequently changing their position, descend to their bases, leaving the pointed crags as if resting upon them, are the least interesting part of the wild and chilling wonders surrounding Geyser. Hecla, frowning with volcanic majesty, and exhibiting three vast pyramids encrusted with ice, towering far above the clouds, sends forth enormous volumes of smoke, which, floating away in the direction of the wind, and uniting with them, forms another portion of this horrid circle, which is completed by a ridge of high rocks, wetted by the steams exhaling from springs gushing in a state of ebullition at their feet, and a marsh half a mile in circumference, whence the vapours of fifty others ascend to an amazing height. In the centre is Geyser, the approach to which is perceived at a considerable distance by the rushing noise it occasions, resembling the fall of a cataract over precipices. The aperture whence the water proceeds is nineteen feet in diameter; but the basin or excavation made by the descent of the fluid is fifty-nine feet in breadth, each is covered with a rough stalactic crust, and the latter is nine feet higher than the aperture.

The water has not been known to ascend regularly in a continued stream, but in sudden impulses, after rather long intervals of quiet. The inhabitants of the neighbourhood assert, that the ascent is higher in cold bad weather than at other times, and they, and other observers, affirm that it is elevated sixty fathoms, though without any means of deciding beyond mere conjecture; indeed, the method adopted by Dr. Von Troil and his friends, to ascertain the height to which the water ascended on the 21st of September, 1772, was equally fallible; they supposed the greatest elevation to be only sixty feet. The gentleman alluded to mentions, at thirty-five minutes after twelve they heard three distinct noises, like the discharge of cannons, in the subterraneous caverns whence the spring issues, which were followed by a trembling of the earth and an immediate rise and fall of the water in the basin. At eight minutes after two the water flowed over the border of the basin; at fifteen minutes after three several subterraneous noises were heard, but not so loud as the first; at forty-three minutes after four the water rushed violently over the edge of the basin for about a minute: at forty-nine minutes after the last named hour, many loud explosions were heard, as if near the source of the spring, and the ridges of rocks in the vicinity; after this great effort the water became comparatively quiet.

The impelling power within the earth is very great at Geyser, and is sufficiently so to prevent stones from sinking that are thrown into the aperture; on the contrary, the force of the water carries them up with it to a considerable height. We shall conclude our account of these Icelandic springs in the words of the Doctor. "When the basin was full of water, we placed ourselves before the sun in such a manner, that we could see our shadows in the water; every one observed round the shadow of his own head, though not round the heads of others, a circle of almost the same colours which compose the rainbow, and round this another bright circle: this most probably proceeded from the vapours exhaling from the water. I remember to have seen something similar to it when travelling in the summer, particularly in the meadows. Not far from this place, another spring, at the foot of the neighbouring ridge of rocks, spouted water to the height of one or two yards each time." The gentlemen present thought it possible to close the mouth of this huer with stones, and made the experiment, but the water removed the whole from the aperture, and threw them in a circle round it, afterwards gushing forth with its original freedom.

The waters of these large springs were violently heated, and seemed slightly impregnated with sulphur, though perfectly clear and pure in other respects; some others, less considerable, near them, were thick and turgid, as if mixed with clay. A third class presented the fluid as white as milk, and a few force their way through the earth, heated to a red glow. Near most of the springs are baths, frequented by the natives, some of which are dry, and for sweating. The vapour is collected into those through fissures in the earth, and the thermometer rose from 57 to 93 on introducing it into the open hut used for this purpose.

As it is not our present intention to notice those heated springs which are impregnated with mineral substances, we shall refer to Mineral waters for an account of them. The Island of Ceylon furnishes an instance of hot springs, under the class of the huers of Iceland, except that no volcanic cause exists sufficiently near them to force the water out of the earth with violence. At Cannia, about six miles north-west of Trincomallee, are six wells, built of stone and mortar, in square and circular forms, generally about four feet deep, and less than two in circumference, which are inclosed by a stone wall six feet high, and contain the superior springs, though there are others in the neighbourhood in their natural state. In each the water is refreshing and pleasant to the taste, and air is continually rising to the surface in bubbles, accompanied by steam. The natives of the island, and of the adjacent coast of India, delight to bathe in this water, and seating themselves by the sides of the wells, they lade the warm fluid in earthern or brazen vessels, and pour it over their heads for hours together. Either imagination, or the inherent qualities of the water, produce benefit to those who use it in cases of strains, bruises, or rheumatisms; or possibly the warm bath may accomplish the cure, as it appears from the following analysis, made by Thomas Christie, Esq. surgeon of the 80th regiment, that there are very few proofs of the incorporation of mineral substances with the water, which was inserted in the Madras Gazette, 1799, and subsequently in Mr. Cordiner's description of Ceylon, whence the above account of the springs was derived. "The hot-wells of Cannia are of different degrees of heat; they, however, evidently communicate, for the water in all of them is at an equal distance from the surface of the ground, and a body immersed in one raises the height of the water in the others. As the water also from the six wells exhibit the same chemical phenomena, there can be little doubt that they all proceed from the same spring. On examining the heat of the different wells with great attention, it was found that they varied from 98° to 106½ of Fahrenheit's thermometer, nearly in proportion to their different depths. Bubbles of air are seen to rise from the bottom of the wells, and it was therefore conceived that the water might be acidulous, and impregnated with fixed air. It was found, however, that the water did not sparkle in a glass more than common water, nor did it turn a vegetable colour red; and on filling a large case bottle with the water, and tying an empty wet bladder to the mouth of it, it was found, after shaking a long time, that no air was disengaged. It would therefore appear that the water is not impregnated with any uncommon quantity of air; but that the bubbles are merely common air disengaged from the water by the heat. As the air, however, might be collected with a proper apparatus, its quality may be easily ascertained. The water has no thing peculiar in its colour, smell, or taste. It is not crude or hard, for it dissolves soap easily and perfectly. It contains no sulphurous principle, for a piece of polished silver, when immersed in it, contracted no rust nor dark colour. It contains no acid or alkali in a disengaged state, for on mixing a delicate vegetable colour with it, no change to a green or red colour was perceptible. The water does not contain any selenite, or earthy or alkaline matter, combined with vitriolic acid, for, on adding a solution of mercury in nitrous acid to it, no sediment was deposited; nor does it contain any earthy matter in combination with marine acid, nor any copper, nor zinc; for, on mixing mineral and volatile alkalies with the water, no precipitate was formed. On mixture with a decoction of galls, the water acquired a blackish tinge, which shows it to be slightly impregnated with iron. On a mixture with a solution of silver in nitrous acid, some precipitate of luna cornea was produced; this shows it to contain a very small portion of sea-salt, but not more than the common water of Trincomallee, upon which the solution of silver had the same effect, with this difference, that the precipitate from the water of the hot-wells was blackest, probably from the impregnation of iron. These experiments were made at the wells, with water from those of the highest and of the lowest temperature, on the 4th of July, 1798, when the heat of the atmosphere was at 91 degrees. They were also repeated upon the water after it was brought to Trincomallee, with the same effect. From them it would appear that the hot-wells of Cannia possess few mineral qualities, or indeed any virtue besides their heat, which is of a temperature not unfavourable for hot bathing. For many complaints also, the drinking of hot water is recommended, and for this purpose, as well as for bathing, a hot spring is preferable to water heated artificially, because it is always of a fixed degree of temperature."

It is extremely probable that an analysis of the water from the huers of Iceland would produce nearly the same result, whence it may be safely concluded, that the water is suddenly heated in its passage through the fissures or caverns of the earth by its approach to volcanic fires, and that its properties are exactly the same with those of the springs which flow from the bases of hills in a perfectly cold state.

HUGONIA, in botany, so named in memory of Augustus Johannes de Hugo, a genus of the Monadelphia Decandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: five-styled; corolla five-petalled; drupe with a striated nut. There is but one species; *viz.* H. mystax, a native of the East Indies.

HUGUENOTS, a term of contempt, first given to the French protestants in the year 1560. The origin of this term is much involved in obscurity; and various attempts have been made to account for it, and for its application to the friends of the reformed church in France. Some suppose the appellation of Huguenots was derived from Huguon, a word used in Tourain, signifying persons that walk during the night season in the streets, and that it was applied to the French Protestants in consequence of their making choice of that season, in order to avoid persecution, in which to perform public worship. Others, again, believe, that this term owes its origin to the name of a supposed hobgoblin, called king Hugon, that was said to wander about the streets of Tours during the night-time, and that the reformed where the disciples of this nocturnal monarch. But the most probable conjecture seems to be, that this term owes its origin to an erroneous pronunciation by the French of the German word Eidgnossen, which signifies *sworn-fellows*, or *confederates*. This had been originally the name of that part of the inhabitants of Geneva, who entered into an alliance with the Swiss cantons, in order to maintain their liberties against the tyrannical attempts of Charles III. Duke of Savoy. These valiant confederates were called Eignots, and from thence it is not at all unlikely was derived the word Huguenots.

To whatever cause this term owes its origin, it is certain that the Christians of the French Protestants churches, which it was made to designate, suffered most severely from the persecutions which at that time, and after the revocation of the edict of Nantes, raged with desolating fury both in France and other countries. The countenance and support of many princes of the royal blood, and of several of the nobility, could not save the Huguenots from suffering the most unparalleled persecution. Peace itself, which had been granted them by Henry III. in the year 1576, proved the foundation of a most terrible civil war. The profligate House of Guise, urged by the wicked and cruel suggestions of the Roman Pontiffs, did whatever lay in its power to destroy the royal family, and totally ruin the Protestant reformation; while the Huguenots, inspired with the spirit of loyalty, and a noble religious enthusiasm, fought in defence of their faith and their sovereigns with various success. The deeds of horror, which these commotions produced, are scarcely exceeded by any thing we find recorded in the annals of murder and persecution. The civil war to which we are here alluding raged nearly sixty years, during which there were destroyed, according to Puffendorf, a million of people: one hundred and fifty millions of money were spent: nine cities, four hundred villages, twenty thousand churches, two thousand monasteries, and ten thousand houses, were burnt, or laid level with the ground. These terrible devastations were at length stopped by the hand of Providence, which placed Henry IV. on the throne of France. This prince, who, though he had so many outrages to avenge, so many crimes to punish, thought only of burying all animosity in oblivion, and of healing all wounds. Then absolute power was employed only in promoting prosperity in the state, and the felicity of every individual. The Roman Catholic religion remained dominant; but the famous edict of Nantes effaced intolerance, and soothed the irritation of the conqured party, to whom liberty of conscience and a political existence were secured.

The edict of Nantes confirmed to the Protestants all the favours that had ever been granted to them by Henry III. To these privileges others were also added; such as a free admission to all employments of trust, honour and profit. These wise and politic regulations were perfectly satisfactory to good sense and equity: they were, however, not enough for fanaticism: it made several attempts on the saviour of France, and at length succeeded in assassinating him. From this melancholy day (May 14, 1610) the troubles of the Huguenots began to be renewed. Alarmed at the intrigues that were perpetually working against their rights and liberties, they again took up arms, but were successfully opposed by Richelieu. The government succeeded in rendering its authority absolute; and factions and discontents agitated and disturbed the two parties in no small degree. These discontents continued to increase until the reign of Louis XIV. This ambitious, weak, and credulous prince was persuaded wholly to revoke the edict of Nantes, which had been long openly violated. This was a deplorable epocha for the Huguenots. They were not only expelled the parliament, and deprived of all their civil and religious liberties, but multitudes of the most industrious families in France were reduced to beggary. They were harrased in all manner of ways. Eight hundred thousand persons (Voltaire says five hundred thousand) left the kingdom, and fled into other countries, where their descendants are still to be met with, and where they have carried prosperity, to the prejudice of their own unjust country. Such of these unfortunate people as remained in France lost all civil existence, were pursued without remission, without pity, and like wild beasts; their blood frequently streamed under the steel of the executioner or of the soldiery. This last explosion, however, at length ceased. The unfortunate Louis the XVI. whatever were his weaknesses and failings in other respects, had not been rendered inhuman by a large share of Catholicism; but laboured to heal all their wounds, when the storm arose, of which he was one of the first and the most illustrious of the victims. It ought ever to be remembered, to the honour of this unhappy monarch, that he paid no attention to the intolerant and disgraceful "Memoire de l' Assemblée generale du clergé," in 1780, against the reformed. During his reign a law was past, which gave to his non-Roman Catholic subjects, as they were denominated, all the civil advantages and privileges of their Roman Catholic brethren. From that period the situation of the French Protestants (for the obnoxious term Huguenots seems to have been almost laid aside) has been tolerably happy. But what seems to have given a stability and respectability to the French Protestants, are the decrees which have been passed in their favour by the present Emperor of France. On Sunday the 9th of August, 1807, the consistory of the Protestant church being admitted to an audience, their president, M. Marron, addressed the Emperor in a speech of considerable eloquence, in which he gratefully acknowledged his protection and care of them as a religious body; and declared that the roofs of their temples shall ever resound with praises for such signal favours as they enjoy under his auspices. His speech was answered in the most gracious and cordial manner. The following expressions in it are remarkable: "I accept the blessing and the congratulation of the consistory. You owe me no obligation: I wish not men to think themselves indebted to me, because I have been merely just. Conscience is not within the jurisdiction of human laws. I guarantee to you, for myself and my successors, not only the intendance, but also the perfect freedom and inviolability of your worship. The Protestants have always proved themselves to be good citizens, and faithful subjects of the law. Though I do not profess their religion, tell them that I place them in the circle of my best friends!"

Thus are the once despised and persecuted Huguenots raised from situations of suffering and wretchedness, to that rank in society, which is the unalienable right of every honest man, be his religious principles what they may.

HULK, in sea language, a name given to any old vessel laid by as unfit for service. In the royal ports they are used for the accommodation of a ship's company, while their own vessel is in dock under repair.

HULL, in the sea language, is the main body of a ship, without either masts, yards, sails, or rigging. Thus, to strike a hull in a storm is to take in her sails, and to lash the helm on the lee side of the ship; and to hull, or lie a hull, is said of a ship whose sails are thus taken in, and helm lashed a-lee.

HUMANITIES, in the plural, signify grammar, rhetoric, and poetry, known by the name of *literæ humaniores;* for teaching of which there are professors in the universities of Scotland, called humanists.

HUMERUS, in anatomy, the upper part of the arm, between the scapula and elbow. See ANATOMY.

HUMIDITY. See HYGROMETER.

HUMMING *bird.* See TROCHILUS.

HUMULUS, *hops,* in botany, a genus of the Dioecia Pentandria class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essentisl character: male, calyx five-leaved; corolla none: female, calyx one-leafed, spreading obliquely, entire; corolla none; styles two; seed one, within a leafed calyx. There is but one species, *viz.* H. lupulus, HOPS, which see.

HURA, in botany, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: male, ament imbricated; perianth truncated; corolla none; filaments cylindrical, peltate at the tip, surrounded by very many anthers in pairs: female, calyx and corolla none; style funnel-form; stigma twelve-cleft; capsule twelve-celled; seed one. There is but one species, *viz.* H. crepitans, sand-box tree. This grows naturally in the Spanish West Indies, from whence it has been introduced into the British colonies of America, where some of the plants are preserved by way of curiosity. It is about twenty-four feet in height, dividing into many branches, which abound with a milky juice. The fruit is very curious in its structure, and the tree, when it grows well, is spreading, and sometimes casts a shade forty feet in diameter; from the quickness of its vegetation, its parts are of so loose a texture, that a loud clap of thunder, or a sudden gust of wind, frequently causes the largest boughs to snap asunder; the trunk is of little use, except for fire-wood.

HURDLES, in fortification, twigs of willows or osiers interwoven close together, sustained by long stakes, and usually laden with earth. Hurdles, called also clays, are made in the figure of a long square; the length being five or six feet, and the breadth three, or three and a half: the closer they are woven, the better. They serve to render batteries firm, or to consolidate the passage over muddy ditches: or to cover traverses and lodgments, for the defence of the workmen, against the fire-works or the stones that may be thrown against them.

HURDLES, in husbandry, certain frames, made either of split timber, or of hazel-rods wattled together, to serve for gates in inclosures, or to make sheep-folds. &c.

HURRICANE, a furious storm of wind, owing to a contrariety of winds. See article WIND and WHIRLWIND. Hurricanes are frequent in the West Indies, where they make terrible ravages, by rooting up trees, destroying houses and shipping, and the like. The natives, it is said, can foretell hurricanes by the following prognostics: 1. All hurricanes happen either on the day of the full, change, or quarter of the moon. 2. From the unusual redness of the sun, the great stillness, and at the same time, turbulence of the skies, swelling of the sea, and the like, happening at the change of the moon, they conclude there will be a hurricane next full-moon; and if the same signs be observed on the full moon, they may expect one next new moon. As to the cause of hurricanes, they undoubtedly arise from the violent struggle of two opposite winds. Now as the wind betwixt the tropics is generally easterly, and upon the sun's going back from the northern tropic the western winds pour down with violence upon those parts, the opposition of these contrary winds cannot fail to produce a hurricane. Hurricanes shift not through all the points of the compass, but begin always with a north wind, veer to the east, and then cease; and their shifting between these two points is so sudden and violent, that it is impossible for any ship to veer with it; whence it happens that the sails are carried away, yards and all, and sometimes the masts themselves wreathed round like an osier.

HUSBAND and WIFE, usually termed baron and feme, are one person in law; that is, the very being or legal existence of the woman is suspended during the marriage; or, at least, is incorporated and consolidated into that of the husband, under whose wing, protection, and cover, she performs every thing; she is therefore, called, in our law (French,) a feme covert, that is, under the protection and influence of her husband, her baron, or lord; and her condition during her marriage is called her coverture. A man cannot grant lands to his wife during the coverture, nor any estate or interest to her, nor enter into covenant with her; but he may, by his deed, covenant with others for her use, as for her jointure, or the like; and he may give to her, by devise or will, because the devise or will does not take effect till after his death.

All deeds executed by the wife, and acts done by her during her coverture, are void; except a fine, or the like matter of record, in which case she must be solely and secretly examined, that it may be known whether or not her act be voluntary. A wife is so much favoured, in respect of that power and authority which her husband has over her, that she shall not suffer any punishment for committing a bare theft, in company with, or by coercion of, her husband; but if she commit a theft of her own voluntary act, or by the bare command of her husband, or be guilty of treason, murder, or robbery, in company with or by coerçion of her husband, she is punishable as much as if she were sole; because of the odiousness and dangerous consequence of these crimes. By marriage, the husband hath power over his wife's person; and the courts of law still permit a husband to restrain a wife of her liberty, in case of any gross misbehaviour: but if he threaten to kill her, &c. she may make him find surety of the peace, by suing a writ of *supplicavit* out of Chancery, or by preferring articles of the peace against him in the court of the King's Bench, or she may apply to the spiritual court for a divorce on account of cruelty. The husband, by marriage, obtains a freehold in right of his wife, if he takes a woman to wife that is seized of a freehold; and he may make a lease thereof for twenty-one years, or three lives, if it be made according to the statute, 32 Henry VIII. c. 28. The husband also gains a chattel real, as a term for years, to dispose of, if he please, by grant or lease in her life-time, or by surviving her: otherwise it remains with the wife; and upon execution for the husband's debt, the sheriff may sell the term during the life of the wife. The husband also, by marriage, hath an absolute gift of all chattels personal, in possession of the wife in her own right, whether he survives her or not. But if these chattles personal are choses in action, that is, things to be sued for by action, as debts by obligation, contract, or the like, the husband shall not have them, unless he and his wife recover them.

By custom in London a wife may carry on a separate trade; and, as such, is liable to the statutes of bankruptcy, with respect to the goods in such separate trade, with which the husband cannot intermeddle. If the wife is indebted before marriage, the husband is bound afterwards to pay the debt, living with the wife; for he has adopted her and her circumstances together; but if the wife die, the husband shall not be charged for the debt of his wife after her death, if the creditor of the wife do not get judgment during the coverture.

The husband is bound to provide his wife necessaries, and if she contract for them, he is obliged to pay for them; but for any thing besides necessaries, he is not chargeable: and also, if a wife elope, and live with another man, the husband is not chargeable even for necessaries; at least if the persons who furnish them be sufficiently apprised of her elopement. A man having issue by his wife, born alive, shall be tenant by the courtesy of all the lands in fee simple, or fee-tail general, of which she shall die seized; and after her death, he shall have all chattles real; as the term of the wife, or a lease for years of the wife, and all other chattles in possession; and also all such as are of a mixed nature (partly in possession and partly in action), as rents in arrear, incurred before the marriage or after; but things merely in action, as of a bond or obligation to the wife, he can only claim them as administrator to his wife, if he survive her. If the wife survive the husband, she shall have for her dower the third part of all his freehold lands: so she shall have her term for years again, if he have not altered the property during his life: so also she shall have again all other chattels real and mixed; and so things in action, as debts, shall remain to her, if they were not received during the marriage: but if she elope from her husband, and go away with her adulterer, she shall lose her dower; unless her husband had willingly, without coercion ecclesiastical, been reconciled to her, and permitted her to cohabit with him.

Husband *ship's*, the owner who takes the direction and management of a ship's concerns upon himself, the other owners paying him a commission for his trouble.

HUSBANDRY. See Agriculture.

HUSO. See Acipencer.

HUSTINGS. This court is held before the Lord Mayor and Aldermen of London. Error or attaint lies there, of a judgment or false verdict in the Sheriff's court. Other cities and towns, as York, Lincoln, &c. also have had a court of the same name.

HYACINTH, in mineralogy, a species of the zircon genus: the colour is red, which passes through various shades into orange yellow, and from the yellow it passes into greenish grey, and greenish white. It occurs in grains, and likewise crystallized: its specific gravity is from 4 to 4.6. Different specimens have been analized; one from the island of Ceylon contained,

Zircon - - - - - - -	70
Silica - - - - - - -	25
Oxide of iron - - - -	0.50
	95.50
Loss - - - - - - -	4.50
	100

When exposed to the blow-pipe it loses its colour, but not its tranparency: it is infusible, exepting with borax, which converts it into a white transparent glass. If exposed to heat made by oxygen gas, it melts into a greyish white glass bead. It is found chiefly in the sand at Ceylon, though some specimens have been obtained is various parts of the continent of Europe. It will take a fine polish, and when very pure is highly esteemed.

HYACINTHUS, in botany, *Hyacinth* or *Harebells*, a genus of the Hexandria Monogynia class and order. Natural order of Lilia Roy, or Liliaceæ. Asphodeli, Jussieu. Essential character: corolla bell shaped, with three honied pores by the germ. There are seventeen species.

HYADES, in astronomy, seven stars in the bull's head, famous among the poets for the bringing of rain.

The principal of them is in the left eye, called by the Arabs, Aldebaran. See Aldebaran and Astronomy.

HYALITE, in mineralogy, a species of the flint genus. Colour yellow and greyish white: it occurs in thin crusts on other minerals, and has much resemblance to gum, and is nearly allied to opal.

HYBERNACULUM, in botany, that part of the plant which defends the embryo-herb from injuries during the severities of winter, hence the name, hybernaculum, or winter-quarters.

HYBLÆA. See Phalæna.

HYDNUN, in botany, a genus of the Cryptogamia Fungi. Generic character: a horozontal fungus, echinated beneath with awl-shaped fibres. Linnæus has six species of this fungus, five with stems, and one without; these chiefly grow on decaying wood.

HYDRA, in astronomy, a southern constellation, imagined to represent a water-serpent. The number of stars in this constellation in Ptolemy's catalogue is twenty-five, and in the Britannic catalogue, sixty-eight.

HYDRA, *polypes*, in natural history, a genus of the Vermes Zoophyta class and order. Animal fixing itself by the base, linear, gelatinous, naked, contractile, and furnished with setaceous tentacula or feelers; inhabiting fresh waters, and producing its deciduous offspring or eggs from the sides. There are five species. H. gelatinosa, minute, gelatinous, milk-white, cylindrical, with twelve tentacula shorter than the body: it inhabits Denmark in clusters on the under side of Fuci. But on the viridis, the fusca, and the grisca, the greater number of experiments have been made by naturalists, to ascertain their true nature and very wonderful habits. They are generally found in ditches. Whoever has carefully ex-examined these when the sun is very powerful, will find many little transparent lumps, of the appearance of jelly, and size of a pea, and flatted upon one side. The same kind of substances are likewise to be met with on the under side of the leaves of plants that grow in such places. These are the polypes in a quiescent state, and apparently inanimate. They are generally fixed by one end to some solid substance, with a large opening, which is the mouth; at the other, having several arms fixed round it, projecting as rays from the centre. They are slender, pellucid, and capable of contracting themselves into a very small compass, or of extending to a considerable length. The arms are capable of the same contraction and expansion as the body, and with these they lay hold of minute worms and insects, bringing them to the mouth, and swallowing them. The indigestible parts are again thrown out by the mouth. The green polype was that first discovered by M. Thembley: and the first appearances of spontaneous motion were perceived in its arms, which it can contract, expand, and twist about in various directions. On the first appearance of danger they contract to such a degree, that they appear little longer than a grain of sand, of a fine green colour, the arms disappearing entirely. Soon afterwards, he found the grisca, and afterwards the fusca. The bodies of the viridis and grisca diminish almost insensibly from the anterior to the posterior extremity; but the fusca is for the most part of an equal size, for two-thirds of its length, from the anterior to the posterior extremities, from which it becomes abruptly smaller, and then continues of a regular size to the end. These three kinds have at least six, and at most twelve or thirteen arms. They can contract themselves till their bodies do not exceed one fourth of an inch in length, and they can stop at any intermediate degree of expansion or contraction. They are of various sizes, from an inch to an inch and a half long. Their arms are seldom longer than their bodies, though some have them an inch, and some even eight inches long. The thickness of their bodies decreases as they extend themselves, and vice versa; and they may be made to contract themselves, either by agitating the water in which they are contained, or by touching the animals themselves. When taken out of the water they all contract so much, that they appear only like a little lump of jelly. They can contract or expand one arm, or any number of arms, independently of the rest; and they can likewise bend their bodies or arms in all possible directions. They can also dilate or contract their bodies in various places, and sometimes appear thick set with folds, which, when carelessly viewed, appear like rings. Their progressive motion is performed by that power which they have, of contracting and dilating their bodies. When about to move, they bend down their heads and arms, lay hold by means of them on some other substance to which they design to fasten themselves; then they loosen their tail, and draw it towards the head; then either fix it in that place, or stretching forward their head as before, repeat the same operation. They ascend or descend at pleasure in this manner upon aquatic plants, or upon the sides of the vessel in which they are kept; they sometimes hang by the tail from the surface of the water, or sometimes by one of the arms; and they can walk with ease upon the surface of the water. On examining the tail with a microscope, a small part of it will be found to be dry above the surface of the water; and, as it were, in a little concave space, of which the tail forms the bottom; so that it seems to be suspended on the surface of the water on the same principle that a small pin or needle is made to swim. When a polype, therefore, means to pass from the sides of the glass to the surface of the water, it has only to put that part out of the water by which it is to be supported, and to give it time to dry, which it always does upon these occasions; and they attach themselves so firmly by the tail to aquatic plants, stones, &c. that they cannot be easily disengaged: they often further strengthen these attachments by means of one or two of their arms, which serve as a kind of anchors for fixing them to the adjacent substances.

The fusca has the longest arms, and makes use of the most curious manœuvres to seize its prey. They are best viewed in a glass seven or eight inches deep, when their arms commonly hang down to the bottom. When this or any other kind is hungry, it spreads its arms in a kind of circle to a considerable extent, inclosing in this, as in a net, every insect which has the misfortune to come within the circumference. While the animal is contracted by seizing its prey, the arms are observed to swell like the muscles of the human body when in action. Though no appearance of eyes can be observed in the polype, they certainly have some knowledge of the approach of their prey, and shew the greatest attention to it as soon as it comes near them. It seizes a worm the moment it is touched by one of the arms; and in conveying it to the mouth, it frequently twists the arm into a spiral, like a cork-screw, by which means the insect is brought to the mouth in a much shorter time than otherwise it would be; and so soon are the insects on which the polypes feed killed by them, that M. Fontana thinks they must contain the most powerful kind of poison; for the lips scarcely touch the animal when it expires, though there cannot be any wound perceived on it when dead. The worm, when swallowed, appears sometimes single, sometimes double, according to circumstances. When full, the polype contracts itself, hangs down as in a kind of stupor, but extends again in proportion as the food is digested, and the excrementitious part is discharged. The manner in which the polypes generate is most perceptible in the grisca and fusca, as being considerably larger than the viridis. If we examine one of them in summer, when the animals are most active, and prepared for propagation, some small tubercles will be found proceeding from its sides, which constantly increase in bulk, until at last in two or three days they assume the figure of small polypes. When they first begin to shoot, the excrescence becomes pointed, assuming a conical figure, and deeper colour than the rest of the body. In a short time it becomes truncated, and then cylindrical, after which the arms begin to shoot from the anterior end. The tail adheres to the body of the parent animal, but gradually grows smaller, until at last it adheres only by a point, and is then ready to be separated. When this is the case, both the mother and young ones fix themselves to the sides of the glass, and are separated from each other by a sudden jerk. The time requisite for the formation of the young ones is very different, according to the warmth of the weather, and the nature of the food eaten by the mother. Sometimes they are fully formed, and ready to drop off, in twenty-four hours; in other cases, when the weather is cold, fifteen days have been requisite for bringing them to perfection. The polypes produce young ones indiscriminately from all parts of their bodies, and five or six young ones have frequently been produced at once; nay, M. Trembley has observed nine or ten produced at the same time. Nothing like copulation among these creatures was ever observed by M. Trembley, though for two years he had thousands of them under his inspection.

When a polype is cut transversely, or longitudinally, into two or three parts, each part in a short time becomes a perfect animal; and so great is this prolific power, that a new animal will be produced even from a small portion of the skin of the old one. If the young ones be mutilated while they grow upon the parent, the parts so cut off will be reproduced; and the same property belongs to the parent. A truncated portion will send forth young ones before it has acquired a new head and tail of its own, and sometimes the head of the young one supplies the place of that which should have grown out of the old one. If we slit a polype longitudinally through the head to the middle of the body, we shall have one formed with two heads; and by again slitting these in the same manner, we may form one with as many heads as we please. A still more surprizing property of these animals is, that they may be grafted together. If the truncated portions of a polype be placed end to end, and gently pushed together, they will unite into a single one. The two portions are first joined together by a slender neck, which gradually fills up and disappears, the food passing from one part into the other: and thus we may form polypes, not only from different portions of the same animal, but from those of different animals. We may fix the head of one to the body of another, and the compound animal will grow, eat and multiply, as if it had never been divided. By pushing the body of one into the month of another, so far that their heads may be brought into contact, and kept in that situation for some time, they will at last unite into one animal, only having double the usual number of arms. The hydra fusca may be turned inside out like a glove, at the same time that it continues to eat and live as before. The lining of the stomach now forms the outer skin, and the former epidermis constitutes the lining of the stomach. See Adams on the Microscope.

HYDRACHNA, a genus of insects of the order Aptera. Head, thorax, and abdomen united; two feelers, jointed; from two to six eyes; eight legs, ciliate, and formed for swimming. The insects of this genus are inhabitants of the water, and swim with considerable swiftness: they prey on the larva of Tipulæ and Monoculi: the eggs are red and at first spherical, but afterwards become semi-lunar; larva six-footed, and furnished with a singular proboscis. There are about fifty species. H. geographica, so called from the fancied map-like distribution of its variegations. It is one of the largest of the genus, and is occasionally seen in the clear ponds, and other stagnant waters. This is reckoned one of the most beautiful of the British insects.

HYDRANGEA, in botany, a genus of the Decandria Digynia class and order. Natural order of Succulentæ. Saxifragæ, Jussieu. Essential character: capsule two-celled, two-beaked, containing many seeds; corolla five petalled; calyx five-cleft; superior. There are three species.

HYDRARGYRUM, an old name given to mercury.

HYDRASTIS, in botany, a genus of the Polyandria Polygynia class and order. Natural order of Ranunculaceæ, Jussieu. Essential character; calyx none; petals three; nectary none; berry composed of one seeded acini, or granulations. There is but one species, *viz.* H. canadensis, Canadian yellow root.

HYDRATE, in chemistry, lately introduced by Proust to express the chemical union of water with any substance, and especially with certain metallic oxides.—The hydrate of copper is a blue-green oxide of this metal, which differs from the brown oxide only in containing a large quantity of water, which a low red heat will expel.

HYDRAULICS teach us to ascertain the velocity and impetus of fluids when in motion, and serves as the basis for computing the powers of various machinery acted upon by running water.

The first principle we shall inculcate in this service is, that water, being an inelastic fluid, (though many have thrown away much time in the attempt to prove the contrary,) can only be set in motion by two causes, *viz.* the increased pressure of the air, as in the air-vessels of fire-engines, and by gravitation; that is, where it is liberated from confinement, and allowed to descend to an inferior level. In the former case, water may be made to rise by machinery suited to the purpose; in the latter, it will inviolably seek a lower situation.

The velocity of water, proceeding through a hole in the side of a vessel, is ever proportioned to the distance of the aperture from the level of the fluid, the square root of the intermediate space being the guide. It must, however, be recollected, that in consequence of the decrease of that space, as the water is let out, the pressure becomes gradually less; therefore the medium, or mean distance, between the surface and the vent whence the water issues, will be found, in general, a correct standard. Hence we see, that, in order to force double the quantity of water through the lowest of two apertures, the distance must be quadrupled. For if a hole made at C in the pipe A B, fig. 1, will supply one gallon of water in a minute; to draw double that quantity in the same time, the lower hole, D. must measure from the surface, B, four times as much as from C to the surface.

This establishes the above position, and proves, besides, that the force is equal to the velocity, as indeed we know to result in every branch of mechanism.—To shew this, let the pipe, A B, be perforated in several parts, as at C D E; the first, *i. e.* C, being one foot; that at D being four feet; and that at E being seven feet below the surface, B; between E and A we will suppose only one foot interval, so that D may be in the centre of the height A B. Draw the horizontal line, A F, and from D describe the semicircle, B G A, having D G equal to D A, or D B, for its radius. Now the water will, as it flows from D, describe a parabola, and will fall upon the line, A F, at such a distance from A, as will be equal to double the radius, D G. In like manner the water flowing from the aperture, C, will reach that point, *viz.* K, on the horizontal A F, which may measure double the sine, C H, on the same semi-circle: and the sine of the arc taken opposite to E, *i. e.* E L, is equal to the sine, C H, the water rushing from E will intersect, or meet, the water falling from C, at the point K. It is to be observed, that the parabolic curve of the water proceeding from C to K has a greater tendency to gravitation than that issuing from E, which rushes with far more force, and consequently has a greater tendency to an horizontal direction. For the aperture at C is only acted upon by a column of one foot deep, *i. e* from B to C, but the column of water from B to E measures seven feet. We have already stated, that the velocity is equal to the square root of the column's height above the aperture.

It is the peculiar property of fluids to preserve their level, notwithstanding any varieties of course, or inequality of elevation. Thus, supposing the pipe, A B C D, fig. 2, to be bent into the form required for passing over declivities, as shown: the water will rise to the height, A D; but where the channel exceeds the level of that line, there will be a break in the course of the fluid, such as appears at B: yet the course may descend to any depth, as at C, provided the pipe be brought back to the original height. If either end be in the smallest degree lower than the other, the water will sink to the level of the lower retaining brim. And if the supply be continual, the water issuing from the lowest end will mount nearly to the level of the source. This is the principle on which fountains are in general found. To effect this, however, the pipe should be small, so as to contract the issue of the fluid, and to give it greater velocity, by causing it to expose a smaller surface for the air to press upon. This contraction should not be carried to excess; else the water would want force to pass through the atmosphere, and, being subdued, would break into drops, and fall without gaining any height. The conduit-pipe is usually made about five diameters of the fountain-pipe; under such proportions the water will ordinarily flow so freely as to give a good jet.

The inelastic nature of water causes it to retain its surface perfectly level; were it otherwise, vessels would often run aground, where, at present, they find depth sufficient to float them; and the whole body of a river would present a thousand opposing and unequal resistances; whereas we find the resistance to be uniform. To prove this, let a piece of wood be put into a pail of water, the fluid will in every part remain equally dense, and the surface will be perfectly level. For a further elucidation of this property, we refer to HYDROSTATICS, wherein it will be found very conspicuous.

The ingenious Mr. Bramah has lately applied the inelasticity of water to a variety of purposes, especially in the application of a power to remote effects.—Thus, if water be filled into the pipe, A B C D, fig. 3, and that a piston be applied to A B, made perfectly tight, so that no water can possibly escape, when that piston is pressed down by means of a force capable of overcoming the friction of its sides, and the friction of the water within the tube, it will cause the water to rise in the pipe, C D, whatever may be the length of the conjunctive part, A C.—Therefore, if a piston is inserted into the pipe C D, it will be acted upon in perfect conformity with the motion of the piston in A B; the power to move which may be trifling, when the diameter of the pipe is small, and the purpose not relating to forcible operations. Thus, for the mere intention of ringing a bell at D, a hundred yards distant from the pull, A, a bore of less than a quarter of an inch in diameter would answer every purpose, and would yield to the pressure of the finger, with very little exertion. On the other hand, when machinery is to be set in motion, the size of the piston, and the force whereby it is to be moved, must be proportioned to the resistance generated by friction, and by the opposition to the action of the machine. It is necessary to observe, that where the two pistons are of equal diameter, their actions will be equal; but that if the pipe, A B, be larger than C D, it will produce an increased action in the latter, which, in such case, must have a proportionate increase of altitude, and, *vice versa*, when the action of A B is to be greater than that of C D.—Our readers will be sensible that a tube of less diameter can be made to contain the same quantity as that of greater capacity, only by adding to its length; and that both their areas being filled and emptied alternately by the same action, and in the same time, that which has the greatest altitude must have the greatest scope of action, and move with an increased velocity in exact ratio with the difference of the diameters. When the velocity of the machinery attached to the movement-tube is to be diminished, without losing the height to which the secondary power is thus raised by the additional length of the tube, the segment on which it is made to act must be that of a larger circle, as shewn in fig. 4, where the tube, A B, is of double the diameter of that at C D, which would raise the lever, E, to the height F. Now, if this lever were the handle of a pump, requiring a considerable exercise of power, it is evident the fulcrum, G, must be placed very near to the pump-tube, H; whereby the radius of the circle, G F, is greatly increased, and the plonge of the pump-piston, H, much diminished. If, on the contrary, the fulcrum had been at O, *i. e.* dividing the distance between D and X into three parts, of which two are given to the lever, N, the plonge would be far deeper, but the power would be greatly reduced; the segment, D F, occupying a greater angle with the fulcrum O, than it does with the fulcrum G. This is amply explained under the head of MECHANICS.

Where water is enclosed within a vessel, or in a tube, in such manner that air cannot penetrate, it will not flow out in the same manner, as if air were admitted to supply the place of any quantity that might be required to be drawn off. Of this every person must be sensible who has ever attempted to draw wine, beer, &c. from a full cask, without opening a vent at the top, near the bung, to admit air, as the fluid might evacuate the upper part of the vessel. From this we prove, that although all fluids have a direct disposition to gravitation, they are perfectly inelastic; if they were otherwise, we should find that, by expansion, they would be capable of filling a greater or lesser space at times; and that as the wine, &c. were drawn off below, the portion remaining in the vessel would expand, and, though less dense, would fill the whole interior.

Of this property advantage has been taken to draw off liquors from one vessel to another by means of a very simple instrument called a syphon. This is a pipe of tin, copper, &c. according to its purpose, bent at any angle, but generally about seventy to eighty degrees, in such manner that one limb may reach down through the bung-hole of the cask to be emptied, to its very bottom; the other leg should be the longest, so that when filled it may contain a heavier body of fluid than that limb within the vessel. See fig. 5. in which the syphon, A B C, is inserted into a vessel to be emptied. In large syphons it is necessary to insert a cock at the lower end, to prevent the escape of the fluid when first filled. In small syphons it is common to put a small parallel tube, which being applied to the mouth, the end C, being immersed in the liquor to be drawn off, the operator inhales forcibly, and by thus drawing the air out of the syphon, causes the liquor to rise in its place. The absence of air, which first caused the fluid to ascend into the tube, occasions it to remain until the finger is removed from the end A; when the pressure of the air within the vessel causes the liquor to press through the syphon, which continues to the last to draw off the contents of the vessel, they pressing forward through the long end, A. It is proper to remark, that large syphons sometimes require to be previously filled, and then to be set in the vessels to be drawn off; but, in general, the casks, &c. can be tilted sufficiently to answer this purpose, and to bring the shorter limb nearer to a horizontal position than the longer limb, whereby the latter my possess a greater perpendicular altitude, and consequently a greater tendency to gravitation. For we trust, that, in Fig. 1, it has been demonstrated, that the pressure of a fluid is in proportion to its perpendicular height. We must caution the reader, that as a column of water of thirty-three feet in perpendicular height is equal to the weight of the atmosphere pressing on the surface of such a column, it follows, that no syphon exceeding that length will act, because the power would be less than the weight to be raised.

A comical display of the properties of the syphon is seen in what is called "The cup of Tantalus;" the designation of which is derived from fabulous history, wherein we are told, that Tantalus, king of Phrygia, was condemned by Jupiter to suffer perpetual hunger and thirst, amidst a profusion of delicacies, which always receded when applied to his lips. To imitate this disappointment, a syphon, having its two limbs parallel and contiguous, is fixed into the middle of a cup double its height; one limb receiving the liquid at the bottom of the interior, and the other discharging it through the centre of the bottom, as seen in fig. 6. Thus, when the outlet is stopped by means of a finger applied thereto, the cup may be offered quite full to the person on whom the joke is to be practised, observing that the syphon will not act until the liquor in the cup exceeds the level of its bend, when the whole will be drawn through the tube. This whimsical contrivance is rendered yet more diverting, by having the syphon so contrived, that its action may commence only when the cup is inclined a little, as is usual when a person is about to drink; and if only a small flower, &c. be at the bottom of the vessel, appearing merely as an ornament, but allowing the liquor to pass under its petals, &c. into a tube made through one of two handles, and brought under the bottom.

Many springs are derived from natural syphons, existing in the sides of mountains, &c. at various depths, and to various extents. Some springs, situated on the tops of hills, near to large ones, supply water all the year, others only periodically, when they usually flow in profusion. In either case, the ignorant multitude rarely attribute the supply to the proper cause. We shall demonstrate from whence it originates.

When various caverns, in which water is either pent up or received, lay in a regular descent, one below the other, the water will naturally pass from one to the other, and cause a regular flow, more or less abundant, according as the source may be more or less abundantly supplied.

If the soil through which it passes be close and retentive, the water will then be occasionally raised, as well as lowered, in proportion to the weight of the incumbent fluid, and will rise, if so guided by the channel through which it passes, even to the height of the source, as may be proved by what has already been shewn in fig. 2. Thus, after various changes of altitude, the fluid may escape at any height not above that source; or it may be carried away to any depth. The place where it issues forth is called a spring. Fig. 7. exhibits such a current, which we will suppose to have a perpetual supply.

But the intermitting spring may also have a regular supply. This is occasioned by the existence of caverns connected by syphons, as we may see by reference to fig. 8, where A is the source, *b b* the channel: B is a cavern, which by means of the arch, or rising channel, *c c*, becomes a syphon leading into D. It is obvious that, in the first instance, the water must, after filling B, rise in the channel, *b b*, so as to be above the greatest height of *c c*, to cause its passing off into E, and thence *ad libitum*. Now the channel, *c c*, being of greater diameter than the channel, *b b*, when the former commences its operation, it will discharge more than the latter can supply, so as to keep up the discharge from *c c*; therefore, after B has been exhausted so far as to allow air to pass from it into *c c*, a certain quantity in that channel, which has not gained the summit, will recede into B, and the water must again rise to the height in *b b*, which shall cause it to flow over the summit of *c c*, before the spring can again appear to be supplied. Yet the flow from the source was never diminished.

The existence, or otherwise, of a vacuum, or void space, was long agitated, and that too with no small degree of acrimony, among the philosophers of old; and we may say of a date by no means ancient. Common sense should have told us, what experience so amply proves, that where one body or element retires, another must supply its place, else the whole creation would inevitably be torn asunder. It is, indeed, well known, that the elasticity of the air, which could be rarified *ad infinitum*, if we had the means of effecting the process, enables it to occupy large spaces on emergency, or to contract within the narrowest bounds. See Pneumatics. Under ordinary circumstances, however, we consider the air as being of a particular standard, namely, that a column ascending to the summit of our atmosphere corresponds in weight with a column of water of thirty-three feet in height, allowing the bases, *i. e.* of the air and of the water, to be equal. Thus we find that where the air is withdrawn, by means of suckers, pistons, valves, &c. from within a pipe, of which the lowest part is immersed in the water contained in a well, &c. the fluid will rise to the height of thirty-three feet within the pipe, supplying the place of the air thus withdrawn. This is effected by the pressure of the atmosphere on the surface of the water; whereby it is forced into the space formerly occupied by the air. Generally speaking, it is not a sudden operation; for unless the well be very shallow, it will require many strokes of a pump to withdraw so much air as may so far rarify the residue within the pipe, as to allow the water to rise thirty-three feet above its level. This is the greatest height to which water can be induced by a sucking pump. In this contrivance the piston, A, see fig. 9, has a valve, which, as the rod draws up, is closed by the pressure of the air above it; but in descending it opens, and allows the water, which had flowed into the lower part, whence the air was withdrawn, to rush through; as the piston is raised again, the weight of the water forcibly oppresses the valve, until it finds a lateral passage at B, whence it issues, and in this manner any quantity may be raised. If the water has a direct issue, as in the common spouts of pumps, no further apparatus is wanted; but if it is to be retained, or pass through any other pipes more elevated than the debouchure, B, there must be a small angular projection, as shewn by the dotted lines, to admit the valve C, also pointing upwards. In dry weather, or when the pump is not much used, the leather binding of the piston, as also the valves, will become dry; therefore it is necessary, on such occasions, to throw in a pail-full or two of water, to moisten them; else the air will pass downwards as the piston rises, and prevent that exhaustion on which the ascent of the water depends. It is generally necessary to have a valve at the bottom of the pipe, to keep in the water drawn into it, in order that the labour may be decreased; and that, if the pumping be intermitted, there may be less trouble in bringing up the water within reach of the piston.

Where the water lays near the surface,

a *lifting-pump* may be used. This is nearly the same with the former; but requires the piston should be forced down beneath the level of the water in the well. In this it is not so indespensably necessary that the leather on the piston should fit so close; though it is the better for so doing. In the lifting-pump, the whole depends on actually raising the water from the well as though it were done by means of a bucket; this occasions many to apply that designation to the piston. The same precautions are necessary, if the water is to be passed into any pipe, as has been stated regarding the debouchure of the sucking-pump.

The forcing pump has a solid piston, as seen at A in fig. 10, which, after the water has passed the valve at B, is pressed down, and causes the fluid to pass into the conducting pipe C, where there is also a valve *d*, to prevent its return. The valve at B closes as the piston descends, while that at *d* rises, to allow its escape from the main pipe. When the piston rises, the water follows, as in the two former instances, through the lower valve B, while the smaller valve at *d* is also closed by the super-incumbent water in the conduit, *e*, and by the attraction of the piston the water rushing after it to prevent a vacuum. In this kind of pump, the piston must fit extremely close; both on account of the intended attraction of the fluid from below, and to prevent its escape upwards, when the piston is pressed downwards.

The whole of those inventions, which raise water by alternate risings and fallings of only one piston, are subject to the inconvenience of having the water issue in jerks, which, in some instances, would prove highly inconvenient. To remedy this, a cistern should be placed near the debouchure, or spout, whence a small stream would flow with much less variation than from the spout itself. But the best mode of regulating the issue of water is by aid of an air-vessel, as in a fire-engine See Pneumatics.

To detail all the varieties of pumps that are in use would be both beyond the limits of this work, and of no real utility to the reader: we shall, therefore, enter upon the description of the valves in general estimation, and then proceed to give a brief account of hydraulic machinery.

The most common kind of valve consists of a piece of stiff leather, such as is applied for soles in shoes, and is generally known by the name of pump-leather.—On its upper side a piece of milled lead is rivetted firmly, and the part where it is to be fixed on the frame, or shell, of the piston is grooved, for the purpose of giving it pliancy, that it may work up and down, as if on a hinge. Fig. 11, shows the plan; and fig. 12, the profile of this valve, which is cheap, simple, and easily repaired, though it has the defect of being liable to choke, and of not rising high enough to allow a sufficient passage for the water.

Fig. 13, shows a *button-valve*, which is merely a piece of turned metal A, having a shank, B, of about eight inches or a foot in length according to the depth of the block, *x z*. The shank passes through the bar C, at the bottom of the block, and is prevented from coming up too high by the stud or nut *o*, at its bottom. When the water rises, it forces up the button A, and passes through the hollow in the block, of which the superior part is expanded so as to fit the bottom, which, being the frustrum of a cone, necessarily fits close into the expanded part as the water presses it, after having passed upwards in consequence of the descent of the piston, which may either be solid, as in a forcing-pump, or valved, as in a lifting or a sucking-pump. This valve may be applied to a piston, as well as to that part of the pipe which retains the water, that may be within reach of the piston's action. An improvement has been made to this valve, by adding a ball of some weight to the bottom of the shank B, and excavating the button, in order to reduce its weight in proportion: this insures the regular descent of the button to its seat.

The *butterfly-valve*, exhibited in fig. 14, varies from the two former, in having two semicircular flaps appended by hinges to a bar passing over the centre of the excavated piston. This valve is peculiarly eligible, because if one part should be stiff and adhere to the piston, the other will play with an increased effect, though not equal to the action of both valves.

The simplest valve with which we are acquainted is the sphere, which is made of metal, and fits into a semi-spherical cavity on the top of the piston or block. When the piston (if it be on that) rises, the sphere falls into the socket; but when the piston is depressed, the rush of water from below forces the sphere upwards. The only inconvenience attendant upon this valve, which is shown at fig. 15, is, that its diameter, being nearly equal to that of the bore, leaves a very narrow passage for the water. This, however, might perhaps be obviated, by making an excavation in the pipe, as shown by the dotted lines, and by driving nails through, to obstruct the ball from rising too high.

These are the general principles of the valves in common use; though we could enumerate a great variety, which have all been strongly recommended, but in practice proved very deficient. We shall, therefore, proceed with the detail of hydraulic machines, commencing with those which supply the place of pumps, by raising water to given heights. The most simple, and, perhaps, the most ancient, is the spiral pump of Archimedes. It consists of a cylinder of wood, about a foot in diameter, and of any length at pleasure: on this a leaden pipe of any bore is wound from the bottom to the top, spirally.—When the bottom of the cylinder revolves in the water, (by means of a common winch handle at the top, and of a pintle in the centre of its base, which rests in a box or step for that purpose below) the reclined position, as shown in fig. 16, occasions the water to enter the bottom of the pipe, and to be carried by the revolutions of the cylinder completely up to the top, where it discharges into a vessel. This, however, raises but a small quantity, though the height may be indefinite: therefore, where such a machine is in use, it will be found eligible to have the whole cylinder covered with various pipes, like the bands in a rope, whereby the quantity of water raised would be proportionably increased with very little addition of power: the greatest resistance would arise from the friction upon the supporting axis, especially the lower one under the surface. Some of these machines have been worked in strong runnig brooks, by means of water-boards, the same as the great wheels in undershot mills.

The *horn-drum*, so called from a number of segments passing from the circumference of a large flat cylinder to its centre, is an easy mode of raising water. The scoops or mouths, by turns, dip into the water, and as they rise cause it to pass up the horn or segment, until it is discharged into a trough placed under the end of the axis, which is hollow, and has its pintle fastened to a cross, as seen in fig. 17. Such wheels usually work with water (or float) boards; and some of them have projecting fins, from which rectangular buckets are suspended; these dip into the water as the wheel turns, and successively discharge into a trough, by means of a pin at A, which causes every bucket, as it passes, to turn to a horizontal instead of an erect position. The latter invention is ascribed to the Persians. The reader will, no doubt, readily perceive, that a strong current, or other force, is needful to move machines so laden as the Persian wheel, it sometimes raising near a ton of water in each revolution; and that nothing but the necessity for raising water could induce to so great a loss of power. When treating of Mills, and of Pumps, as also of Pneumatics, with which Hydraulics are often intimately blended, we shall enlarge more on this subject; for the present, concluding with the ordinary mode of applying a water wheel to pumps, as may be seen at London Bridge, and in a great variety of instances, where immense quantities are raised by means of running water, referring to the article Steam-Engine for the operations dependant on that power. We have, in speaking of Fluids, said much on their properties, which the reader will find both amusing and instructive: indeed, we consider this doctrine to be indispensable, as a study, with those who court an intimate acquaintance with hydraulics.

Fig. 18, shows the section of three forcing pumps, *o p q*, with their pistons, as acted upon by three cranks, *a b c*, each equally radiated from the branch *d e*, and moved by a water wheel, of which *f* is the axis: it is plain that the several cranks stand at an angle of 120 degrees respectively. By this means there is a counterbalance among them mutually, and each gives one stroke or plunge during each revolution of the wheel. If the wheel is large, it will of course move slowly; and, unless the pumps be very large, but little water will be raised: therefore it is usual to acelerate the motion of the branch bearing the cranks, by means of a spur, or of a trundle, turned by the water-wheel, and bearing such proportion thereto as the required increase of velocity may demand. For the manner of applying such a spur, &c. see the article Mill-Work.

HYDRAULICON, *water-organ*, in music, an instrument acted upon by water, the invention of which is said to be of higher antiquity than that of the wind organ.

HYDROCELE, in surgery, denotes any hernia arising from water, but is particularly used for such a one of the scrotum, which sometimes grows to the size of one's head, without pain, but extremely troublesome to the patient. See Surgery,

HYDROCEPHALUS, in surgery, a preternatural distention of the head to an uncommon size, by a stagnation and extravasation of the lymph, which, when collected withinside of the bones of the cranium, the hydrocephalus is then termed internal; as it is external, when retained between the common integuments and the cranium. See MEDICINE.

HYDROCHARIS, in botany, a genus of the Dioecia Enneandria class and order. Natural order of Palmæ. Hydrocharides, Jussieu. Essential character: male, spathe two-leaved; calyx, trifid; corolla, three petalled; filaments the three inner style bearing: female, calyx trifid; corolla three petalled; style six; capsule six-celled, many seeded, inferior. There is but one species, with many varieties, *viz.* H. morsus ranæ, frog bit.

HYDROCOTYLE, in botany, *marsh pennywort*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ. Essential character: umbel simple, with a four-leaved involucre; petals entire; seeds semi-orbiculate, compressed. There are fifteen species.

HYDRODYNAMICS treat of the powers, forces, and velocities, of fluids in motion. Having entered fully into the detail of all relating thereto, while treating of FLUIDS, HYDRAULICS, HYDROSTATICS, MILLS, and WATER *Wheels*, we forbear from that repetition, which would trespass on the space allotted to other articles, referring the reader to those heads for what appertains thereto.

HYDROGEN. It had been long known to the chemists, that a vapour or air is disengaged in some processes, which kindled on the approach of an ignited body. Van Helmont gave this the name of gas igneum, and it seems to have attracted the attention of Boyle, Mayow, and Hales. The chemists knew, that such a vapour or air was commonly disengaged during the solution of certain metals in muriatic or dilute sulphuric acid, that it burnt at the mouth of the phial, and if mixed with atmospheric air, exploded when kindled by a match.

Mr. Cavendish, however, first examined its properties fully, showed that it is permanently elastic, not absorbed by water, and that it is much lighter than atmospheric air. (Philos. Trans. vol. lvi. p. 141). This substance forming water when combined with oxygen, and being therefore the radical of that compound, the name hydrogen was given to it at the formation of the new nomenclature.

It is always obtained from the decomposition of water, as it cannot, from other substances, in which it exists, be easily disengaged in perfect purity. Some substance is made to act on water, which exerts an attraction to the oxygen, without combining with the hydrogen, when, of course, the hydrogen is disengaged, and passes into the elastic form.

At the common temperature of the globe, this decomposition cannot be effected with rapidity by any single affinity. Iron, moistened with water, decomposes it very slowly, and evolves hydrogen; but at the temperature of ignition, the decomposition is more rapid. If a coil of iron wire, or a quantity of iron filings, be put into an iron or coated glass, or earthen tube, which is placed across a small furnace, and surrounded with burning fuel, so as to be brought to a red heat, on distilling water from a retort connected with it, the vapour, in passing over the surface of the ignited iron, is decomposed, the iron attracts its oxygen, and hydrogen gas issues from the extremity of the tube.

This process is a troublesome one, and by the agency of an acid, water is decomposed as rapidly by iron or zinc, at a natural temperature. Zinc affords the hydrogen in the greatest purity. One part of it, in small pieces, is put into a retort, or a bottle with a bent tube adapted to it; two parts of sulphuric acid, previously diluted with five times its weight of water, are poured upon it, an effervescence is immediately excited, hydrogen gas escapes, and is to be collected in jars filled with water, and placed on the shelf of the pneumatic trough. Its disengagement continues until the zinc is dissolved. Iron may be employed in place of zinc, but containing generally a little carbon, which is dissolved by the hydrogen, it affords a gas less pure. Muriatic acid serves the same purpose as sulphuric acid, but must be diluted with only twice or three times its weight of water.

In the experiment, the hydrogen gas is derived entirely from the decomposition of the water, the oxygen of which is attracted by the metal. That the acid suffers no decomposition is proved, by the liquor, at the end of the experiment, being capable of saturating as much of an alkali as the quantity of acid employed would have done in a pure state. The agency of the acid was formerly explained, on the absurd doctrine of disposing affinity,—that it had no attraction to the pure metal, but to the oxide of the metal;

that, to satisfy this affinity, it caused the oxidation of the metal at the expense of the water, and then combined with the oxide thus formed. In conformity to Berthollet's speculations, it may be referred to the affinities of the acid to iron, and to oxygen, conspiring with the affinity of iron to oxygen: these co-operating produce a ternary combination, while the hydrogen gas is disengaged.

Hydrogen gas is permanently elastic. When collected over water, it is observed to have a peculiar smell, slightly fetid, which is not so perceptible when it is collected over quicksilver, and which is lost when the gas is exposed to substances which powerfully attract humidity. It is not the only substance in which water appears requisite to develope odour.

This is the lightest of the gases, and indeed the lightest substance whose gravity can be ascertained by weighing. Its specific gravity varies considerably, according to its state with regard to humidity. When it has been transmitted through water, or has remained for some time exposed to it, it is about ten times lighter than atmospheric air; when it has been received over quicksilver, and exposed to any substance which attracts water strongly, as quicklime, it is nearly 13 times lighter, or atmospheric air being 1,000, hydrogen is 84. Its specific gravity in this state, water being 1000, is stated by Lavoisier at 0.0946.100 cubic inches weigh 2.613 grains. It is from this levity, that it was applied with success to the construction of balloons; a varnished silk or linen bag, filled with it, having a specific gravity so much less than atmospheric air, as not only to rise in the atmosphere, but also to elevate an additional weight.

The chemical property, by which hydrogen gas is most eminently distinguished, is its great inflammability. When an ignited body is approached to it, in contact with the atmosphere, it is immediately kindled, and continues to burn while the air is admitted; if previously mixed with atmospheric air, and a burning body approached to the mixture, or an electric spark sent through it, it instantly inflames with detonation; and when it has been mixed with oxygen gas, the detonation is more violent. When burning at the extremity of a capillary tube, on bringing a wide tube over the flame, a singular phenomenon, accidentally observed by Dr. Higgins, is produced, that of sounds of various tones, which vary in acuteness and strength, according to the width, the length of the tube, and the kind of substance of which it is formed, owing, apparently, as Picket and De la Rive have explained it, to the vibrations excited in the matter of the tube by the rapid expansion and condensation of the watery vapour near and around the flame, and which, regulated and equalized by regular reflections from the sides of the tube, constitute a musical sound. (Nicholson's Journal, 8vo. vol. i. p. 129; ibid. vol. iv. p. 23).

Though hydrogen gas be inflammable, it is incapable of supporting the combustion of other inflammables. If a burning body be quickly immersed in it, it is immediately extinguished.

This gas is incapable of supporting animal life by respiration; an animal immersed in it is soon killed. At the same time, it does not appear to be so positively deleterious as the other noxious gases. Scheele long ago observed, that he was able to breathe it for twenty inspirations. (Treatise on Air and Fire, p. 160.) Fontana showed, what Scheele indeed had observed, that if the lungs were previously emptied as much as possible of atmospheric air, by a forcible expiration, it cannot be breathed so long, though still it did not appear to him to be positively deleterious, like some of the unrespirable gases, (Opuscules Physiques, p. 2.) Rosier, even after expelling the air from the lungs, breathed hydrogen gas for several respirations; and Mr. Davy, in his experiments on the respiration of the gases, remarked, that in one experiment, after a complete exhaustion of the lungs, he found great difficulty in breathing hydrogen for half a minute, though in a subsequent experiment, with the same preparation, he breathed it for near a minute. The first six or seven inspirations produced no sensations whatever; in half a minute, a sense of oppression was felt at the breast, which increased until the pain of suffocation interrupted the experiment. (Chemical Researches, p. 400. 466.) Hydrogen, therefore, is incapable of supporting life; the respiration of it can be continued only for a short time, and animals confined in it soon die. It appears only to prove fatal, not by a positively noxious quality, but by excluding atmospheric air, the due supply of which, by respiration, is indispensable to life. Blood exposed to it acquires a deep black colour, and the gas suffers a diminution of volume.

Hydrogen is not, as several of the other gases are, noxious to vegetable life; at the same time it appears to contribute little to the nourishment of plants, Dr. Priestley having found, that it still continued inflammable after a growing vegetable had been confined in it for several months. It can apparently supply, to a certain extent, the place of light, in supporting vegetation. Von Humboldt observed, that some cryptogamic plants in mines, and of course secluded from light, were not pale, but of a green colour, such as they would have had from growing under exposure to the light of day; and he concluded, with sufficient probability, that the agency of light had, in this case, been supplied by the hydrogen gas, which is evolved in greater or less abundance in such situations.

Hydrogen gas is so sparingly soluble in water, that, when agitated with it, it suffers no perceptible diminution of volume. When the water has been previously freed from atmospheric air, Mr. Henry found, that one hundred cubic inches take up 1.5 of the gas under a common atmospheric pressure; under increased pressure, a larger quantity, equal to one-third of the volume of the water, is absorbed.

The affinities of hydrogen seem principally exerted towards inflammable bodies. It unites with sulphur, phosphorus, and carbon, and forms gaseous compounds; it appears to be capable of dissolving even some of the metals, particularly, iron, zinc, and arsenic. United with nitrogen, it forms one of the alkalies, ammonia: with oxygen, water. It is also a constituent principle of the greater number of the vegetable and animal products.

Hydrogen gas may be regarded as a product of some natural operations. It is found collected often in mines, derived probably from the decomposition of water by metals; it is known to the miners by the name of fire-damp, and is often the cause of accidents, from exploding on the approach of an ignited body. It is also extricated from stagnant water, and from marshy situations, from the slow decomposition of vegetable and animal substances, holding, dissolved in it, carbon, and perhaps also phosphorus and nitrogen, and forming, as has been supposed with some probability, gases, which render the air of such places unhealthy. From its levity, it has been supposed, that the quantity of it thus produced at the surface of the earth will rise through the atmosphere, and occupy the higher regions; and on its presence some of the phenomena of meteorology, particularly the sudden appearance of some fiery meteors, have been supposed to depend. Its affinities have not been ascertained with any precision, as to their relative force.

HYDROGRAPHY, the art of measuring and describing the sea, rivers, lakes, and canals. With regard to the sea, it gives an account of its tides, counter-tides, soundings, bays, gulphs, creeks, &c.; as also of the rocks, shelves, sands, shallows, promontories, harbours, the distance and bearing of one port from another, with every thing that is remarkable, whether out at sea, or on the coast.

HYDROLEA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Convolvuli, Jussieu. Essential character: calyx five-leaved; corolla wheel-shaped; filaments cordate at the base; capsule two-celled, two-valved. There are four species.

HYDROMANCY, a method of divination by water, practised by the ancients in this manner; they filled a cup or bowl of water; then fastening a ring to a piece of thread tied to their finger, held it over the water, and repeated a certain form of words, desiring to be satisfied with regard to their inquiry; and if the question was answered in the affirmative, the ring would strike the sides of the bowl of its own accord.

HYDROMETER. The best method of weighing equal quantities of corrosive volatile fluids, to determine their specific gravities, appears to consist in inclosing them in a bottle with a conical stopper, in the side of which stopper a fine mark is cut with a file. The fluid being poured into the bottle, it is easy to put in the stopper, because the redundant fluid escapes through the notch, or mark, and may be carefully wiped off. Equal bulks of water and other fluids are by this means weighed to a great degree of accuracy, care being taken to keep the temperature as equal as possible, by avoiding any contact of the bottle with the hand or otherwise. The bottle itself shews, with much precision, by a rise or fall of the liquid in the notch of the stopper, whether any such change has taken place. See GRAVITY, *specific*.

But as the operation of weighing requires considerable attention and steadiness, and also a good balance, the floating instrument, called the hydrometer, has always been essteemed by philosophers, as well as men of business. It consists of a hollow ball, either of metal or glass, capable of floating in any known liquid; from the one side of the ball proceeds a stem, which terminates in a weight, and from the side diametrically opposite proceeds another stem, most commonly of an equal thickness throughout. The weight is so proportioned, that the instrument may float with the last mentioned stem upright. In the less accurate hydrometer this stem is graduated, and serves to show the density of the fluid, by the depth to which it sinks, as the heavier fluids will buoy up the instrument more than such as are lighter. In this way, however, it is clear, that the stem must be comparatively thick, in order to possess any extensive range; for the weight of vitriolic ether is not equal to three-fourths of the same bulk of water, and therefore such an hydrometer, intended to exhibit the comparative densities of these fluids, must have its stem equal in bulk to more than one-fourth of the whole instrument. If this bulk be given chiefly in thickness, the smaller differences of density will not be perceptible, and it cannot, with any convenience, be given in length.

To remedy this imperfection, various contrivances have been proposed, for the most part grounded on the consideration, that a change in the ballast, or weight employed to sink the ball, would so far change the instrument, that the same short range of gradations on a slender stem, which were employed to exhibit the densities of ardent spirits, might be employed in experiments upon water. Some have adjusted weights to be screwed upon the lower stem, and others, with more neatness and accuracy, have adjusted them to be slipped upon the extremity of the upper stem. But the method of Fahrenheit appears to be on all accounts the simplest and most accurate.

The hydrometer of Fahrenheit consists of a hollow ball, with a counterpoise below, and a very slender stem above, terminating in a small dish. The middle, or half length of the stem, is distinguished by a fine line across. In this instrument every division of the stem is rejected, and it is immersed in all experiments to the middle of the stem, by placing proper weights in the little dish above. Then, as the part immersed is constantly of the same magnitude, and the whole weight of the hydrometer is known, this last weight, added to the weights in the dish, will be equal to the weight of fluid displaced by the instrument, as all writers on hydrostatics prove. And accordingly the specific gravities for the common form of the tables will be had by the proportion. As the whole weight of the hydrometer and its load, when adjusted in distilled water, is to the number 1,000, &c. so is the whole weight, when adjusted in any other fluid, to the number expressing its specific gravity.

In order to show the degree of accuracy an instrument of this kind is capable of, it may in the first place be observed, that the greatest impediment to its sensibility arises from the attraction or repulsion between the surface of the fluid and that of the stem. If the instrument be carefully wiped with a clean soft linen cloth, the metallic surface will be equally disposed to attract or repel the fluid. So that if it possess a tendency to descend, there will be a cavity surrounding the stem; or if, on the contrary, its tendency be to rise, the fluid will stand round the stem in a small protuberance. The operator must assist this tendency by applying the pincers, with which he takes up his weights to the rim of the dish. It is very easy to know when the surface of the fluid is truly flat, by observing the reflected image of the window, or any other fit object seen near the stem in the fluid. In this way the adjustment of the weights in the dish may, without difficulty, be brought to the fiftieth part of a grain. If, therefore, the instrument displace one thousand grains of water, the result will be very true to four places of figures, or even to five. This will be as exact as most scales are capable of affording

Some writers have spoken of the adjustment of an hydrometer of this kind, so that it shall at some certain temperature displace one thousand grains of water, as if this were a great difficulty. It is true, indeed, that the performance of a piece of workmanship of this nature would require both skill and judgment on the part of the artist; but it is by no means necessary.

Nothing more is required on the part of the workman, than that the hydrometer shall be light enough to float in ether, and capable of sustaining at least one-third of its own weight in the dish, without oversetting in a denser fluid. This last requisite is obtained by giving a due length to the stem beneath, to which the counterpoise is attached. With such an instrument, whatever may be its weight, or the quantity of water it displaces, the chemist may proceed to make his experiments, and deduce his specific gravities by the proportion before laid down. Or, to save occasional computation, he may once for all make a table of the specific gravities, corresponding to every number of the load in the dish, from one grain up to the whole number of grains, so that, by looking for the load in one column, he may always find the specific gravity in the column opposite.

This method is very ready and convenient in practice; but if it be preferred, the weights may be adjusted to the hydrometer, so as to shew the specific gravity, without computation or reference. For this purpose the hydrometer must be properly counterpoised in distilled water, at the assumed standard temperature; suppose 60°, and the whole weight of the instrument and its load called 1.000, &c. Then the weight of the instrument and its load must be separately determined in grains and parts, or other weights, by a good pair of scales, and as the whole weight of the instrument and its load is proportioned to the weight of the instrument alone, so will be the number 1.000, &c. to a fourth term, expressing the weight of the instrument in such parts as make the whole 1.000, &c. Make an actual set of decimal weights, of which 1.000, &c. shall be equal to the hydrometer and its load; and it is clear, that, whatever may be the load in these weights, if it be added to the number denoting the weight of the instrument, the sum will denote the specific gravity of the fluid, wherein the instrument floats with that load.

By following the above easy method, it will be found that every hydrometer, wheresoever made, must give the same results. The subject is indeed in itself sufficiently simple, and would require scarcely any discussion, if it had not happened that many philosophers, for want of requisite attention, have made their experiments with hydrometers graduated on the stem by no certain rule, by which operators, at a distance from each other, might compare their experiments. The hydrometers, or pesé-liquers of Baumé, though in reality comparable with each other, are subject, in part, to the defect, that their results, having no independent numerical measure, require explanation to those who do not know the instruments. Thus, for example, when a chemist acquaints us that a fluid indicated fourteen degrees of the pesé-liquer of Baumé, we cannot usefully apply this result, unless we have some rule to deduce the correspondent specific gravity; whereas we should not have been in any respect at a loss, if the author had mentioned the specific gravity itself. As a considerable number of French philosophers refer to this instrument, it will be of use to explain its principles.

M. Baumé appears to have directed his attention chiefly to the acquisition of a means of making hydrometers with a graduated stem, which should correspond in their results, notwithstanding any differences in their balls or stems. There is little doubt but he was led into the method he adopted, by reflecting on that by which thermometers are usually graduated. See THERMOMETER.

As thermometers are graduated independent of each other, by commencing with an interval between two stationary points of temperature, so M. Baumé adopted two determinate densities, for the sake of marking an interval on the stem of his hydrometer. These densities were those of pure water, and of water containing $\frac{15}{85}$ parts of its weight of pure dry common salt in solution. The temperature was ten degrees of Reaumur above freezing, or 54.5° of Fahrenheit. His instrument for salts was so balanced, as nearly to sink in pure water. When it was plunged in this saline solution, the stem arose in part above the surface. The elevated portion was assumed to be fifteen degrees, and he divided the rest of the stem with a pair of compasses into similar degrees.

It is unnecessary to inquire, in this place, whether this interval be constant, or how far it may be varied by any difference in the purity, and more especially the degree of dryness of the salt. Neither will it be requisite to inquire, how far the principle of measuring specific gravities by degrees, representing equal increments, or decrements, in the bulk of fluids, of equal weight, but different specific gravities, may be of value, or the contrary. It does not seem probable, that Baumé's instrument will ever become of general use, for which reason nothing further need be ascertained, than the specific gravities corresponding with its degrees, in order that such experiments as have this element among their data may be easily understood by chemical readers.

M. Baumé, in his "Elémens de Pharmacie," has given a table of the degrees of his hydrometer for spirits, indicated by different mixtures of alcohol and pure water, where he says, the spirit made use of gave 37 degrees at the freezing point of water; and in a column of the table he states the bulk of this spirit, compared with that of an equal weight of water, as $35\frac{5}{8}$ to 30. The last proportion answers to a specific gravity of 0.842, very nearly. A mixture of two parts, by weight, of this spirit, with thirty of pure water, gave twelve degrees of the hydrometer at the freezing point. This mixture, therefore, contained $6\frac{1}{2}$ parts of Blagden's standard to 100 water; and by Gilpin's excellent tables, its specific gravity must have been 0.9915. By the same tables these specific gravities of 0.842 and 0.9915 would, at 10° Reaumur, or 55° Fahrenheit, have fallen to 0.832 and 0.9905. Here then are two specific gravities of spirit corresponding with the degrees 12 and 37, whence the following table is constructed.

BAUME'S HYDROMETER FOR SPIRITS.

Temperature 55° Fahrenheit, or 10° Reaumur.

Deg.	Sp. Grav.	Deg.	Sp. Grav.
10 =	1.000	26 =	.892
11 =	.990	27 =	.886
12 =	.985	28 =	.880
13 =	.977	29 =	.874
14 =	.970	30 =	.868
15 =	.963	31 =	.862
16 =	.955	32 =	.857
17 =	.949	33 =	.852
18 =	.942	34 =	.847
19 =	.935	35 =	.842
20 =	.928	36 =	.837
21 =	.922	37 =	.832
22 =	.915	38 =	.827
23 =	.909	39 =	.822
24 =	.903	40 =	.817
25 =	.897		

With regard to the hydrometer for salts, the learned author of the first part of the "Encyclopédie, Guyton de Morveau," who by no means considers this an accurate instrument, affirms, that the sixty-sixth degree corresponds nearly with a specific gravity of 1.848; and as this number lies near the extreme of the scale, I shall use it to deduce the rest.

BAUME'S HYDROMETER FOR SALTS.

Temperature 55° Fahrenheit, or 10° Reaumur.

Deg.	Sp. Grav.	Deg.	Sp. Grav.
0 =	1.000	39 =	1.373
3 =	1.020	42 =	1.414
6 =	1.040	45 =	1.455
9 =	1.064	48 =	1.500
12 =	1.089	51 =	1.547
15 =	1.114	54 =	1.594
18 =	1.140	57 =	1.659
21 =	1.170	60 =	1.717
24 =	1.200	63 =	1.779
27 =	1.230	66 =	1.848
30 =	1.261	69 =	1.920
33 =	1.295	72 =	2.000
36 =	1.333		

It may not be amiss to add, however, that in the Philosophical Magazine, Mr. Bingley, the assay-master of the Mint, has given the following numbers as the specific gravity of nitric acid, found to answer to the degrees of an areometer of Baumé by actual trial; temperature about 60° Fahrenheit. But his appears to have been a different instrument, as it was graduated only from 0 to 50°.

Deg.	Sp. Grav.	Deg.	Sp. Grav.
18 =	1.150	36 =	1.333
20 =	1.167	37 =	1.342
26 =	1.216	38 =	1.350
28 =	1.233	39 =	1.358
29 =	1.250	40 =	1.367
30 =	1.267	41 =	1.383
31 =	1.275	42 =	1.400
32 =	1.283	43 =	1.416
34 =	1.300	45 =	1.435
35 =	1.312		

One of the principal uses of the hydrometer in common life being to determine the specific gravity of vinous spirits on the mixtures of alcohol, which consist of water, an article of no value in a commercial light, and alcohol, which is of considerable price, it becomes of importance to determine how much of each may be contained in any mixture. The following tables, extracted from the large table of Gilpin in the "Philosophical Transactions," may be considered as of the first authority. They were made with mixtures of water and alcohol, of 0.825 at 60°. The alcohol was obtained from malt.

HYDROMETER.

Real Specific Gravities of Spirits at different Temperatures.

Heat.	The pure spirit.	100 grains of spirit to 5 gr. of water.	100 grains of spirit to 10 gr. of water.	100 grains of spirit to 15 gr. of water.	100 grains of spirit to 20 gr. of water.	100 grains of spirit to 25 gr. of water.	100 grains of spirit to 30 gr. of water.	100 grains of spirit to 35 gr. of water.	100 grains of spirit to 40 gr. of water.	100 grains of spirit to 45 gr. of water.	100 grains of spirit to 5 gr. of water.
30°	.83896	.84995	.85957	.86825	.87585	.88282	.88921	.89511	.90054	.90558	.91023
35	83672	84769	85729	86587	87357	88059	88701	89294	89839	90345	90811
40	83445	84539	85507	86361	87134	87838	88481	89073	89617	90127	90596
45	83214	84310	85277	86131	86905	87613	88255	88849	89396	89909	90380
50	82977	84076	85042	85902	86676	87384	88030	88626	89174	89684	90160
55	82736	83834	84802	85664	86441	87150	87796	88393	88945	89458	89933
60	82500	83599	84568	85430	86208	86918	87569	88169	88720	89232	89707
65	82262	83362	84334	85193	85976	86686	87337	87938	88490	89006	89479
70	82023	83124	84092	84951	85736	86451	87105	87705	88254	88773	89252
75	81780	82878	03851	84710	85496	86212	86864	87466	88018	88558	89018
80	81530	82631	83603	84467	85248	85966	86622	87228	87776	88301	88781
85	81291	82396	83371	84243	85036	85757	86411	87021	87590	88120	88605
90	81044	82150	83126	84001	84797	85518	86172	86787	87360	87889	88376
95	80794	81900	82877	83753	84550	85272	85928	86542	87114	87654	88146
100	80548	81657	82639	83513	84308	85031	85688	86302	86879	87421	87915

Heat.	100 grains of spirit to 55 gr. of water.	100 grains of spirit to 60 gr. of water.	100 grains of spirit to 65 gr. of water.	100 grains of spirit to 70 gr. of water.	100 grains of spirit to 75 gr. of water.	100 grains of spirit to 80 gr. of water.	100 grains of spirit to 85 gr. of water.	100 grains of spirit to 90 gr. of water.	100 grains of spirit to 95 gr. of water.	100 grains of spirit to 100 gr. of water.
30°	.91449	.91847	.92217	.92563	.92889	.93191	.93474	.93741	.93991	.94222
35	91241	91640	92009	92355	92680	92986	93274	93541	93790	94025
40	91026	91428	91799	92151	92476	92783	93072	93341	93592	93827
45	90812	91211	91584	91937	92264	92570	92859	93131	93382	93621
50	90596	90997	91370	91723	92051	92358	92647	92919	93177	93419
55	90367	90768	91144	91502	91837	92145	92436	92707	92963	93208
60	90144	90549	90927	91287	91622	91933	92225	92499	92758	93002
65	89920	90328	90707	91066	91400	91715	92010	92283	92546	92794
70	89695	90104	90484	90847	91181	91493	91793	92069	92333	92580
75	89464	89872	90252	90617	90952	91270	91569	91849	92111	92364
80	89225	89639	90021	90385	90723	91046	91340	91622	91891	92142
85	89043	89460	89843	90209	90558	90882	91186	91465	91729	91969
90	88817	89230	89617	89988	90342	90668	90967	91248	91511	91751
95	88588	89003	89390	89763	90119	90443	90747	91029	91290	91531
100	88357	88769	89158	89536	89889	90215	90522	90805	91066	91310

Heat.	95 grains of spirit to 100 gr. of water.	90 grains of spirit to 100 gr. of water.	85 grains of spirit to 100 gr. of water.	80 grains of spirit to 100 gr. of water.	75 grains of spirit to 100 gr. of water.	70 grains of spirit to 100 gr. of water.	65 grains of spirit to 100 gr. of water.	60 grains of spirit to 100 gr. of water.	55 grains of spirit to 100 gr. of water.	50 grains of spirit to 100 gr. of water.
30°	.94447	.94675	.94920	.95173	.95429	.95681	.95944	.96209	.96470	.96719
35	94249	94484	94734	94988	95246	95502	95772	96048	96315	96579
40	94058	94295	94547	94802	95060	95328	95602	95879	96159	96434
45	93860	94096	94348	94605	94871	95143	95423	95705	95993	96280
50	93658	93897	94149	94414	94683	94958	95243	95534	95831	96126
55	93452	93696	93948	94213	94486	94767	95057	95357	95662	95966
60	93247	93493	93749	94018	94296	94579	94876	95181	95493	95804
65	93040	93285	93546	93822	94099	94388	94689	95000	95318	95635
70	92828	93076	93337	93616	93898	94193	94500	94813	95139	95469
75	92613	92865	93132	93413	93695	93989	94301	94623	94957	95292
80	92393	92646	92917	93201	93488	93785	94102	94431	94768	95111

Heat.	45 grains of spirit to 100 gr. of water.	40 grains of spirit to 100 gr. of water.	35 grains of spirit to 100 gr. of water.	30 grains of spirit to 100 gr. of water.	25 grains of spirit to 100 gr. of water.	20 grains of spirit to 100 gr. of water.	15 grains of spirit to 100 gr. of water.	10 grains of spirit to 100 gr. of water.	5 grains of spirit to 100 gr. of water.
30°	.96967	.97200	.97418	.97635	.97860	.98108	.98412	.98804	.99334
35	96840	97086	97319	97556	97801	98076	98397	98804	99344
40	96706	96967	97220	97472	97737	98033	98373	98795	99345
45	96563	96840	97110	97384	97666	97980	98338	98774	99338
50	96420	96708	96995	97284	97589	97920	98293	98745	99316
55	96272	96575	96877	97181	97500	97847	98239	98702	99284
60	96122	96437	96752	97074	97410	97771	98176	98654	99244
65	95962	96288	96620	96959	97309	97688	98106	98594	99194
70	95802	96143	96484	96836	97203	97596	98028	98527	99134
75	95638	95987	96344	96708	97086	97495	97943	98454	99066
80	95467	95826	96192	96568	96963	97385	97845	98367	98991

HYDROPHILUS, in natural history, a genus of insects of the order Coleoptera. Antennæ clavate, the club perfoliate; feelers four, filiform; the hind legs are formed for swimming, fringed on the inner side, and nearly unarmed with claws. The insects of this genus, like those of the Dytiscus, which see, are inhabitants of ponds and stagnant waters, where they swim with much dexterity, turning round with great velocity; they fly abroad by night in search of other waters. The males are distinguished from the females, by having a horny concave flap or shield on the fore legs, near the setting on of the feet; the hind legs are peculiarly fitted for their aquatic situation, being furnished on the inner side with a series of long and close-set filaments, resembling a fin, by which they are enabled to swim with great ease. The larva remain about two years and a half before they change into pupæ, forming a convenient cell, and secreting themselves in some bank. They are very voracious, and destructive to the more tender aquatic insects, worms, and young fish, which they seize with their forked jaws, and destroy, by sucking out their juice. There are upwards of thirty species. The principal European species is the H. piceus, water-clock. The female of this species affords an example of a faculty, which seems to be exercised by no other insect of this order, *viz.* that of spinning a kind of web, or flattish circular case of silk, which it leaves floating on the water, and in which it deposits its eggs. This case, says Dr. Shaw, is terminated, on its upper surface, by a lengthened conical process, resembling a horn, of a brown colour, and of a much stronger nature than the case itself, which is white. The larvæ, as soon as hatched, make their escape from the envelopement of the case, and commit themselves to the water.

HYDROPHOBIA, in medicine, an aversion or dread of water; a terrible symptom of the rabies canini. See Medicine.

HYDROPHYLAX, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: calyx four-parted; corolla funnel-form; fruit ancipital, one-seeded. There is only one species, *viz.* H. maritima, found in driving sand, on the sea-shore, near Guduluhr in the East Indies.

HYDROPHYLLUM, in botany, *water-leaf*, a genus of the Pentandria Monogynia class and order. Natural order of Borragineæ, Jussieu. Essential character: corolla bell-shaped, having five longitudinal melliferous streaks on the inside; stigma bifid; capsule globular, two-valved. There are two species, *viz.* H. virginicum, Virginian water-leaf; and H. canadense, Canadian water-leaf.

HYDROSCOPE, an instrument anciently used for the measuring of time. The hydroscope was a kind of water-clock, consisting of a cylindrical tube, conical at bottom: the cylinder was graduated, or marked out with divisions, to which the top of the water, becoming successively contiguous, as it trickled out at the vertex of the cone, pointed out the hour.

HYDROSTATICAL *balance*, a kind of balance contrived for the easy and exact finding the specific gravities of bodies, both liquid and solid. See HYDROSTATICS.

HYDROSTATICS relate to the resting equilibrium of non-elastic fluids; and to the pressure of solids immersed therein. A fluid is a body whose parts are infinitely minute, capable of dislocation in consequence of the smallest force, invariably (when suffered to rest) resuming a perfect level surface, and presenting an equal resistance throughout every part of the body immersed.

Philosophers consider fluids to be divided into two classes, *viz.* the elastic, such as air, vapour, and gas; all which may be compressed more or less: and the inelastic, *viz.* water, mercury, spirits &c. which cannot be compressed; though by being heated they distend considerably. It may be proper to observe in this place, that Mr. Canton, in the years 1762 and 1764, published the results of experiments he had made, whereby it was endeavoured to be proved, that all fluids were compressible, though in so trifling a degree as not to affect their bulks when under examination. With the barometer at 29½, and the thermometer at 50, he declares the following compressions were effected.

	Spec. Grav.	Compression.
With Spirit of Wine	846	66 parts in a million
Oil of olives	918	48 ditto
Rain water	1,000	46 ditto
Sea water	1,028	40 ditto
Mercury	13,595	3 ditto

We leave the reader to judge whether it be probable, by any apparatus of human formation, and under human guidance, to ascertain that the three millionth parts, said to have been compressed, were really so. Indeed, even the sixty-sixth millionth parts, suffered to be compressed in the spirits of wine, must appear extremely doubtful; though we cannot but conclude that, as air exists in every atom of nature, more or less, with a sufficient force, every fluid were subject to compression into a smaller space than is occupied by it when perfectly at liberty. Speaking generally, the definitions above given may be considered as applicable to all cases with which we are acquainted; and may, perhaps, be completely true.

We shall commence the detail, incident to this subject, with an account of the method of obtaining the specific gravities of bodies: that is, by showing the comparative weights of various solids and fluids, as ascertained by the most careful and skilful chemists. The reader must, however, consider the weights as taken at a medium. See GRAVITY, *specific*, where is given a table of specific gravities.

The reader will observe, that the whole of the above are compared with rain-water, which appear at 1.000 parts; but it is very remarkable, that the density of that fluid varies greatly according to its temperature; and that it by no means affords a regular scale of weight, or of bulk, in proportion to the degrees of heat. This will be seen from the following table, taken from the observations of Dr. Blagden and Mr. Gilpin.

Degrees of Heat.	Bulk of the Water.	Specific Gravity.
30°		
35	99910	1.00090
40	99070	1.00094
45	99914	1.00086
50	99932	1.00068
55	99962	1.00038
60	100000	1.00000
65	100050	0.99950
70	100106	0.99894
75	100171	0.99830
80	100242	0.99759
85	100320	0.99681
90	100404	0.99598
95	100501	0.99502
100	100602	0.99402

We must suppose the water of the Dead Sea to be highly impregnated; since it appears to weigh nearly a fourth more than common sea water.

The anomalies lay between 32° and 45°, and are accounted for by the contraction which takes place in water about to freeze, and its sudden expansion afterwards; by this we understand the cause of bottles, pitchers, &c. being burst, when the water they contain freezes. The difference in bulk between water and liquors, in the winter and in the summer season, averages about three per cent: hence many great dealers have thought it worth their while to buy only in the former season, when the liquors have been most concentrated.

HYDROSTATICS.

The specific gravity of a body, either fluid or solid, is ordinarily found by means of the hydrostatic balance; a most ingenious device for exactly ascertaining the weight, either immersed in the water, or in the air. The construction of this instrument requires peculiar nicety, but it may be appended to any common balance; as will be understood from the following description. Each scale should have a small hook fixed to the centre of its bottom, or lower side; so these small weights may be attached by means of horse-hair, or fine silk, thence to suspend a body in water without wetting the scale. First weigh the body in the usual manner in the scales, with great exactness; immerse it in water, and the equilibrium will be instantly destroyed. To restore it, put into the scale, from which the body immersed in the water is suspended, as much weight as will bring it even with the other scale, in which the opposing weight remains unaltered. The added weight will be equal to that of a quantity of water equalling the immersed body in bulk. Now, if the weight of the body in air be divided by what it weighed in the water, the quotient will show how much that body is heavier than its bulk of water.

A guinea, new from the mint, will require 129 grains to be offered to its weight in air; but, on being immersed in water, will require 7¼ grains more to restore the equilibrium lost by the immersion. From this we see, that a quantity of water equal in bulk with the guinea weighs 7¼ grains, or 7.25, by which divide 129, (the weight in air,) and the quotient will be 17.793; shewing that the guinea is as 17.793, to one of water.

But we sometimes have occasion to ascertain the precise weight of bodies that are lighter than water, say a piece of cork, and which, if unaided, would float on its surface. In such case, it is necessary to affix a weight (having previously found its exact poise) thereto; when, by immersing both, and deducting the amount of the collateral weight, the residue will be left to account of the cork. If you would weigh quicksilver, it must be first balanced in a glass bucket, of which the weight is known, and which has been weighed also by immersion. When the bucket has been brought to equilibrium in the water, pour in the quicksilver, and the additional weight requisite to counterbalance it will show its exact weight.

Perhaps the following general rules for finding the specific gravity of bodies may prove useful and familiar to every understanding. 1, "When the body is heavier than water." Weigh it both in water, and in the atmosphere, and the difference between the results will show the quantity lost in the former mode; then, as the weight lost in water is to the weight in air, so is the gravity of water to the gravity of the body. 2. "When the body, being specifically lighter, will not sink in water." Render the body heavy enough to sink by means of some appendage, as a small piece of lead, &c.; weigh the body and the appendage, both separately and together, in the air, and in the water; find out how much each loses in the water, and subtract those losses from the whole weight of each in air. Then, as the last remainder is to the weight of the light body in air, so is the gravity of water to the gravity of the body. 3. "When a fluid is to be weighed." Weigh the fluid in a cup, which is to be deemed an appendage, and treated according to the foregoing rule, observing, that as the whole weight is to the loss of weight, so is the gravity of the solid to the gravity of the fluid.

We may ascertain the respective weights of two known ingredients in a given compound thus: take the differences of every pair of the three specific gravities; (*viz.* the specific gravities of the compound, and of each ingredient:) multiply each quantity by the difference of the other two; then, as the greatest product is to the whole weight of the compound, so is each of the other two products to each respective weight of the two ingredients.

If a piece of glass, or of metal, be immersed by suspension in different fluids, it will lose in weight; that is, it will require an equipoise, according to the weight of the fluids respectively: observing, that in the lightest fluid, say alcohol, it will lose least weight. This is the principle on which the hydrometer acts, as will be subsequently shown.

Vessels filled with water weigh more than when empty: to prove this, let a bottle be loaded so as to sink in a pail of water, deep enough for the water to cover its mouth, which should be previously closed by a plug, in such manner as might be easily pushed in; append the bottle in equilibrio to the hydrostatic balance, and drive in the plug: the water will follow and destroy the equilibrium.

Fluids press every away alike, though their general tendency is to gravitation. Thus, if a vessel be made weaker in the side than at the bottom, and be so laden or oppressed by the weight of water, as to burst the vessel, the weakest part, wherever situated, will become the outlet; but, so soon as liberated, the fluid will invariably descend, unless acted upon by a syphon, as shown in treating of hydraulics. The pressure upwards is, however, merely in conformity with circumstances attendant upon general pressure, and proves the tendency of fluids to find their own level. Thus, if you take a glass tube of moderate diameter, open at both ends, and stop one closely with your finger, when you immerse the other end in any fluid, it will enter but little within the vacancy; because the columns of air within the tube repress it. But when the finger is withdrawn, the water will ascend within the tube, to the level of the body in which it is immersed.

As fluids press in all directions, it is evident their whole weight cannot be applied against one part or side; while on the other hand it is equally true, that, in some instances, the bottoms of vessels receive a pressure which does not appear to be their due. Thus, in a pan whose base is narrower than its brim, the bottom sustains only the weight of a column equal to its area, multiplied by its height; yet if the pan be of a bell-shape, having its base broader than its brim, the bottom will sustain a weight equal to its area, also multiplied by its height. Consequently, in a vessel of a conical form, the base would be oppressed as much as if the sides were cylindrical. This is called the hydrostatic paradox; but will be easily reconciled by the consideration, that if a tube of glass be made with a curved bottom, so as to turn up in the form of the letter U, but with one leg or part much wider than the other, the water will rise equally in both. If to each a piston be fitted, their weights being equal, and that one piston be first put into the wider leg of the tube, it will cause the fluid to rise in the other in proportion to its weight; but on applying the lesser piston to the corresponding smaller tube, the two will be held in equilibrio. We have indeed further proof of the pressure of water upwards, by means of two boards, whose sides are joined by leather, as in a pair of bellows; these may be of any form, or of any size. At the top of one of the boards cut a hole, and insert a tube of about four or five feet in length, so as to be perfectly tight: place on the board several weights, according to the size of the machine, and pour water into the tube. The upper board will bear up against the weights, provided they be not disproportionately heavy; and will admit the water between the top and bottom to the extent admitted by the pliable sides. Some water ought to be poured in before the weights are set on. A circle of about twenty inches in diameter will thus lift and support three weights, of 100*lb.* each. Where either air or any other fluid is debarred from access between two planks annexed in the water, the lower one being kept to the bottom forcibly, they will not separate, unless a force equal to the weight of the superincumbent fluid be applied; because the lateral and superior parts of the fluid are prevented from exerting their pressure, except in that direction which keeps the two planks together; but if the smallest opening be given, the pressure of the atmosphere will urge the fluid between them, and by confining it to act as a wedge, force the upper one to the surface. The comparative weights of fluids are ascertained by the HYDROMETER, which see.

The comparative weight of fluids is given with the table of specific gravities, (see GRAVITY, *specific*); but it may be as well to point out in this place, that a gallon of proof spirit weighs 7*lb.* 12*oz.* avoirdupois.

If a vessel contain two immiscible fluids (such as water and mercury), and a solid of some intermediate gravity be immersed under the surface of the lighter fluid, and float on the heavier, the part of the solid immersed in the latter will be to the whole solid, as the difference between the specific gravities of the solid and of the lighter fluid is to the difference between the specific gravities of the two fluids.—For a body immersed in a fluid will, when left to itself, sink, if its specific gravity be *greater* than that of the fluid; if *less*, it will rise to the surface: if the gravities be equal, the body will remain in whatever part of the fluid it may be placed.—But in the case adverted to, the one fluid being heavier and the other lighter than the body immersed, it is necessary to combine their gravities by the mode above shown.

Balloons are properly hydrostatic machines, and derive their property of ascending from the earth into the upper part of our atmosphere entirely from the difference between the specific gravity of the air, or gas, with which they are filled, and the exterior, or atmospheric, air in which they float. The weight of the materials must be taken into consideration; for unless the specific gravity of the interior be so much less than that of the exterior air, as to allow for the weight of the materials as a counterpoise, the balloon cannot be made to float even in a stationary manner; but when liberated will fall to the ground. The contents of the balloon being ascertained in cubic feet, it will be easy to ascertain what weight the balloon can lift, when filled with rarified air, according as that may have been rendered more light than the atmospheric air: if filled with gas, the interior will be at least seven times lighter than an equal quantity of atmospheric air. From this it will be seen, that to bear up a weight of 300*lb.* the balloon must be large, and the specific gravity of its contents be adequate to overcome the resistance of that impediment. As the air of the upper part of our atmosphere becomes gradually more rare, and consequently lighter, according to its distance from the earth's surface, we may conclude that there is a point in its altitude, beyond which a balloon could not soar; because its own weight, even if nothing were appended, would at such a point perfectly equipoise the difference between the confined gas and the surrounding atmosphere. And this is the more perfectly to be admitted, from the knowledge we have acquired of the difficulty with which balloons are made to reach certain heights, and of their ascent being shown (by the slower fall of the mercury within the barometer) to be far slower in the upper regions when they approach that state of equipoise. Were it not for the opposition offered by the superior air, a balloon would rise instantaneously, from the moment of its liberation, in a most rapid manner, to that height where its equipose should be found. We have said thus much in explanation of the nature of the balloon, as appertaining to the laws of hydrostatics, referring the reader to the article AEROSTATION, for whatever appertains to the practical experience we have had of that science, which at first seemed to promise the most important aid to various others, but in which it has completely failed: the whole of the principles on which aerostation depends have been long understood.

We shall now speak of the *diving-bell*, which also depends on hydrostatic principles, though, like the balloon, it has a close connection with pneumatics. The upper part of a diving-bell is always made to contain a certain quantity of air, more or less compressed, in proportion to the depth to which the bell sinks. Thus, if we invert a small tumbler into a vessel nearly filled with water, and allow it to descend perpendicularly, so that no air may be allowed to escape, the water will rise a very little way within it. If the tumbler be but partially immersed, the water could at the utmost but rise to its own level; but if immersed so deep as to exceed its own interior, and that the bottom edge of the tumbler does not touch the bottom of the vessel, the water will, in consequence of its own greater weight at a greater depth, rise rather, though scarce perceptibly, higher in the tumbler, and occasion the air to be compressed into a smaller space. But the quantity of vital principle in the compressed air will be equal to that quantity of air in the open atmosphere which would fill the interior of the tumbler. If the inverted tumbler were first placed at the bottom of an empty vessel, and that water were afterwards poured into the latter, the effect would be precisely the same.

The air contained within the upper part of a diving-bell not only debars the ingress of water, but, like the rarified air in the balloon, gives the machine such a buoyancy, that, unless made very substantial, and duly laden at the bottom, or broadest part, it would sink with difficulty, and be apt to turn on its side, so that the air would escape. Under the head of DIVING-*bell*, the reader will find an ample detail of the inventions hitherto extant in that branch of adventure.

With regard to the depth to which floating bodies become immersed in fluids, we may consider the following general principles, or propositions, to be sufficient for the purpose of our readers.—Bodies, whose bases, or bottoms, are angular, like the keels of ships, will be immersed deeper than those whose bases are flat, such as barges: hence sharp-built vessels necessarily (to use the technical term) "draw more water" than those of a more obtuse form: the reason of which is easily demonstrated, *viz.* As every body floating on a fluid will be immersed in proportion to its weight, and will displace a quantity of water equal thereto, it follows, that as a triangle is equal to only half a parallelogram of equal base and altitude, a parallelogram (or flat-bottomed vessel) will, under equal pressure, sink only half the depth of a triangular shaped bottom, of equal base and altitude. For the same reason, vessels that have sharp stems make an easier passage though the water than such as are more "bluff," or obtuse, "at the bows:" the more acute the triangle in that part, the less the resistance; for the triangle displaces only half the quantity of water that would be removed by a parallelogram of equal base and altitude; *ergo*, it would proceed twice as far, within a given time, as the latter, were not the friction, in some degree, increased.

It must be obvious, that whether the vessel alone, or the circumstance of her being laden, cause her to weigh more than the quantity of water displaced by her whole bulk, up to the very gunwale, is not material; for in such case she cannot float, but must be depressed by the sum of specific gravity thus produced. This will appear in a very natural and simple manner, if we load a cup with small shot, &c. for, though partly empty, the cup will sink whenever the whole weight may exceed that of the water displaced. Both the cup and the shot are, however, specifically heavier than their bulk of water, and the former would sink if let in sideways; but then it would only displace a quantity of water corresponding with its own bulk, which would be trivial, when compared with that removed by its pressure as a floating body. On the other hand, we find that a ship may be laden with cotton, which is far lighter than water, so as to sink, at least to a level with the water, though not to precipitate to the bottom, unless forced by the adjunction, in whatever form or manner, of such other substances as are heavier than water, by which the levity of the cotton may not only be counterpoised, but exceeded. In India, where the principles of hydrostatics are absolutely unknown, the peasants make rafts of the straw, which they perceive to be lighter than water, and on them load the corn threshed from that straw, perceiving it to be heavier than water. Thus they act upon the best principles, merely from observation!

Perhaps, among the most curious circumstances that come within the verge of our subject, nothing can more fully exemplify what has been advanced, than the fact, well known, of some vessels sailing better *upon* than *before* the wind. We have no doubt that, if the forms of their bottoms were correctly ascertained, they would be found to present such a surface in the former position, when "keeled a little," as created a more favourable position of the gravity of the vessel, though it must be at least equal, or, indeed, greater, if much pressed by the wind, than in the latter position.

Before we quit this subject, it is necessary to inform the reader, that, except in cases relating purely to statics, few instances occur, in which the various matters appertaining to hydrostatics can be treated in a manner perfectly abstracted from pneumatics, or from hydrodynamics. Under the head of FLUIDS, and of HYDRAULICS, we have treated of the principles of fluids in motion, in such a way as may give a popular idea of those very intricate subjects; recommending to the student to read the whole contained under those articles with attention, and combining their several actions as derived from one great principle.

HYDRO *sulphuret*, in chemistry, the combination of sulphuretted hydrogen with an alkaline or earthy base. The general properties of these substances are, that they are soluble in water, and are crystallizable; the solution is colourless, while the action of the air is excluded; but when that is admitted, a yellow colour is soon acquired, owing to the oxygen of the atmosphere combining with the hydrogen of a portion of the sulphuretted hydrogen, while the sulphur combines with the remaining portion of it, forming a super-sulphuretted hydrogen, in union with the base. Mr. Murray observes, that "the knowledge which we have acquired of sulphuretted hydrogen, and of its combinations, has thrown light on the composition of the mineral sulphureous waters, and of the changes which they suffer. As sulphur is by itself insoluble in water, and as frequently no traces of an alkali, by which it might be rendered soluble, could be discovered in them, chemists found it difficult to conjecture by what means its solution was effected. The discovery of sulphuretted hydrogen, and of its solubility in water, solved the difficulty; and the mutual action exerted between it and the oxygen elucidate the changes these waters suffer from exposure to the air."

HYGROMETER, a machine or instrument to measure the degrees of dryness or moisture of the atmosphere.

There are divers sorts of hygrometers; for whatever body either swells or shrinks by dryness or moisture is capable of being formed into an hygrometer. Such are woods of most kinds, particularly ash, deal, poplar, &c. Such also is catgut, the beard of a wild oat, &c.

All bodies that are susceptible of imbibing water have a greater or less disposition to unite themselves with that fluid, by the effect of an attraction similar to chemical affinity. If we plunge into water several of these bodies, such as wood, a sponge, paper, &c. they will appropriate to themselves a quantity of that liquid, which will vary with the bodies respectively; and as, in proportion as they tend towards the point of saturation, their affinity for the water continues to diminish, when those which have most powerfully attracted the water have arrived at the point, where their attractive force is found solely equal to that of the body which acted most feebly upon the same liquid, there will be established a species of equilibrium between all those bodies, in such manner, that at this term the imbibing will be stopped. If there be brought into contact two wetted or soaked bodies, whose affinities for water are not in equilibrio, that, whose affinity is the weakest, will yield of its fluid to the other, until the equilibrium is established; and it is in this disposition of a body to moisten another body that touches it, that what is called humidity properly consists. Of all bodies, the air is that of which we are most interested to know the different degrees of humidity, and it is also towards the means of procuring this knowledge that philosophers have principally directed their researches; hence the various kinds of instruments that have been contrived to measure the humidity of the air. A multitude of bodies are known, in which the humidity, in proportion as it augments or diminishes, occasions divers degrees of dilatation or of contraction, according as the body is inclined to one or other of these effects, by reason of its organization, of its texture, or of the disposition of the fibres, of which it is the assemblage. For example, water, by introducing itself within cords, makes the fibres twist, and become situated obliquely, produces between those fibres such a separation, as causes the cord to thicken or swell, and, by a necessary consequence, to shorten. The twisted threads, of which cloths are fabricated, may be considered as small cords, which experience, in like manner, a contraction by the action of humidity; whence it happens, that cloths, especially when wetted for the first time, contract in the two directions of their intersecting threads; paper, on the contrary, which is only an assemblage of filaments, very thin, very short, and disposed irregularly in all directions, lengthens in all the dimensions of its surface, in proportion as the water, by insinuating itself between the intervals of those same filaments, acts by placing them further asunder, proceeding from the middle towards the edges. Different bodies have been employed successively in the construction of hygrometers, chosen from among those in which humidity produces the most sensible motions. Philosophers have sought also to measure the humidity of the air by the augmentation of weight undergone by certain substances, such, as a tuft of wool, or portions of salt, by absorbing the water contained in the air. But, besides that these methods were in themselves very imperfect, the bodies employed were subject to alterations, which would make them lose their hygrometic quality more or less promptly; they had, therefore, the double inconvenience of being inaccurate, and not being of long service. To deduce from hygrometry real advantages, it must be put in a state of rivalry with the thermometer, by presenting a series of exact observations, such as may be comparable in the different hygrometers. The celebrated Saussure, to whom we are indebted for a very estimable work on hygrometry, has attained the accomplishment of this object by a process of which we shall attempt to give some idea. The principal piece in this hygrometer is a hair, which Saussure first causes to undergo a preparation, the design of which is to divest it of a kind of oiliness that is natural to it, and that secures it to a certain point from the action of humidity. This preparation is made at the same time upon a certain number of hairs forming a tuft, the thickness of which need not exceed that of a writing pen, and contained in a fine cloth serving them for a case. The hairs thus inveloped are immersed in a long-necked phial full of water, which holds in solution nearly a hundredth part of its weight of sulphate of soda, making this water boil nearly thirty minutes; the hairs are then passed through two vessels of pure water while they are boiling; afterwards they are drawn from their wrapper, and separated; then they are suspended to dry in the air; after which there only remains to make choice of those which are the cleanest, softest, most brilliant, and most transparent. It is known that humidity lengthens the hair, and that the process of drying shortens it. To render both these effects more perceptible, Saussure attached one of the two ends of the hair to a fixed point, and the other to the circumference of a moveable cylinder, that carries at one of its extremities a light index or hand. The hair is bound by a counter-weight of about three grains, suspended by a delicate silk, which is rolled in a contrary way about the same cylinder. In proportion as the hair lengthens or shortens, it causes the cylinder to turn in one or the other direction, and, by a necessary consequence, the little index turns likewise, the motions of which are measured on the circumference of a graduated circle, about which the index performs its revolution as in common clocks. In this manner a very small variation in the length of the hair becomes perceptible, by the much more considerable motion that it occasions in the extremity of the index; and it will be easily conceived, that equal degrees of expansion, or of contraction in the hair, answer to equal arcs described by the extremity of the index. To give to the scale such a basis, as may establish a relation between all the hygrometers that are constructed upon the same principles, Saussure assumes two fixed terms, one of which is the extreme of humidity, and the other that of dryness: he determines the first by placing the hygrometer under a glass receiver, the whole interior surface of which he had completely moistened with water; the air being saturated by this water acts by its humidity upon the hair to lengthen it. He moistened anew the interior of the receiver, as often as it was necessary; and he knew that the term of extreme humidity was attained, when, by a longer continuance under the receiver, the hair ceased to extend itself. To obtain the contrary limit of extreme dryness, the same philosopher made use of a hot and well dried receiver, under which he included the hygrometer with a piece of iron plate, likewise heated and covered with a fixed alkali. This salt, by exercising its absorbent faculty upon the remaining humidity in the surrounding air, causes the hair to contract itself, until it has attained the ultimate limit of its contraction. The scale of the instrument is divided into a hundred degrees. The zero indicates the limit of extreme dryness, and the number one hundred that of extreme humidity. The effects of moisture and of dryness upon the hair are modified by those of heat, which act upon it, sometimes in the same sense, and sometimes in a contrary one; so that, if it be supposed, for example, that the air is heated about the hygrometer on one part, this air, whose dissolving faculty with regard to the water will be augmented, will take away from the hair a portion of the water, which it had imbibed, thus tending to shorten the hair; while, on the other part, the heat, by penetrating it, will tend, though much more feebly, to lengthen it; and hence the total effect will be found to consist of two partial and contrary effects, the one hygrometric, the other pyrometric. In observations which require a certain precision, it is therefore necessary to consult the thermometer at the same time with the hygrometer; and, on this account, the inventor has constructed, from observation, a table of correction, which will put it in the power of philosophers always to ascertain the degree of humidity of the air, from the effect produced by the heat.

De Luc, who devoted his attention to the same object has followed a different method. This philosopher employed for the construction of his hygrometers, a very thin slip of whale-bone, which performs the same office as the hair in the hygrometer of Saussure. He kept this whale-bone bent by means of a spring, the action of which he preferred to that of a weight: he determined the degree of extreme humidity, by immersing the slip of whale-bone entirely under water; and to fix the opposite limit, which is that of extreme dryness, he made use of calcined lime, which he inclosed with the hygrometer under a glass bell. The choice of lime is founded on this, that the calcination having produced a higher degree of dryness, if it be afterward left to cool, so far that it may be placed without inconvenience under the glass bell destined for the experiment, it will be still found, as to sense, in the same state of dryness, since it is very slow in acquiring humidity; and thus all its absorbent faculty will be employed to dry up, by little and little, the air contained under the receiver, and to make the hygrometer itself pass to a state which approaches the nearest possible to extreme dryness. The hygrometer has been long neglected in meteorological observations; it is necessary to associate with it the thermometer and the barometer, to be in a state to unravel the complication of different causes which influence the variations of the atmosphere; and it is only by the aid of a long series of observations, made by these various instruments, together with all the indications which are deduced from the state of the heavens, that we can obtain such data as will enable us to prognosticate, with great probability, the temporary changes, and to arrive at a plausible theory upon this subject, so interesting, and so naturally calculated to excite our curiosity.

Mr. Marshall says, that a simple instrument of this sort may be formed by means of "a flaxen line (large well manufactured whip cord) five feet long, and having a graduated scale fixed to an index, moving on a fulcrum. The length of the index, from the fulcrum to the point, should be ten inches; that of the lever, from the fulcrum to the middle of the eye, to which the cord is fixed, two and a half." He adds, that "the principle on which this hygrometer acts is obvious. The air becoming moist, the cord imbibes its moisture; the line, in consequence, is shortened, and the index rises. On the contrary, the air becoming dry, the cord discharges its moisture,—lengthens,—and the index falls. It may be true," he says, "that no two hygrometers will keep pace with each other sufficiently to satisfy the curious. He will venture to say, however, from seven months close attention, that two hygrometers, on this simple construction, have coincided sufficiently for the uses of agriculture. It is true," he adds, "they diminished in the degree of action; but as the scale may be readily diminished in extent, and as a fresh line may be so cheaply and so readily supplied, this is not a valid objection." It is remarked, that "this diminution in the degree of action depends considerably on the construction; the propriety, or rather delicacy, of which rests, almost solely, on this point: the weight of the index should be so proportioned to the weight of the lever and cord, that the cord may be kept perfectly straight, without being too much stretched. He made one with a long heavy index, and in order to gain a more extensive scale with a short lever; but, even when it was first put up, it could barely act; and in a few weeks it flagged, and was not able to raise the index, though the air was uncommonly moist. He therefore made another with the same length, both of index and lever, but with a lighter index, and a heavier lever, so as to gain the proportion above mentioned, and it has acted exceedingly well." He thinks that no farmer, "who wishes to profit by the hygrometer, should have less than two. Three or four would be more advisable. They would then assist in correcting each other; and, in case of renewal or alteration, there would be no danger of losing the state of the atmosphere; which, if only one is kept, must necessarily be the case. The principle on which this hygrometer is formed is not, he says, confined to a small cord, and an index of ten inches long: it may be extended to a rope, of any length or thickness, and to an index and scale of almost any dimensions and extent." But one, or more, on a portable construction, might, he thinks, be found useful. An axe is the form he has thought of; the edge, graduated, will constitute the scale; and the handle will receive the cord: this may be hung up in the shade, exposed to the action of the air; or, by means of a spike in the end of the handle, it may be placed in the open field. By placing it on fallow ground, it may be actuated by the perspiration of the earth; among vegetables by vegetable perspiration; by the means of one, or, more probably, by the means of several, placed at varied heights, the different degrees of moisture at different altitudes may be ascertained, &c. In fact, he considers the hygrometer, whether it is a prognostic of the weather or not, as a most valuable oracle to the farmer. See Weather.

HYMEN, in anatomy, a thin membrane stretched transversely across the vagina, at a small distance from its entrance. It is sometimes found entire, completely intercepting the passage—sometimes it exists but partially—and often not at all.

HYMENÆ, in botany, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx five-parted; petals five, almost equal; style twisted inwards; legume filled with farinaceous pulp. There is only one species, *viz.* H. courbaril, locust tree. The wild bees are fond of building their nests in this tree, which grows to a considerable size in the West Indies, and is looked upon as excellent timber; but it must be very old before it is cut, otherwise the heart will be but small. It is in great request for wheel-work in the sugar mills, particularly for cogs to the wheels, being remarkably hard and tough. Professor Jacquin says, that a cubic foot weighs about a hundred pounds, and that it will take a fine polish.

HYMENOPTERA, in natural history, the fifth order of insects according to the Linnæan system. The insects of this order are furnished with four membranaceous wings, and also with a sting, or a process resembling one. The wasp and the bee are insects of this order. It consists of the following genera:

Ammophila	Mutilla
Apis	Scolia
Chalcis	Sirex
Chrysis	Sphex
Cynips	Tenthredo
Formica	Thynnus
Ichneumon	Tiphia
Leucopsis	Vespa

HYOBANCHE, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx, seven-leaved; corolla ringent, without any lower lip; capsule two-celled, many-seeded. There is but one species, *viz*. H. sanguinea, a native of the Cape of Good Hope, and is parasitical at the roots of shrubs.

HYOSCYAMUS, in botany, *henbane*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla funnel-form, obtuse; stamina inclined; capsule two-celled, covered with a lid. There are eight species.

HYOSERIS, in botany, *swine's lettuce* or *succory*, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx almost equal; down hairy and calycled; receptacle naked. There are ten species.

HYPECOUM, in botany, a genus of the Tetrandria Digynia class and order. Natural order of Corydales. Papaveraceæ, Jussieu. Essential character: calyx two-leaved; petals four, the two outer broader, and trifid; fruit a silique. There are three species.

HYPELATE, in botany, a genus of the Polygamia Monoecia class and order. Essential character: calyx five-leaved; corolla five-petalled; stigma bent down, three-cornered: drupe one-seeded. There is but one species, *viz.* H. trifoliata, a native of Jamaica, where it is common in the low lands.

HYPERBOLA, in geometry, the section, GEH, (Plate VII. Miscel. fig. 5.) of a cone, ABC, made by a plane, so that the axis, EF, of the section inclines to the opposite leg of the cone, BC, which, in the parabola, is parallel to it, and in the ellipsis intersects it. The axis of the hyperbolical section will meet also with the opposite side of the cone, when produced above the vertex at D.

Definitions. 1. If at the point E (fig. 6.) in any plane, the end of the rule EH be so fixed, that it may be freely carried round, as about a centre; and at the other end of the rule H there is fixed the end of a thread shorter than the rule, and let the other end of the thread be fixed at the point F, in the same plane; but the distance of the points EF must be greater than the excess of the rule above the length of the thread; then let the thread be applied to the side of the rule EH, by the help of a pin G, and be stretched along it; afterwards let the rule be carried round, and in the mean time let the thread, kept stretched by the pin, be constantly applied to the rule: a certain line will be described by the motion of the pin, which is called the hyperbola. But if the extremity of the same rule, which was fixed in the point E, is fixed in the point F, and the end of the thread is fixed in the point E, and the same things performed as before, there will be described another line opposite to the former, which is likewise called an hyperbola; and both together are called opposite hyperbolas. These lines may be extended to any greater distance from the points EF, *viz.* if a thread is taken of a length greater than that distance. 2. The points E and F are called the foci. 3. And the point C, which bisects the right line between the two focus's, is called the centre of the hyperbola, or of the opposite hyperbolas. 4. Any right line passing through the centre, and meeting the hyperbolas, is called a transverse diameter; and the points in which it meets them, their vertices; but the right line, which passes through the centre, and bisects any right line terminated by the opposite hyperbolas, but not passing through the centre, is called a right diameter. 5. The diameter which passes through the foci is called the transverse axis. 6. If from A or *a*, the extremities of the transverse axis, there is put a right line AD, equal to the distance of the centre C from either focus, and with A, as a centre, and the distance AD, there is a circle described, meeting the right line which is drawn through the centre of the hyperbola, at right angles to the transverse axis, in B *b*; the line B *b* is called the second axis. 7. Two diameters, either of which bisects all the right lines parallel to the other, and which are terminated both ways by the hyperbola, or opposite hyperbolas, are called conjugate diameters. 8. Any right line, not passing through the centre, but terminated both ways by the hyperbola, or opposite hyperbolas, and bisected by a diameter, is called an ordinate applied, or simply an ordinate to that diameter: the diameter, likewise, which is parallel to that other right line ordinately applied to the other diameter, is said to be ordinately applied to it. 9. The right line which meets the hyperbola in one point only, but produced both ways falls without the opposite hyperbolas, is said to touch it in that point, or is a tangent to it. 10. If through the vertex of the transverse axis a right line is drawn, equal and parallel to the second axis, and is bisected by the transverse axis, the right lines drawn through the centre, and the extremities of the parallel line, are called asymptotes. 11. The right line drawn through the centre of the hyperbola, parallel to the tangent, and equal to the segment of the tangent between the asymptotes, and which is bisected in the centre, is called the second diameter of that which is drawn through the point of contact. 12. A third proportional to two diameters, one of which is transverse, the other second to it, is called the *latus rectum*, or parameter of that diameter, which is the first of the three proportionals. And, 13. Lastly, fig. 9. If upon two right lines A *a*, B *b*, mutually bisecting each other at right angles, the opposite hyperbolas AG, *a g*, are described; and if upon the same right lines there are described two other opposite hyperbolas, BK, *b k*, of which the transverse axis, B *b*, is the second axis of the two first and the second axis of the two last, A *a*, is the transverse axis of the two first; these four are called conjugated hyperbolas, and their asymptotes shall be common.

Prop. 1. (fig. 6.) The square of the half of the second axis is equal to the rectangle contained by the right lines between the foci and the vertexes of the transverse axis.

Let A *a* be the transverse axis, C the centre, E and F the foci, and B *b* the second axis, which is evidently bisected in the centre C, from the definition: let A B be joined: then since (by def. 6.) AB and CF are equal; the squares of AC and CB, together, will be equal to the square of CF, that is, (6. 2.) to the square of AC and the rectangle AF *a* together; wherefore, taking away the square of AC, which is common, the square of CB will be equal to the rectangle AF *a*.

Prop. II. If from any point G (fig. 7 and 8.) of the hyperbola, a right line GD is drawn at right angles to the transverse axis, A *a*, and if from the same point there is drawn the right line GF to the focus nearest to that point; the half of the transverse axis CA will be to the distance of the focus from the centre, *viz* CF, as the distance of the perpendicular CD is to the sum of the half of the transverse axis, and the right line drawn to the focus.

Let GE be drawn to the other focus, and on the axis *a* A produced, let there be set off AH equal GF; then, with the centre G, and the distance GF, describe a circle cutting the axis *a* A in K and F, and the right line EG in the points L and M: then since EF is double CF, and FK double FD, EK shall be also double CD; and since EL or A *a* is double CA, and LM double GE or AH, EM shall also be double CH; but because of the circle, EL or A *a* : EF : : EK : EM; and taking their halves, it will be as CA : CF : : CD : CH.

Prop. III. (fig. 7 and 8.) the same things being supposed, if from A, the extremity of the transverse axis nearest to the point G, there is set off a right line AH on the axis produced, equal to the distance of the point G from the focus F, nearest to the said extremity; the square of the perpendicular GD shall be equal to the excess of the rectangle EHF, contained under the segments between H (the extremity of the right line AH) and the foci, above the rectangle AD *a*, contained under the segments cut off between the perpendicular and the extremities of the axis.

For since the right line CH is any how cut in A, the squares of CA and CH together will be equal to twice the rectangle ACH, and the square of AH, (7. 2.) *i. e.* because CA, CF, CD, CH, are proportionals to twice the rectangle FCD, and to the square of AH or GF; that is, to twice the rectangle of FCD and the squares of FD and DG, that is, to the squares of FC, CD, and DG, (7. 2.) wherefore the two squares of CA and CH are equal to three squares of FC, CD and DG; and taking away the squares of CA and CF from both sides, the remaining rectangle EHF, will be equal to the remaining rectangle AD *a*, and to the square of DG (6. 2.)

Prop. IV. (fig. 7 and 8.) If from any point G of the hyperbola, there is drawn a right line parallel to the second axis B *b*, meeting the transverse axis A *a* in D; the square of the transverse axis shall be to the square of the second axis, as the rectangle contained under the segments of the transverse axis, between the parallel and its extremities, to the square of the parallel.

Prop. V. (fig. 8.) If from any point G of the hyperbola there is drawn a right line parallel to the transverse axis A *a* meeting the second axis in N; the square of the second axis shall be, to the square of the transverse, as the sum of the squares of the half of the second axis and its segment, between the centre and the right line, to the square of the line itself; that is, $CB^2 : CA^2 : : CB^2 + GD^2 : CA^2 +$ the rectangle AD *a*;

that is, as CB^2+CN^2 is to CD^2 or GN^2.

Prop. VI. (fig. 9.) It is another property of the hyperbola, that the asymptotes, D *d*, E *e*, do never absolutely meet with the curve. See Asymptote.

Prop. VII. If through any point F (fig. 9.) of the hyperbola, there is drawn a right line I F L parallel to the second axis, and meeting the asymptotes in I and L; the rectangle contained under the right lines which are intercepted between the asymptotes and the hyperbola, is equal to the square of the half of the second axis, that is, $CB^2 = IFL = IHL$.

Prop VIII. (fig. 10.) If from any point F of the hyperbola, there is drawn to the transverse diameter, AB, a right line ordinately applied to it F G; and from the extremity of the diameter there is drawn AH perpendicular to it, and equal to the *latus rectum*; the square of the ordinate shall be equal to the rectangle applied to the *latus rectum*, being of the breadth of the abscissa between the ordinate and the vertex, and which exceeds it by a figure like and alike situated to that which is contained under the diameter and the *latus rectum*.

For join BH, and from the point G let there be drawn GM parallel to AH, and meeting BH in M, and through M let there be drawn MN parallel to AB, meeting AH in N, and let the rectangles MNHO, BAHP, be completed. Then since the rectangle AGB is to the square of GF, as AB is to AH, *i. e.* as GB is to GM, *i. e.* as the rectangle A G B is to the rectangle AGM; A G B shall be to the square of GF, as the same AGB to the rectangle AGM: wherefore the square of G F is equal to the rectangle A G M, which is applied to the *latus rectum*, AH, having the breadth AG, and exceeds the rectangle H A G O by the rectangle MNHO, like to BAHP; from which excess the name of hyperbola was given to this curve by Apollonius.

Prob. 1. An easy method to describe the hyperbola, fig. 11. having the transverse diameter, D E, and the foci N *n* given. From N, at any distance, as N F, strike an arch; and with the same opening of the compasses with one foot in E, the vertex, set off EG equal to NF in the axis continued; then with the distance GD, and one foot in *n*, the other focus, cross the former arch in F. So F is a point in the hyperbola: and by this method repeated may be found any other point *f*, further on, and as many more as you please.

An asymptote being taken for a diameter; divided into equal parts, and through all the divisions, which form so many abscisses continually increasing equally, ordinates to the curve being drawn parallel to the other symptote; the abscisses will represent an infinite series of natural numbers, and the corresponding hyperbolic or asymptotic spaces will represent the series of logarithms of the same number. Hence different hyperbolas will furnish different series of logarithms; so that to determine any particular series of logarithms, choice must be made of some particular hyperbola. Now the most simple of all hyperbolas is the equilateral one, *i. e.* that whose asymptotes make a right angle between themselves.

Equilateral hyperbola is that wherein the conjugate axes are equal.

Apollonian hyperbola is the common hyperbola, or the hyperbola of the first kind: thus called in contradistinction to the hyperbolas of the higher kinds, or infinite hyperbolas: for the hyperbola of the first kind, or order, has two asymptotes; that of the second order has three; that of the third four, &c.

HYPERBOLE, in rhetoric, a figure, whereby the truth and reality of things are excessively either enlarged or diminished. See Rhetoric.

HYPERBOLIC, or *hyperbolical*, something relating either to an hyperbole, or an hyperbola.

Hyperbolic *cylindroid*, is a solid figure, whose generation is given by Sir Christopher Wren, in the "Philosophical Transactions." Thus, two opposite hyperbolas being joined by the transverse axis, and through the centre a right line being drawn at right angles to that axis; and about that, as an axis, the hyperbolas being supposed to revolve; by such revolution, a body will be generated, which is called the hyperbolic cylindroid, whose bases, and all sections parallel to them, will be circles. In a subsequent transaction, the same author applies it to the grinding of hyperbolical glasses: affirming that they must be formed this way, or not at all. Hyperbolic leg of a curve, is that which approaches infinitely near to some asymptote. Sir Isaac Newton reduces all curves, both of the first and higher kinds, into those with hyperbolic legs, and those with parabolic ones.

Hyperbolic *line*, is used, by some authors, for what we call the hyperbola itself. In this sense, the plane surface, terminated by the curve line, is called the hyperbola, or hyperbolic space; and the curve line that terminates it the hyperbolic line.

HYPERICUM, in botany, *St. John's wort*, a genus of the Polydelphia Polyandria class and order. Natural order of Rotaceæ. Hyperica, Jussieu. Essential character: calyx five-parted; petals five; filaments many, connected at the base in five bundles. There are fifty-seven species. These are principally shrubs or under shrubs, with cylindrical, ancipital, or quadrangular stems; leaves frequently with pellucid dots; flowers, sometimes in cymes, frequently in corymbs, with the peduncles often trichotomous and three flowered.

HYPHYDRA, in botany, a genus of the Monoecia Gynandria class and order. Essential character: male, calyx one-leafed, three parted; corolla none; stamens six, inserted above the germ; female, calyx and corolla none; style triangular, with three stigmas; capsule one-celled, three-valved; seed single. There is but one species, *viz.* H. fluviatilis, a little plant which grows three or four feet under water; it is a native of Guiana.

HYPNUM, in botany, a genus of the Cryptogamia Musci class and order. Natural order of Musci or Mosses. Generic character: capsule oblong; peristoneum double, outer with sixteen broadish teeth, inner membranaceous, equally lanciniated; segments broadish, with capillary ones interposed. Males germaceous, on different plants. Botanists differ greatly as to the number of species; some reckon forty, others fifty, and Dr. Withering enumerates seventy, and to facilitate the investigation of the species, he has thrown them into seven divisions.

HYPOCHOERIS, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx subimbricate; down feathered; receptacle chaffy. There are five species.

HYPOTHECATE, in law, to hypothecate a ship, is to pawn the same for necessaries; and a master may hypothecate either ship or goods for relief, when in distress at sea; for he represents the traders as well as owners; and in whose hands soever a ship or goods hypothecated come, they are liable. But it has been recently held in the court of King's Bench, that if the master pay for the repairs himself, and do not hypothecate the ship, he has no lien upon the ship for his debt.

HYPOTHENUSE, in geometry, the longest side of a right angled triangle; or it is that side which subtends the right angle. Euclid, lib. i. proposition 47, demonstrates, that in every rectilinear right angled triangle, the square of the hypothenuse is equal to the squares of both the other sides. This celebrated problem was discovered by Pythagoras, who is said to have sacrificed a hecatomb to the Muses, in gratitude for the discovery.

HYPOTHESIS, in general, denotes something supposed to be true, or taken for granted, in order to prove or illustrate a point in question. An hypothesis is either probable or improbable, according as it accounts rationally or not for any phenomenon; of the former kind we may reckon the Copernican system and Huygens's hypothesis concerning the ring of Saturn; and the Ptolemaic system may be esteemed an instance of the latter.

HYPOXIS, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Narcissi, Jussieu. Essential character: calyx a two valved glume; corolla, six-parted, permanent, superior; capsule narrower at the base. There are fourteen species.

HYRAX, in natural history, a genus of Mammalia, of the order Glires. Generic character: front teeth in the upper jaw two, broad and somewhat distant; in the lower jaw four, broad, flat, contiguous, and notched; grinders large, four on each side in both jaws; fore-feet four-toed, hind feet three-toed; no tail; no clavicles. What distinguishes this genus from the whole class of Glires, besides, is the circumstance of having four teeth instead of two in the lower jaw, and indeed the teeth in general are differently formed. There are two species.

H. capensis, or the Cape hyrax, is about as large as a rabbit, and abounds in the mountainous districts near the Cape of Good Hope, leaping from rock to rock with extreme agility, feeding by day, and retreating at night to the clefts and holes of the mountains. It has no power of burrowing any recess for itself. Its sound is a reiterated squeak. It subsists entirely on vegetable food, and prepares a bed for its repose and comfort in its favourite recess. It may be easily familiarized, and in a state of domestication is extremely cleanly and alert.

H. syriacus, or the bristly hyrax, is to be met with particularly in Ethiopia and Abyssinia, and particularly under the rocks of the Mountains of the Sun. Its full length is about seventeen inches. These animals are called by the natives of these countries Ashkokos. They are gregarious, and, occasionally, seen in companies of several scores, basking before the clefts of the rocks in the open sunshine. They are gentle, weak and fearful, but if handled with roughness will bite with great severity. They are supposed to live on grain, fruits, and roots, and when kept in confinement, they will live upon bread and milk. They feed without any voracity, and even the pangs of hunger could not impel them to attack chickens or smaller birds, which have been thrown to them in that state, in the way of experiment. Their motion is not firm upon their legs, but rather by stealing along, by a few paces at a time, upon their bellies, in the manner of the bat in approaching its prey. For the Hyrax, see Mammalia, Plate XII. fig. 5.

HYPTIS, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx turbinate; corolla with a very spreading border; lower lip semibifid; anthers hanging down. There are two species.

HYSSOPUS, in botany, *hyssop*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ, Jussieu. Essential character: corolla, lower lip with a small middle crenate segment; stamens straight, distant. There are three species.

HYSTERICS. See MEDICINE.

HYSTRIX, *porcupine*, in natural history, a genus of quadrupeds of the order Glires. Generic character: two foreteeth in the upper and the under jaw, cut obliquely; eight grinders: body with spines and hair; toes four or five on the fore feet. There are five species. H. cristata, or the common porcupine, is about two feet in length, exclusively of the tail. It is found in Africa and India, and is seen not unfrequently in the warmer climates of Europe, particularly in Italy and Sicily. It is covered on the upper part of its body with variegated spines, or quills, which are long and sharp, and which, when irritated, it erects with particular intenseness, and a rustling and alarming noise, giving the idea of formidable hostility. It was supposed by the ancients to possess the power of darting these with unerring, and sometimes fatal, aim against its adversaries; but it is ascertained to employ them merely to repel an assailant. Its principal food consists of the bark of trees, roots, and fruit, and is almost universally collected by it in the night. In the day it lies retired, and sleeping in a subterraneous habitation, which it is said to construct with particular ingenuity, dividing it into several apartments. It produces two at a birth, and if taken young is tamed with considerable facility. Its flesh is eaten, not only in Africa but in Italy, and is thought extremely luscious, on which account it can be taken by few in any large quantity. See Mammalia, Plate XII. fig. 3.

H. prehensilis, or the Brazilian porcupine. This is about a foot long, and its tail about a foot and a half, by which it clings to the branches of trees, and facilitates its object of attack or escape. It is covered with strong, short, and extremely sharp spines, on most of those parts of its body particularly exposed to assault. It is found in the warm climates of America, and particularly in Brazil, where it inhabits the woods, and subsists not only upon fruits and vegetables, like the former species, but also on small birds. Its sounds resemble the grunting of a pig. It secludes itself during the day in the hollows of trees, or under their roots, and by night engages in its excursions and repasts. See Mammalia, Plate XII. fig. 4.

I.

I or i, the ninth letter, and third vowel of the alphabet, is pronounced by throwing the breath suddenly against the palate, as it comes out of the larynx, with a small hollowing of the tongue, and nearly the same opening of the lips as in pronouncing *a* or *e*. Its sound varies; in some words it is long, as *high*, *mind*, &c.: in others short, as *bid*, *hid*, *sin*, &c.; in others again it is pronounced like *y*, as in *collier*, *onion*, &c.: and in a few it sounds like *ee*, as in *machine*, *magazine*, &c. No English word ends in *i*, *e* being either added to it, or else the *i* turned into *y*.

But besides the vowel, there is the jod consonant; which, because of its different pronunciation, has likewise a different form, thus, J j. In English it has the soft sound of *g*, nor is it used but when *g* soft is required before vowels where *g* is usually hard: thus we say, *jack*, *jet join*, &c. instead of *gack*, *get*, *goin*, &c. which would be contrary to the genius of the English language.

I, used as a numeral, signifies no more than one, and stands for so many units as it is repeated times: thus I, one; II, two; III, three, &c. and when put before a higher numeral it subtracts itself, as IV, four; IX, nine. &c.: but when set after it, so many are added to the higher numeral as there are I's added: thus VI, is 5+1, or six; VII, 5+2, or seven; VIII, 5+3, or eight. The ancient Romans likewise used IↃ for 500, CIↃ for 1,000, IↃↃ for 5,000, CCIↃↃ for 10,000, IↃↃↃ for 50,000, and CCCIↃↃↃ for 100,000. Farther than this, as Pliny observes, they did not go in their notation; but, when necessary, repeated the last number, as CCCIↃↃↃ, CCCIↃↃↃ for 200,000; CCCIↃↃↃ,CCCIↃↃↃ,CCCIↃↃↃ for 300,000; and so on.

JACK, in mechanics, an instrument of common use for raising heavy timber, or very great weights of any kind.

The common kitchen jack is a compound engine, where the weight is the power applied to overcome the friction of the parts, and the weight with which the spit is charged; and a steady and uniform motion is obtained by means of the fly.

Jack, in naval affairs, a sort of flag, or colour, displayed from a staff erected on the outer end of a ship's bowsprit. In the British navy, the jack is a small union flag; but in merchant ships the union is bordered with red.

Jack *smoke*. See Smoke *jack*.

Jack *in the box*, a large wooden male screw, turning in a female one, which forms the upper part of a strong wooden box, shaped like a frustum of a pyramid. It is used by means of levers passing through holes in it, as a press in packing, and for other purposes.

Jack *block*, a block occasionally attached to the top-gallant tie, and through which the top-gallant top-rope is reeved, to sway up or to strike the yard.

JACKALL, in zoology, an animal of the dog kind, with a slender snout. See Canis.

JACKET *cork*. See Cork *jacket*.

JACOB'S *staff*, sometimes called a cross-staff, a mathematical instrument to take altitudes at sea, consisting of a brass circle divided into four equal parts by two lines cutting each other in the centre; at each extremity of either line is fixed a sight perpendicularly over the lines, with holes below each slit for the better discovery of distant objects. The cross is of course mounted on a stand for use.

JACOBUS, an ancient gold coin, worth 25*s*. See Coin.

JACQUINIA, in botany, so named in honour of Nic. Jos. de Jacquin, professor of botany at Vienna, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Sapotæ, Jussieu. Essential character: corolla ten-cleft; stamens inserted into the receptacle; berry one-seeded. There are four species, natives of the West Indies and South America.

JACTITATION *of marriage*, in law, is when one of the party boasts, or gives out, that he or she is married to the other, whereby a common reputation of their matrimony may ensue. On this ground the party injured may libel the other in the spiritual court; and unless the defendant undertake, and make out a proof of the actual marriage, he or she is enjoined perpetual silence on that head.

JADE. See Nephrite.

JALAP is the root of the convolvulus jalappa. It derives its name from Xalapa, a town of Mexico, in the environs of which it grows plentifully. It is also found among the sands of Vera Cruz. This plant resembles in appearance the convolvolus of our hedges. Its stem is climbing, angular, and covered with a slight down. Its leaves alternately disposed are rather large, sometimes entire and cordiform, sometimes divided into several lobes, more or less distinct. The flower is campaniform, whithish on the outside, and of a dark purple within. Its root, which is the only part in use, is tuberose, large, lengthened out into the form of a French turnip, white on the inside, and full of a milky juice. The weight of the roots is from twelve to twenty pounds. They are cut into slices, in order to dry them. They then acquire a brown colour, and a resinous appearance. Their taste is rather acrid, and excites a nausea. Jalap to the amount of 50,000*l.* sterling is consumed in Europe annually.

IAMBICS, certain songs, or satires, which are supposed to have given birth to the ancient comedy. The word is applied also to a particular kind of Latin verse, of which the simple foot consists of a short and long syllable. Ruddiman makes two kinds of iambic, *viz.* dimeter and trimeter; the former containing four feet, and the latter six.

JANSENISTS, in church history, a sect of the Roman Catholics in France, who follow the opinions of Jansenius, bishop of Ypres, and docter of divinity of the Universities of Louvain and Douay, in relation to grace and predestination.

In the year 1640, the two universities just mentioned, and particularly Father Molina and Father Leonard Celsus, thought fit to condemn the opinions of the Jesuits on grace and free-will. This having set the controversy on foot, Jansenius opposed to the doctrine of the Jesuits the sentiments of St. Augustine, and wrote a treatise on grace, which he entitled Augustinus. This treatise was attacked by the Jesuits, who accused Jansenius of maintaining dangerous and heretical opinions; and afterwards, in 1642, obtained of Pope Urban VIII. a formal condemnation of the treatise wrote by Jansenius: when the partisans of Jansenius gave out that this bull was spurious, and composed by a person entirely devoted to the Jesuits. After the death of Urban VIII. the affair of Jansenism began to be more warmly controverted, and gave birth to an infinite number of polemical writings concerning grace; and what occasioned some mirth, was the titles which each party gave to their writings: one writer published "The Torch of St. Augustin," another found "Snuffers for St. Augustin's Torch," and Father Vernon formed "A Gag for the Jansenists," &c. In the year 1650, sixty-eight bishops of France subscribed a letter to pope Innocent X. to obtain an inquiry into, and condemnation of, the five following propositions, extracted from Jansenius's Augustinus: 1. Some of God's commandments are impossible to be observed by the righteous, even though they endeavour with all their power to accomplish them. 2. In the state of corrupted nature, we are incapable of resisting inward grace. 3. Merit and demerit, in a state of corrupted nature, does not depend on a liberty which excludes necessity, but on a liberty which excludes constraint. 4. The semipelagians admitted the necessity of an inward preventing grace for the performance of each particular act, even for the beginning of faith, but they were heretics in maintaining that this grace was of such a nature that the will of man was able either to resist or obey it. 5. It is semipelagianism to say, that Jesus Christ died, or shed his blood, for all mankind, in general.

JARGON. See ZIRCON.

JASIONE, in botany, a genus of the Syngenesia Monogynia class and order. Natural order of Campanaceæ. Essential character: calyx, common, ten-leaved; corolla five-petalled, regular; capsule inferior, two-celled. There are four species, natives of the West Indies.

JASMINUM, in botany, English *jasmine-tree,* a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Essential character: corolla salver-shaped; berry dicoccous; seeds arillated; antheræ within the tube. There are seventeen species.

JASPER, in mineralogy, a species of the clay genus, divided by Werner into six sub-species, *viz.* the Egyptian, the striped, the porcelain, the common, the agate, and the opal jasper.

The Egyptian jasper exhibits two or more colours in concentric zones or bands, more or less regular, with interspersed spots or dendritic figures. It is brittle, and the specific gravity is about 2.6. It occurs in rolled pieces, which are mostly spherical. Before the blow-pipe it is infusible without addition. It is found in Egypt and the adjoining desarts, and, on account of its beautiful colour and great hardness, it is used for similar ornamental and useful purposes as the agate

The colours of the striped jasper are grey, green, yellow, and red; these are often found together, and arranged in striped and flamed delineations. It occurs in large beds in Saxony, and also in Siberia, where it is of a very beautiful kind. It admits of a high polish, and is used for purposes of ornament chiefly. It derives its name from the striped colour delineations with which it is marked. The porcelain jasper generally exhibits but a single colour, and is sometimes marked with cloudy delineations. It melts before the blow-pipe, and is found to consist of

Silica - - - - - - -	60.75
Alumina - - - - - -	27.25
Magnesia - - - - -	3.00
Oxide of Iron - - -	2.50
Potash - - - - - - -	3.66
	97.16
Loss - - - - - -	2.84
	100.

It occurs in beds in pseudo-volcanic hills, and it is supposed that it is slaty clay, converted into a kind of porcelain by the action of fire. It is found in great plenty in Bohemia.

The common jasper is found generally in veins that occur in primitive rocks in many parts of Europe. It is susceptible of a high polish, and is in considerable request for ornamental purposes. Opal jasper is found in nests, in porphyry, near Tokay, in Hungary, in the neighbourhood of Constantinople, and in some Siberian mountains. It is supposed to be the connecting link between jasper and opal, and is distinguishable by the liveliness of its colours, its superior lustre, and constant conchoidal fracture.

JATROPHA, in botany, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: male, calyx none; corolla one-petalled, funnel-form; stamina ten, alternately longer and shorter: female, calyx none, corolla five-petalled, spreading; styles three, bifid; capsule three-celled; seed one. There are fourteen species, of which we shall give a short account of the J. elastica, elastic gum-tree; it is a native of Guiana, of Quito, and Brazil, particularly in Para, where it is called masaradub. The Indians, by an incision in the bark, extract a viscid white substance, like that which issues from the fig-tree; they receive it into earthen moulds, to make rings, bracelets, girdles, syringes, hats, boots, flambeaux, figures of animals, &c. The abbe Rouchon says that the inhabitants of Madagascar also made flambeaux of it, which burn without wicks, and afford them a very good light when they go out to fish in the night time; that surgery has derived some benefit from it, as it serves to make excellent bandages; and that in a state of solution it is very proper for coating over silk, to render it impervious to air or water. It has the extensibility of leather, with a very considerable elasticity. Spirit of wine makes no impression on this substance, but it dissolves in ether and linseed oil, or in nut oil digested gently in a sand bath: there are also other fat and oily substances which affect it very sensibly. The Chinese have been long acquainted with the art of dissolving it, and of giving it various colours.

JAUNDICE. See MEDICINE.

JAY, in ornithology, the variegated corvus, with the covering feathers of the wings blue, variegated with black and white. See CORVUS.

IBERIS, in botany, *candy-tuft*, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ, or Cruciformes. Cruciferæ, Jussieu. Essential character: corolla irregular, with the outer petals larger: silicle emarginate, many-seeded. There are fourteen species.

IBEX, in zoology, an animal of the goat kind, with extremely long nodose horns, which bend backwards, and are of a blackish colour, and annulated on the surface. The body is of a dark dusky colour, and is less in proportion to the height than that of the common goat: it has a great resemblance to the deer kind; the legs are also perfectly like those of the deer, straight, elegant, and slender. It is frequent in many parts of Europe, and, notwithstanding its vast horns, runs and leaps with surprising force and agility. See CAPRA.

ICE, water in the solid state. When water is exposed to a diminished temperature, it assumes the solid state, by shooting into crystals, which cross each other in angles of 60 degrees. During this process of solidification, the temperature remains constant, being 32 degrees of the scale of Fahrenheit. See CALORIC; also FREEZING.

During congelation most of the gasiform fluids, which may have been contained in the water, are separated in the elastic form, and exhibit bubbles in the ice, unless the congelation may have been gradually effected from the bottom, or one of the sides; in which case the bubbles are driven out, and the ice is much clearer.

Ice is considerably lighter than water, namely, about one-eighth part; and this increase of dimensions is acquired with prodigious force, sufficient to burst the strongest iron vessels, and even pieces of artillery. It does not arise from the extrication of the gases; for the refractive power of ice is less than that of water, as Dr. Hooke long ago shewed, and has since been confirmed by Wollaston.

M. Prévost observes, that congelation takes place much more suddenly than the opposite process of liquefaction; and that, of course, the same quantity of heat must be more rapidly extricated in freezing, than is absorbed in thawing; that the heat thus extricated being disposed to fly off in all directions, and little of it being retained by the neighbouring bodies, more heat is lost than is gained by the alteration: so that, where ice has once been formed, its production is in this manner redoubled. This circumstance must occur whenever it freezes, that is, on shore, in latitudes above 35 degrees; and it appears, from 30 degrees to the pole, the land is somewhat colder than the sea, and the more as it is farther distant from it; and nearer the equator the land is warmer than the sea: but the process of congelation cannot, by any means, be the principal cause of the difference, and it is probable that the different capacity of earth and water for heat is materially concerned in it.

Since the atmosphere is very little heated by the passage of the sun's rays through it, it is naturally colder than the earth's surface; and for this reason the most elevated tracts of land, which are the most prominent, and the most exposed to the effects of the atmosphere, are always colder than situations near the level of the sea.

The northern hemisphere is somewhat warmer than the southern, perhaps because of the greater proportion of land that it contains, and also in some measure on account of the greater length of its summer than that of the southern; for although, as it was long ago observed by Simpson, the different distance of the sun compensates precisely for the different velocity of the earth in its orbit, with respect to the whole quantity of heat received on either side of the equinoctial points, yet M. Prévost has shewn that, in all probability, the same quantity of heat must produce a greater effect when it is more slowly applied; because the portion lost by radiation from the heated body is greater as the temperature is higher. Since, therefore, on account of the eccentricity of the earth's orbit, the north pole is turned towards the sun seven or eight days longer than the south pole, the northern winters must be milder than the southern; yet the southern summers, though shorter, ought to be somewhat warmer than the northern; but, in fact, they are colder, partly perhaps from the much greater proportion of sea, which in some degree equalizes the temperature, and partly for other reasons. The comparative intensity of the southern summer and winter is not exactly known; but in the island of New Georgia, the summer is said to be extremely cold.

The northern ice extends about 9° from the pole; the southern 18° or 20°; in some parts even 30°; and floating ice has occasionally been found in both hemispheres as far as 40° from the poles, and sometimes, as it has been said, even in latitude 41° or 42°. Between 54° and 60° south latitude, the snow lies on the ground, at the sea-side, throughout the summer. The line of perpetual congelation is three miles above the surface at the equator, where the mean heat is 84°; at Teneriffe, in latitude 28°, two miles; and in the latitude of London, a little more than a mile; and in latitude 80° north only 1,200 feet. At the pole, according to the analogy deduced by Mr. Kirwan, from a comparison of various observations, the mean temperature should be 31°. In London, the mean temperature is 50°; at Rome, and at Montpelier, a little more than 60°; in the island of Madeira 70°; and in Jamaica 80°.

Ice-*house*, a building contrived to preserve ice for the use of a family in the summer season. Ice-houses are more generally used in warm countries than with us, particularly in Italy, where the meanest person, who rents a house, has his vault or cellar for ice. However, as ice is much more used in England than it was formerly, it may not be amiss to give some direction for the choice of their situation, for the manner of building them, and for the management of the ice.

As to the situation, it ought to be placed upon a dry spot of ground, because, wherever there is moisture, the ice will melt; therefore, in all strong lands which retain the wet, too much pains cannot be taken to make drains all round them. The place should also be elevated, and and as much exposed to the sun and air as possible.

As to the figure of the building, that may be according to the fancy of the owner; but a circular form is most proper for the well in which the ice is to be preserved; which should be of a size and depth proportionable to the quantity to be kept; for it is proper to have it large enough to contain ice for two years consumption, so that if a mild winter should happen, in which little or no ice is to be had, there may be a stock to supply the want. At the bottom of the well there should be a space of about two feet deep left, to receive any moisture that may drain from the ice; over this space should be placed a strong wooden grate, and from thence a small drain should be laid under ground to carry off the wet. The sides of the well should be built with brick, at least two bricks thick; for the thicker it is, the less danger there will be of the well being affected by any external cause. When the well is brought up within three feet of the surface, there should be another outer arch or wall begun, which should be carried up to the height of the intended arch of the well; and if there be a second arch turned over this wall, it will add to the goodness of the house: the roof must be high enough above the inner arch to admit of a door-way to get out the ice. If the building is to be covered with slates or tiles, reeds should be laid considerably thick under them, to keep out the sun and external air; and if these reeds are laid the thickness of six or eight inches, and plastered over with lime and hair, there will be no danger of the heat getting through them. The external wall may be built in what form the proprietor pleases; and as these ice-houses are placed in gardens, they are sometimes so contrived as to have a handsome alcove seat in front, with a small door behind it, through which a person might enter to take out the ice; and a large door on the other side, fronting the north, with a porch wide enough for a small cart to back in, in order to shoot down the ice near the mouth of the well, which need not be more than two feet in diameter, and a stone so contrived as to shut it up in the exactest manner; all the vacant space above and between this and the large door should be filled up with straw. The building, thus finished, should have time to dry before the ice is put into it.

It is to be observed, that upon the wooden grate, at the bottom of the well, there should be laid some small faggots, and if upon these a layer of reeds is placed smooth for the ice to lie upon, it will be better than straw, which is commonly used. As to the choice of the ice, the thinner it is, the easier it may be broken into powder; for the smaller it is broken, the better it will unite, when put into the well. In putting it in, care must be taken to ram it as close as possible; and also to allow a vacancy of about two inches, all round, next the side of the well, to give passage to any moisture occasioned by the melting of some of the ice. When the ice is put into the well, if a little saltpetre be mixed with it at every ten inches or a foot in thickness, it will cause it to unite more closely into a solid mass.

ICH DIEN, the motto of the Prince of Wales's arms, signifying, in the high Dutch, "I serve." It was first used by Edward the Black Prince, to shew his subjection to his father king Edward III.

ICHNEUMON, in natural history, a genus of insects of the Hymenoptera order: mouth with a straight horny membranaceous bifid jaw, the tip rounded and ciliate; mandibles curved sharp; lip cylindrical, membranaceous at the tip, and emarginate; feelers four, unequal, filiform, seated in the middle of the lip; antennæ setaceous, of more than thirty articulations; sting exserted, inclosed in a cylindrical sheath, composed of two valves, and not very pungent. There are more than five hundred species enumerated by different authors. These are separated into two families. A. scutel, white or yellow; antennæ annulate with white. B. scutel, white or yellow; antennæ entirely black. C. scutel, the colour of the thorax; antennæ annulate. D. scutel, the colour of the thorax; antennæ black. E. antennæ yellow. F. minute; antennæ filiform; abdomen sessile, ovate.

The whole of this singular genus have been denominated parasitical, on account of the very extraordinary manner in which they provide for the future support of their offspring. The fly feeds on the honey of flowers, and when about to lay her eggs, perforates the body of some other insect, or its larva, with its sting or instrument, at the end of the abdomen, and there deposits them. These eggs in a few days hatch; and the young larva, which resemble minute white maggots, nourish themselves with the juices of their foster parent, which however continues to move about and feed till near the time of its change to a chrysalis, when the larva of the ichneumon creep out, by perforating the skin in various places, and each spinning itself up in a small oval silken case, changes into a chrysalis, and after a certain period they emerge in the state of complete ichneumons.

I. glomeratus may be given as an example of this process. The caterpillar of the common white or cabbage butterfly, which, in the autumnal season, may be observed to creep up some wall, &c. in order to undergo its own change into a chrysalis: but in the space of a day or two, a numerous tribe of small maggots will be seen to emerge from it, and immediately proceed to envelope themselves in distinct, yellow, silken cases, the whole forming a group round the caterpillar. These are the ichneumons glomeratus: they are black, with yellow legs, and they usually make their appearance in about three weeks from the time of their spinning themselves up. Some of the ichneumon genus pierce the skins of newly-changed chrysalises of butterflies and moths, in which their larva remain during their own incomplete state. Others are so minute, that the female pierces even the eggs of moths and butterflies, and deposits her own in each. I. seductor, has a yellow scutel; tip and petiole of the abdomen and crenate band on the fore-part yellow; legs mostly yellow. This insect is found chiefly in Pavia; it forms a nest of cemented clay, in chimneys and windows, divided into cylindrical cells, in each of which is contained a cylindrical, brown, lucid follicle, and in this the larva, with frequently the carcase of a spider, in which the insect had deposited her eggs.

ICHNOGRAPHY, in perspective, the view of any thing cut off by a plane parallel to the horizon, just at the base of it.

Ichnography, in architecture, a description or draught of the platform or ground-work of a house, or other building. Or it is the geometrical plan or platform of an edifice or house, or the groundwork of an house or building, delineated upon paper, describing the form of the several apartments, rooms, windows, chimneys, &c.

Ichnography, in fortification, denotes the plan or representation of the length and breadth of a fortress, the distinct parts of which are marked out, either on the ground itself, or on paper.

ICHTHYOCOLLA. See Isinglass.

ICHTHYOLOGY, is that part of natural history that treats of fishes. And fishes are animals having a heart with one auricle and one ventricle, with cold red blood, which inhabit water, and breathe by means of gills. Most of the species are likewise distinguished by fins and scales. Different naturalists have given different systems; we shall briefly notice some of the principal, because we find them perpetually referred to in works of importance. Aldrovandus, about two hundred years ago, distributed the fishes according to the nature of their residence. His first book treats of those that frequent rocks; the second is devoted to those found near the shores, called littoral; the third, pelagian, &c. Willoughby formed his system from his observation on the anatomy and physiology of fishes; he was followed by Ray, who fixed a series of genera. Artedi, the friend and countryman of Linnæus, has the merit of having first traced the outlines of that classification of fishes, which is now almost generally adopted. For, independently of the cetaceous tribes, which are now generally classed with the mammalia, his method consisted of four orders, *viz.* 1. The malacoterygian, or those which have soft fins, or fins with bony rays, but without spines. 2. The acanthopterian, those with spiny fins. 3. The branchiostegous, corresponding to the amphibia nantes of Linnæus. 4. The chondropterygian, or those which have not true bones, but only cartilages, and the rays of whose fins hardly differ from a membrane. At first Linnæus adopted this method entirely, but he afterwards improved upon it; and now, according to his system, the orders have been instituted from the situation, presence, or absence of the ventral fins.

1. Such as are entirely destitute of these fins are termed pisces apodes, apodal or footless fishes. 2. The jugulares, or jugular, are those which have ventral fins, placed more forward than the pectoral fins, or under the throat. 3. The thoracici, or thoracic, include those whose ventral fins are placed immediately under the pectoral fins, or on the breast. 4. The abdominales, or abdominal, comprise those whose ventral fins are situated behind the pectoral fins, or on the abdomen. 5. There still remains a particular tribe, denominated cartilaginei, which, as their name imports, have a cartilaginous instead of a bony skeleton. This tribe was by Linnæus separated from the rest, on the mistaken idea, that the individuals which compose it were furnished both with lungs and gills, and should be ranked in the class of amphibious animals.

The genera which pertain to the preceding orders are determined by the number of rays in the branchiostegous membrane, the condition of the teeth, the figure of the body, and of other remarkable parts. The characters of the species are taken chiefly from the number of rays in the fins, which differs in the different species. But as the precise enumeration of these rays is sometimes a matter of difficulty, and as they are likewise subject to variation, it is necessary to have recourse to other marks, and to adopt, as subsidiary characters, the form and situation of particular fins, the proportion of the head to the body, the condition of the lateral line, the number of the vertebræ and ribs, &c.

Mr. Pennant describes fishes under the three great divisions of cetaceous, cartilaginous, and bony. The latter, which is by far the most numerous, he subdivides into four sections, entitled, agreeably to the Linnæan orders, apodal, thoracic, jugular, and abdominal.

The shape of the body of fishes is subject to considerable varieties. It is said to be compressed, when the diameter, from side to side, is less than from back to belly; and depressed, on the contrary, when the diameter, from side to side, is greater than from back to belly. It is cylindrical, when it is circular in the greater part of its length; ensiform, or sword-shaped, when the back and belly terminate in a sharp edge, or when the body gradually tapers from the head to the tail; cultrated, or knife-shaped, when the back is somewhat flat, and the angle below acute; carinated, or keel-shaped, when the back is rounded, and the under part of the belly acute, through its length; oblong, when the longitudinal diameter is much longer than the transverse; oval, when the longitudinal diameter not only exceeds the transverse, but the base is circular, and the apex more acute; orbicular, when the longitudinal and transverse diameters are nearly equal; cuneiform, or wedge-shaped, when the body gradually flattens towards the tail: conical, when it is cylindrical, and grows gradually more slender towards the tail; ventricose, when the belly is very prominent; gibbous, when the back presents one or more protuberances; annulated, when the body is surrounded by rings, or elevated lines; articulated, when it is covered with connected and bony plates; trigon, tetragon, pentagon, and hexagon, when the sides are plain, with three, four, or six longitudinal angles; if the number of these angles exceed six, it is termed a polygon.

The surface of the body of fishes is termed naked, when it is destitute of scales; scaly, when provided with them; smooth, when the scales are without angles, furrows, roughness, or inequalities; lubricous, or slippery, when invested with a mucous or slimy humour; tuberculated, or rough, when covered with prominent warts or tubercles; papillous, when covered with fleshy points; spinous, when the asperities are elongated, and pointed at their extremities; loricated, or mailed, when the body is enclosed in a hard, callous, or bony integument, or in scales so closely united as to seem but one; fasciated, or banded, when marked with transverse zones from the back to the belly; striped, when marked with very narrow, scattered and coloured streaks; vittated, when marked with longitudinal zones along the side, from the head to the tail; reticulated, or chequered, when marked with lines forming the appearance of network; pointed or dotted, when marked with points, either longitudinally disposed, or without order; and variegated, when of different colours.

The head is always placed at the anterior part of the body, and reaches from the extremity of the nose to the gills. The head contains the mouth, nose, jaws, lips, teeth, tongue, palate, nostrils, eyes, branchial opercules, the branchiostegous membrane, the aperture of the gills, and the nape. The branchial opercules are scaly or bony processes, situated on both sides of the head, behind the eyes, closing the aperture of the gills, and sustaining the branchial membrane. The branchial, or branchiostegous membrane, is a true fin, formed of cartilaginous crooked bones, joined by a thin membrane, lurking under the opercula, to which it adheres, and is capable of being folded, or expanded, as necessity requires.

The trunk is that part of the body which extends from the nape and branchial aperture to the extremity of the tail. It comprehends the gills, throat, thorax, back, sides, abdomen, lateral line, anus, tail, and scales. The gills, or branchiæ, consist, for the most part, of four crooked, parallel, unequal bones, furnished on the outer, or convex part, with small soft appendages, like the beards of a feather, and generally of a red colour.

The fins consist of several rays, connected by a tender film or membrane; and they are raised, expanded, or moved, in various directions, by means of appropriate muscles. The rays of the fins are either jointed and flexible small bones, whose extremity is often divided into two parts, or hard and prickly, without division at the extremity. In some cases, those on the back of the fish are furnished with membranaceous appendages, simple, or palmated, and adhering to the apex, or sides. The fins, according to their position, are denominated dorsal, pectoral, ventral, anal, or caudal.

The skeleton of a fish is the assemblage of bones which constitutes the framework of its body. The number of these bones is not uniform in each individual, but varies according to age and species. They may be conveniently divided into those of the head, thorax, abdomen, and fins.

The muscles are an assemblage of small bundles of fleshy fibres, partly red, and partly whitish, enveloped in a common membrane. The first of these is called the fleshy portion of the muscle; the second the tendon. Each muscle thus composed is susceptible of contraction and dilatation. The former is accompanied by a visible swelling, hardening, wrinkling, and shortening of the muscle, and the latter by its elongation, expansion, and recovery of its former softness and flexibility. Its force, in general, depends on the quantity of fibrous matter which enters into its composition, and its moving power on the length and size of the fibres.

The brain of fishes is a very small organ relative to the size of the head. It is divided into three equal lobes, of which the two anterior are contiguous; the third being placed behind, and forming the cerebellum. These three lobes are surrounded by a frothy matter, resembling saliva. In this region, the optic and olfactory nerves are easily discovered.

The swimming, or air bladder, or sound, is an oblong, white, membranous bag, sometimes cylindrical, sometimes elliptical, and sometimes divided into two or three lobes, of different lengths. It is usually situated between the vertebræ and the stomach, and included within the peritonæum. In some fishes it communicates with the stomach, and in others with the œsophagus. The flat fishes are unprovided with this organ.

The intestines, which in man are placed transversely, have a longitudinal position in fishes, and are all connected with the substance of the liver. They are in general very short, making only three turns, the last of which terminates in a common outlet or vent. The appendices, or secondary intestines, are very numerous, composing a group of worm-like processes, all ultimately terminating in two large canals, opening into the first intestine, into which they discharge their peculiar fluid. We shall, under the word Pisces, give an account of the several functions peculiar to this class of animals.

ICHTHYOPHTHALMITE, in mineralogy, a stone found in Sudermania, of a yellowish colour: it occurs massive, and crystallized. Specific gravity 2.5 nearly. Before the blow-pipe it froths, and melts into an opaque head. It is supposed to consist of

Silica	52.0
Lime	24.5
Potash	8.1
Water	15.0
	99.6
Loss	.4
	100

ICONOCLASTS, in church history, an appellation given to those persons, who, in the eighth century, opposed image-worship; and is still given by the Church of Rome to all Christians who reject the use of images in religious matters.

ICOSAHEDRON, in geometry, a regular solid, consisting of twenty triangular pyramids, whose vertexes meet in the centre of a sphere, supposed to circumscribe it; and, therefore, have their height and bases equal; wherefore the solidity of one of those pyramids multiplied by twenty, the number of bases, gives the solid content of the icosahedron. See Body.

ICOSANDRIA, in botany, the name of the twelfth class in the Linnæan system, consisting of plants with hermaphrodite flowers, furnished with twenty or more stamina, that are inserted into the inner side of the calyx, or petals, or both. By this last circumstance, and not by the number of stamina, is this class distinguished from the class polyandria, in which the number of stamina is frequently the same with that of the plants of the class icosandria, but they are inserted, not into the calyx or petals, but into the receptable of the flower. The icosandria furnishes the pulpy fruits that are most esteemed, such as apples, plumbs, peaches, cherries, &c. whereas the polyandria are mostly poisonous, as the aconite, columbine, larkspur, hellebore, and others.—The species of the icosandria have a hollow flower-cup, composed of one leaf, to the inner side of which the petals are fastened by their claws. In this class there are five orders, founded upon the number of the styles or female organs. The myrtle, almond, and plumb, have a single female organ; the wild service, two; the service and sesuvium, three; medlar and apple, &c. five; rose, raspberry, strawberry, &c. an indefinite number.

IDENTITY, denotes that by which a thing is itself, and not any thing else; in which sense, identity differs from similitude as well as diversity. The idea of identity we owe to that power which the mind has of comparing the very being and existence of things, whereby, considering any thing as existing at any certain time and place, and comparing it with itself as existing at any other time and place, we accordingly pronounce it the same, or different. Thus, when we see a man at any time and place, and compare him with himself, when we see him again at any other time or place, we pronounce him to be the same we saw before.

To understand identity aright, we ought to consider the essence and existence, and the ideas these words stand for; it being one thing to be the same substance; another, the same man; and a third, the same person. For, suppose an atom existing at a determined time and place, it is the same with itself, and will continue so to be at any other instant, as long as its existence continues; and the same may be said of two or any number of atoms, whilst they continue together; the mass will be the same; but if one atom be taken away, it is not the same mass. In animated beings it is otherwise, for the identity does not depend on the cohesion of its constituent particles, any how united in one mass; but on such a disposition and organization of parts, as is fit to receive and distribute life and nourishment to the whole frame. Man, therefore, who hath such an organization of parts partaking of one common life, continues to be the same man, though that life be communicated to new succeeding particles of matter vitally united to the same organized body; and in this consists the identity of man, considered as an animal only. But personal identity, or the sameness of an intelligent being, consists in a continued consciousness of its being a thinking being, endowed with reason and reflection, capable of pain or pleasure, happiness or misery, that considers itself the same thing in different times and places. By this consciousness every one is to himself, what he calls *self*, without considering whether that *self* be continued in the same or divers substances; and so far as this consciousness extends backward to any past action, or thought, so far extends the identity of that person, and makes it the object of reward and punishment.—Hence it follows, that if the consciousness went with the hand, or any other limb, when severed from the body, it would be the same self that was just before concerned for the whole. And if it were possible for the same man to have a distinct incommunicable consciousness at different times, he would, without doubt, at different times make different persons; which we see is the sense of mankind as to madmen, for human laws do not punish the madman for the sober man's actions, nor the sober man for what the madman did, thereby considering them as two persons.

IDEAOLOGY. The philosophy of the human mind. We are conscious of our own existence; and in this consciousness we perceive a certain variety or successive change, which we distinguish by the name of thought. It seems as if it would be a vain attempt to investigate by what physical operations the proceedings of the mind may be caused, supported, or governed. The primary objects of thought are derived from our sensations or perceptions. We can form no conception of any subject of thought, which shall not be referable to the senses. During the actual time of sensation, we suppose ourselves to be operated upon by some beings or objects which constitute no part of ourselves; and we do not hesitate to infer from those sensations, that an external universe does actually subsist. Berkeley, Hume, and others, have made this a subject of question; and it must be confessed, that we have no absolute proof respecting it. From the certainty, however, that we ourselves do not cause the changes which produce sensation in us, we are irresistibly impelled to an affirmative decision of this question; which after all seems neither important nor useful, more especially when we consider, that the same uncertainty pervades all our researches, whenever we refine so far as to treat of subjects which are not referable to cause and effect.

In many instances, the sensations we experience afford some resemblance of the objects which cause them, as in the figures of bodies; but in others, it is probable that no such resemblance exists, as in colours, sounds, &c. A distinction has therefore very properly been made, between that which is perceived, and the cause of the perception; and, moreover, as we find that effects, similar to our antecedent perceptions, may and do take place, though the organs of sense are not then acted upon, we make a further distinction between these last, and the perceptions themselves. We call them ideas They not only resemble the perceptions, as individually considered, but likewise make their appearance in the same arrangement or order of recurrence. We think we perform a positive act, in many instances, in bringing them forward, which we call an act of the memory, or recollection; and their concomitant appearance, or the succession of ideas by recollection, in the similarity or the order of the sensations, has been called the association of ideas. The same term is likewise applied, when we speak of the recurrence, in idea, of an entire contemporaneous sensation, in consequence of part of it being brought forward in the memory.

Much discussion has taken place among philosophers, respecting the origin and nature of our ideas; in which it must be confessed, that a misapplication of terms, a confusion of intellectual research, with an admixture of theological notions, and several other causes, have united to render a plain subject considerably obscure, even in the hands of men of much talent and acuteness. In particular, it has been a subject of controversy whether man possesses innate ideas If an idea be the recollected picture of a sensation, we must surely date the possession of ideas from the earliest period of the existence of an animal; and it seems absurd to deny to the embryo, before birth, a consciousness of the voluntary power it exerts in muscular motion, or a power of feeling, and perhaps of being affected by sounds:—but, without indulging any wildness of conjecture, are we not compelled,—when we see an animal, in the first hour after its birth, seek the breast by the act of smelling, follow a visible object with its eyes, and alter the adjustment of their axis according to the distance of that object; when the same infant being set upon its feet, immediately and correctly makes the motion of jumping,—are we not compelled to admit, as incomparably the greater probability, that these powers have subsisted, though not exercised, in the fœtal state, rather than that they should have been created at the instant of its birth? This then is our situation with regard to innate ideas, and it would be a contradiction in terms to speak of innate notions or principles. Those deductions of fitness to an end or purpose, which constitute principle, certainly cannot be made till after the requisite propositions have been presented or have occurred to the mind. Previously to this, the conscious being may be said to possess the capacity to perceive and to deduce relations; and it seems of very little consequence whether we call this capacity innate or not.

We are so constituted, that most of our sensations give us either pleasure or pain; and whenever these are vivid, we are put into a situation of mind, respecting them, called desire; namely, for the continuance or return of the pleasurable sensations, and for the cessation or absence of those that are painful. These desires, in their various modifications and combinations, are distinguished by the general name of the passions. Whenever they are strong and urgent, they engage the mind so fully, that the ordinary association of ideas, and the regular processes of reason, become obscured, interrupted, or suspended. A continuance of this state, as when the passions are exalted by disease, is called insanity: and in all states of passion man is more or less insane.

None of our sensations are simple, and consequently none of our ideas can be so. All sensations consist of parts, representing parts of the objects perceived, whether contemporaneously or in succession; and we are also capable of receiving two or more sensations at the same time. Whether the difference between one sensation and another may arise merely from the relations of their own parts with respect to each other, or from any other causes, is not of importance to be discussed in this place; but it is certain that we are greatly interested in observing these relations. Thus we take notice, that one thing is greater or less than another; that in figure, position, duration, and other affections, they are not the same; and that certain changes in inanimate, as well as in conscious beings, are, without exception, followed by other changes, from which we are led to expect and to foretel events. This last class of observations establishes the doctrine of causes and effects; and a large part of our lives is employed in determining the order of these successions.

Among numerous other inaccuracies which tend to mislead in the investigation of ideaology, a principal one is, that the term idea has been confounded with that of notion. Notions always grow out of the relations of ideas, and they always imply comparison. When the notion or thing asserted agrees with the ideas or events, (which are ideas considered in succession) it constitutes truth; if otherwise, it is falshood.

Our sensations in every case, without exception, afford no more than a partial indication of the nature of the objects which cause them. We cannot see the whole of an animal, but only one side, and that very imperfectly; so that the ordinary visible perception of a horse would be the same, whether its hair were long or short, its eyes imperfect or the contrary, &c. and the recollection, or idea, of that individual horse would be still more imperfect, by the omission of particular variations or spots of colour, or other subordinate objects; which, though they may have existed in the sensation, have not remained in the memory. Thus it is, from the nature of things, that some part of the sensations will be abstracted, or left out in the idea; and if, in reasoning upon that subject, namely, the horse, a comparison were to be instituted between that animal and a cow, the attributes they have in common would, in some cases, be alone attended to, and in others form the chief object of consideration. In this manner, arbitrarily, or rather from the necessity of the case, we constantly direct our inquiries to abstract ideas, (which are more or less defective, when generally considered) instead of attending to the individuals, as we must always do in the sensations; that is to say, when we observe and make experiments. And from these obvious truths we may see how it is that we acquire notions of genera, species and individuals; how the first elements of language are formed by abstraction; how difficult it is to reason from sensations or experiments, by the use of ideas, which are their, necessarily imperfect, representatives; and how easy it is for us to mislead ourselves, and others, by paralogism, in the use of general propositions, if we do not constantly adhere to the same degrees of abstraction, or if we do not, in all practical applications, again introduce the abstracted parts, which, though we may have rejected them (like numbers in algebra) for the facility of our mental process, must invariably be resumed, whenever the theatre of nature or society is to be again entered.

These are the principal outlines of the science which treats of ideas, or the materials of our knowledge, and the conduct of mind, in the disposition and treatment of them. Most writers have treated this subject either loosely and without order, or, by running into divisions upon differences, not of primary importance in the nature of things, have confused the various parts into which it most extensively branches. Hence it is that we hear of ideas of sensation and reflection; complex ideas of modes, substances, and relations; ideas distinct, confused, real, fantastical, adequate, inadequate, true, and false. See LANGUAGE, also UNDERSTANDING.

IDIOM, among grammarians, properly signifies the peculiar genius of each language, but is often used in a synonymous sense with dialect.

IDIOSYNCRASY, among physicians, denotes a peculiar temperament of body, whereby it is rendered more liable to certain disorders, than persons of a different constitution usually are.

IDIOTS, in law. An idiot is a fool or madman from his nativity, and one who never has any lucid intervals. The king has the protection of him and his estate, during his life, without rendering any account; because it cannot be presumed that he will ever be capable of taking care of himself or his affairs. By the old common law, there is a writ *de ideota inquirendo*, directed to the sheriff, to inquire, by a jury, whether the party be an idiot or not; and if they find him a perfect idiot, the profits of his lands, and the custody of his person, belong to the king, according to the statute 17 Edward II. c. 9, by which it is enacted that the king shall have the custody of the lands of natural fools, taking the profits of them without waste or destruction, and shall find them necessaries, of whose fee soever the land shall be holden. And, after the death of such idiots, he shall render it to the right heir, so that such idiots shall not aliene, nor their heirs be disinherited. But it seldom happens that a jury finds a man an idiot from his nativity; but only *non compos mentis*, from some particular time; which has an operation very different in point of law: for, in this case, he comes under the denomination of a lunatic; in which respect the king shall not have the profits of his lands, but is accountable for the same to the lunatic, when he comes to his right mind, or otherwise to his executors or administrators. The king, as *parens patriæ*, has the protection of all his subjects; and in a more peculiar manner he is to take care of all those, who, by reason of their imbecility and want of understanding, are incapable of taking care of themselves. But though a lunatic is by commission to be under the care of the public, and such committee is to be appointed for him by the Lord Chancellor, whose acts are subject to the correction and control of the Court of Chancery; yet such an one, whether so appointed, or whether he of his own head take upon him the care and management of the estate of a lunatic, is but in nature of a bailiff or trustee for him, and accountable to him, his executors, or administrators. And as the committees of a lunatic have no interest, but an estate during pleasure, it has been ruled, that they cannot make leases, nor any ways encumber the lunatic's estate, without a special order from the Court of Chancery, where the profits are not sufficient to maintain the lunatic. In case of a lunatic's recovery, he must petition the Chancellor to supersede the commission; upon the hearing of which the lunatic must attend in person, that he may be inspected by the Chancellor. It is also usual for the physician to attend, and to make an affidavit that the lunatic is perfectly recovered.

An idiot, or person *non compos*, may inherit, because the law, in compassion to their natural infirmities, presumes them capable of property. An idiot, or person of non sane memory, may purchase, because it is intended for their benefit, and, if after recovery of their memory they agree thereto, they cannot avoid it; but if they die during their lunacy, their heirs may avoid it; for they shall not be subject to the contracts of persons who wanted capacity to contract: so, if, after their memory recovered, the lunatic, or person *non compos*, die, without agreement to the purchase, their heirs may avoid it. If an ideot or lunatic marry, and die, his wife shall be endowed; for this works no forfeiture, and the king has only custody of the inheritance in one case, and the power of providing for him and his family in the other; but in both cases the freehold and inheritance is in the idiot or lunatic; and therefore if lands descend to an idiot or lunatic after marriage, and the king, on office found, takes those lands into his custody, or grants them over to another as committee in the usual manner, yet the husband shall be tenant by the courtesy, or the wife endowed, since their title does not begin to any purpose till the death of the husband or wife, when the king's title is at end.

It is the general rule, that idiots and lunatics being by reason of their natural disabilities incapable of judging between good and evil, are punishable by no criminal prosecution whatsoever. And therefore a person who loses his memory by sickness, infirmity, or accident, and kills himself, is no *felo de se* And as a person *non compos* cannot be a *felo de se* by killing himself, so neither can he be guilty of homicide in killing another, nor of petit treason. If one committed for a capital offence become *non compos* before conviction, he shall not be arraigned; and if after conviction, he shall not be executed.

There is a distinction between acts done by idiots and lunatics *in pais*, and in a court of record; that as to those solemnly acknowleged in a court of record, as fines and recoveries, and the uses declared on them, they are good, and can neither be avoided by themselves, nor their representatives, for it is to be presumed, that had they been under these disabilities, the judges would not have admitted them to make those acknowledgments. Therefore, if a person *non compos* acknowledge a fine, it shall stand against him and his heirs. And to acts done by them *in pais*, they are distinguished into void and voidable, though as to themselves they are regularly unavoidable, because no man is allowed to disable himself, for the insecurity that may arise in contracts from counterfeited madness and folly; besides, if the excuse were real, it would be repugnant that the party should know or remember what he did: but their heirs and executors may avoid such acts *in pais*, by pleading the disability; because, if they can prove it, it must be presumed real, since nobody can be thought to counterfeit it, when he can expect no benefit from it himself.

There are frequent instances in equity, where not only idiots and lunatics, who come within the protection of the law, but also persons of weak understandings, have been relieved, when they appeared to have been imposed upon in their dealings, and unreasonable purchases and securities obtained from them set aside in their favour. Idiots and lunatics, during their lunacy, are incapable of making any will or testament, as are also persons grown childish by reason of extreme old age. So one actually drunk, if he be so drunk as to have lost the use of his reason: but though a person who wants understanding cannot make a will, yet the rule herein is not to be taken from his not being able to measure an ell of cloth, tell twenty, or the like, but whether he have sense enough to dispose of his estate with understanding.

When an idiot sues, or defends, he shall not appear by guardian, *prochein amy*, or attorney, but he must be ever in proper person: but otherwise of him who becomes *non compos mentis*; for he shall appear by guardian, if within age, or by attorney, if of full age.

JEER, or *Jeer-rope*, in a ship, is a large rope reeved through double or treble blocks, lashed at the mast head, and on the yard, in order to hoist or lower the yards.

Jeers, or being brought to the jeers, in the sea language, signifies a person's being punished at the jeer-capstan, by having his arms extended cross-wise, and tied to the capstan bar when thrust through the barrel, and standing thus, with a heavy weight about his neck. In this posture he is obliged to continue, till he is either brought to confess some crime of which he is accused, or has suffered the punishment which the captain has sentenced him to undergo.

JEHOVAH, one of the Scripture names of God, signifying the Being who is self-existent, and gives existence to others. See the article God. So great a veneration had the Jews for this name, that they left off the custom of pronouncing it, whereby its true pronunciation was forgotten. They call it tetragrammaton, or the name with four letters; and believe, that whoever knows the true pronunciation of it cannot fail to be heard by God.

JEJUNUM, in anatomy, the second of the small intestines, so called, because it is usually found empty. See Anatomy.

JESUITS, in church history, or the society of Jesus, a celebrated religious order in the Romish church, founded by Ignatius Loyola, a Spaniard, who, in the year 1738, assembled ten of his companions, at Rome, and proposed to form a new order, when it was agreed to add to the three ordinary vows of chastity, poverty, and obedience, a fourth, which was to go wherever the Pope should command, to make converts. They were admitted on their own terms; but the order was abolished, on account of the enormities committed by them, in 1773.

JET, a black, inflammable, bituminous substance, harder than asphaltum, and susceptible of a good polish; it becomes electrical by rubbing, attracting light bodies like yellow amber; it resembles cannel-coal in some particulars, as in hardness, receiving a polish, and not soiling the fingers by the touch. It has sometimes been confounded with this substance, but the distinction between them is not difficult: cannel-coal wants the electrical properties of jet, and is much heavier. Magellan supposed that jet was true amber, differing from the yellow kind only in the circumstance of colour, and being lighter, on account of the greater quantity of bituminous matter which enters into its composition. It emits, in combustion, a bituminous smell; it is never found in strata or continued masses, like fossil-stones, but always in separate unconnected heaps, like true amber. It is found in abundance in the Pyrennean mountains; also in some parts of Portugal and Spain, in Sweden, Prussia, Germany, Italy, and Ireland.

Jet *d'eau*, a French term, frequently also used, with us, for a fountain that casts up water to a considerable height in the air. A jet of water is thrown up by the weight of the column of water above its ajutage, or orifice, up to its source or reservoir; and therefore it would rise to the same height as the head or reservoir, if certain causes did not prevent it from rising quite so high. For, first, the velocity of the lower particles of the jet being greater than that of the upper, the lower water strikes that which is next above it; and as the fluids press every way, by its impulse it widens, and consequently shortens the column. Secondly, the water at the top of the jet does not immediately fall off, but forms a kind of ball or head, the weight of which depresses the jet; but if the jet be a little inclined, or not quite upright, it will play higher, though it will not be quite so beautiful. Thirdly, the friction against the sides of the pipe and hole of the adjutage will prevent the jet from rising quite so high, and a small one will be more impeded than a large one. And the fourth cause is the resistance of the air, which is proportional to the square of the velocity of the water nearly; and therefore the defect in the height will be nearly in the same proportion, which is also the same as the proportion of the heights of the reservoirs above the ajutage. Hence, and from experience, it is found that a jet properly constructed, will rise to different heights, according to the height of the reservoir, as in the following table of the heights of reservoirs and the heights of their corresponding jets; the former in feet, and the latter in feet and tenths of a foot.

HEIGHTS OF RESERVOIRS AND THEIR JETS.

Res.	Jet.	Res.	Jet.	Res.	Jet.
5	4.9	31	28.3	57	49.0
6	5.9	32	29.2	58	49.7
7	6.8	33	30.0	59	50.5
8	7.8	34	30.8	60	51.2
9	8.7	35	31.6	61	52.0
10	9.7	36	32.5	62	52.7
11	10.6	37	33.3	63	53.5
12	11.6	38	34.1	64	54.2
13	12.5	39	34.9	65	54.9
14	13.4	40	35.7	66	55.7
15	14.3	41	36.6	67	56.4
16	15.2	42	37.4	68	57.1
17	16.1	43	38.1	69	57.8
18	17.0	44	38.9	70	58.6
19	17.9	45	39.8	71	59.3
20	18.8	46	40.5	72	60.0
21	19.7	47	41.3	73	60.7
22	20.6	48	42.1	74	61.4
23	21.5	49	42.9	75	62.1
24	22.3	50	43.7	76	62.8
25	23.2	51	44.4	77	63.5
26	24.1	52	45.2	78	64.2
27	24.9	53	46.0	79	64.9
28	25.8	54	46.7	80	65.6
29	26.6	55	47.5		
30	27.5	56	48.2		

JETSAM, any thing thrown out of a ship, being in the danger of wreck, and by the waves driven to the shore. See FLOTSAM.

JETTY *head*, a name given to that part of a wharf which projects beyond the rest, but more particularly the front of the wharf, whose side forms one of the cheeks of a wet or dry dock.

JEWEL *blocks*, two small blocks which are suspended at the extremity of the main and fore-top-sail yards, by means of an eye-bolt driven from without into the middle of the yard-arm, parallel to the axis. The use of these blocks is, to retain the upper part of the top-mast studding sails beyond the sheets of the top-sails, so that each of these sails may have its full force of action, which would be diminished by the encroachment of the other over its surface.

JEWS, in church history, the descendants of Judah, the son of Jacob, and of the Israelites, commonly denominated the Twelve Tribes of Israel. This name was first given to those Jews who returned from the captivity of Babylon, because the tribe of Judah made the most conspicuous figure among them.

Our account of this people must be confined to their modern history, and to a brief statement of their present improved condition on the continent, chiefly under the auspices of Bonaparte, one of the most extraordinary characters that ever appeared in the world.

From the reign of Adrian, emperor of Rome, to the present day, the people of the Jewish nation have often been the dupe of some pretender to Messiahship, who has risen up to promise them that restoration to their former dignity and importance, from which they have been driven by the imperious decrees of a righteous Providence. It appears that about twenty-four false Christs have, at various times, excited the hopes and disappointed the expectations of this credulous and superstitious people. The most important of these Messiahs was one Zabathai Tzevi, who in the year 1666, a year of great expectation by many, made a considerable noise at Smyrna, and other places. He was a man of much learning, and promised fairly to realize their expectations of being restored to their ancient inheritances, and of becoming once more a great and prosperous nation. Thousands of the Jews listened to his pretensions; but all his schemes were rendered abortive by an unfortunate difference that arose between him and one Nehemiah, who, pretending to be the son of Ephraim, and whom he said was to be a kind of secondary Messiah, reproved his superior in the office of Messiahship, Zabathai, for his too great forwardness in appearing as the son of David, before the son of Ephraim had led him the way. Zabathai could not brook this doctrine, and therefore excluded his officious forerunner from any part or share in the matter. Nehemiah, mortified at his degradation, reported Zabathai to the Grand Seignior, at Adrianople, as a person dangerous to the government. Zabathai, dejected and fearful, appeared, according to a summons for that purpose, before the Grand Seignior, who requiring a miracle, which was that the pretended Messiah should be stripped naked, and set as a mark for the archers to shoot at, and if the arrows did not pierce his flesh, he would own him to be the true Messiah. Zabathai's faith failed him; he sacrificed his pretensions to his life; and, preferring the faith of the Musslemen to the arrows of the executioners, he furnished his disappointed followers with another proof of their foolish credulity, and the christian prophecies with additional confirmation.

The last of the pretended Christs, that made any considerable number of converts, was one Rabbi Mordecai, a Jew of Germany. He made his appearance in the year 1682. It was not long before he was found out to be an impostor, and was obliged to fly from Italy to Poland to save his life. What became of him afterwards is not known.

After this the most intelligent among the Jews seem to have turned their expectations rather towards a moral and political regeneration, than to their restoration, as a people, to the city of Jerusalem, and to the actual repossession of Palestine, as their inheritance, though there are doubtless multitudes among them who still expect even this local restoration, and live constantly looking for some person to be raised up as their king and deliverer. Whatever may be the ideas of the Israelites in this country, it is certain their brethren on the Continent look up to the French Emperor, as their great promised deliverer and saviour. "The time of our trial," say they, "is expired, the period of our calamities is ended! All the persecutions we have sustained have only tended to unite us the more closely together. We have at all times remained faithful to the commandments of the Lord our God: for our recompense, he has determined in his wisdom that we shall be received into the bosom of other nations, to enjoy the happiness of our forefathers: but, to fulfil this object, it was necessary to find a man, whose virtues, whose valour and wisdom, should exceed every thing which had been before admired by mortals! Napoleon appeared! and God Almighty immediately supported him with the arm of his power. He recalled him from Egypt, while he subjected the tempestuous ocean to his divine laws: he sent his angels to guide his steps, and to watch over his precious life: his divine spirit inspired this hero in the field of battle as in the midst of his palace: from the summit of the hills and mountains he showed him his enemies, dispersed in the plains of Austerlitz and Jena." Thus are the riches and fire of oriental genius, conjoined with the warmth of adulation, peculiar to the French people, made to express the hopes and enjoyments of the children of Israel! This is an epoch in the Jewish history deserving a more minute detail, and worthy of being preserved from the perishing annals of newspapers and pamphlets. Posterity will see how far these flattering prospects have been built on a permanent or a sandy foundation.

In May, 1806, was issued by the French Emperor, the following very extraordinary decree concerning the Jews.

"*Palace of St Cloud*, May, 30, 1806.

"Napoleon, Emperor of the French and King of Italy.

"Accounts having reached us, that in several of the Northern Departments of our empire, certain Jews, not exercising any other profession than that of usury, have, by extorting an enormous interest, reduced a number of farmers to a state of very great distress, we have conceived it our duty to succour such of our subjects, as have been reduced to these sorrowful extremes by an unjustifiable avarice. These circumstances have, at the same time, furnished us with an opportunity of knowing the urgent necessity of re-animating the sentiment of civil morality among those persons, who profess the Jewish religion in the countries under our jurisdiction; sentiments which unhappily have been extinguished among a great number of them, in consequence of the state of debasement under which they have long languished, which it has never entered into my views either to maintain or renew. For the accomplishment of this design, we have resolved to collect the principal persons among the Jews in an assembly; and then through the means of commissioners, whom we shall nominate for the purpose, to communicate our intentions; and who will at the same time learn their wishes, in respect to such manner as they may deem most expedient to awaken among their brethren the exercise of the arts and useful professions of life, in order that an honest industry may take the place of those scandalous resources, to which many persons among the Jews have given themselves up, from the father to the son, for several years past. To this end, and upon the report of our Grand Judge, Minister of Justice, our Minister of the Interior, our Council of State, &c. we declare as follows:

"1. The execution of all contracts or actions against farmers, not merchants, shall be suspended for one year, reckoning from the date of the present decree, simple conservatory acts excepted, such farmers belonging to the departments of Le Sarre, Roer, Mont Tonnere, Haut and Bas Rhin, Rhin and Moselle, Moselle and

Vosges, in cases where they have been granted in favour of the Jews. 2. On the 13th of July next, an assembly of individuals professing the Jewish religion shall be held in our good city of Paris. This assembly is to be formed of those Jews only who inhabit the French territory.—3. The members shall be regulated according to the table hereunto annexed, taken from the various departments, and selected by the prefects from among the Rabbins, proprietors of land, and other Jews, the most distinguished by their probity and intelligence. 4. In the other departments of our empire, not named in the annexed table, should any individuals be found professing the Jewish religion, to the number of one hundred and less than five hundred, the Prefect shall select a deputy for five hundred ; and above that number to one thousand, two deputies; and so on in proportion. 5. The deputies chosen shall be at Paris before the 10th of July, and shall announce their arrival, and their place of residence, to the Secretary of our Minister of the Interior, who shall inform them of the place, the day, and the hour, when the assembly shall meet. Our Minister of the Interior is charged with the execution of the present decree." Here follows a list of the deputies, being seventy-four in number.

These deputies accordingly assembled at Paris on July the 15th, 1806, and were met by the Emperor's commissioners. At their second sitting, the commissioners put several questions to them, relative to the internal economy of the Jewish nation, and their ideas of the allegiance due from the Jews to the French government. The questions were generally answered in favour of the French. At this meeting a letter was read from M. Jacobsohn, Agent of the Finances at the court of Brunswick, addressed to Bonaparte. This letter was expressive of the gratification he felt in the interest which the Emperor of the French had shown towards the people of the Jews in France, and praying his Imperial Majesty to extend the like favour and indulgence to the Israelites inhabiting the countries adjoining the French empire, and in particular to those of Germany.

On the 18th of September, the commissioners again proceeded to the Jewish assembly. At this assembly the deputies were assured of the satisfaction which their answer had given his Imperial Majesty ; and at the same time declared, that it was the wish of the Emperor to insure to them the free exercise of their religion, and the full enjoyment of their political rights. In return for this protection, the Emperor declared it his intention to exact from the Jews a religious guarantee for the entire observance of the principles announced in their answers. For this purpose, it was deemed requisste to constitute a Grand Sanhedrin, that their engagements of loyalty, attachment, &c. might have the most permanent sanction that could possibly be given to them.—This was a most august design, and promised a high day for the poor scattered and despised children of Israel. The restoration of an assembly, which had but seldom been convoked since it pronounced sentence of condemnation, at Jerusalem, upon the Saviour of the world, excited the astonishment, and rouzed the jealousy of the prejudiced and the vindictive, while it called forth the energies, and demanded the admiration of not only the Jews, but of the greater part of all enlightened and reflecting Christians.—Now it was that the scattered sheep of the House of Isreal should again have a voice among their fellow-men ; their declarations, as citizens, should henceforth be placed by the side of the Talmud ; and they should at length be constrained to acknowledge the authority of the laws of their country, under the awful and imposing obligations of morality and religion. This was regarded as the prelude to consequences still more important and flattering : perhaps, indeed, to nothing less than the speedy arrival of that period, when they should again worship under their own vine and their own fig-tree, and none dare to make them afraid.

After assurances of liberty and protection on the one hand, and of gratitude and obedience on the other, it was agreed, that a Grand Sanhedrin should be opened at Paris, at which should be preserved, as much as possible, the ancient Jewish forms and usages. This momentous event was announced to the dispersed remnant of the descendants of Abraham, in a most grateful and pathetic address to the Jewish nation throughout France and Italy ; which contained suitable advice, that the brethren would choose men known for their wisdom, the friends of truth and of justice, and capable of concurring in the great work there before them, and of giving the Grand Sanhedrin a sufficient degree of weight and consideration. The address concludes thus : " The sovereign Arbiter of nations and of kings has permitted this empire to cicatrize its wounds, to restore that tranquillity which continued storms had interrupted, to aggrandize its destiny, to fix ours, and to give happiness to two nations, who must ever applaud him, to whom has been confided the care of their happiness, after that of their defence. Paris 24th, Tishri, 5567." (6th Oct. 1806)

This address was shortly after answered by one of concurrence and congratulation from the people of the Jewish nation at Frankfort on the Maine; and the Prince Primate of Francfort, following the French Emperor's example, put an end to every humiliating distinction between the Jews of that city and the Christian inhabitants. The Israelites soon began to manifest the happy consequences of their emancipation, by considerable improvements in education and the useful arts.

The Grand Sanhedrin assembled on Monday the 9th of February, 1807, while the number and distinction of the spectators added much to its solemnity. Reciprocal assurances of encouragement, congratulation, and thankfulness, were exchanged, and this august assembly proceeded to make several important regulations relative to the Jewish worship and economy. Numerous addresses were read, and the most encouraging orations were delivered, while the great synagogue in the street St. Avoie resounded the praises of the God of Israel, amid repeated cries of *L'Empereur*, *L'Imperatrice*! *La Famille Imperiale!* and *La Brave Armée Francaise!* It might be said of these Israelites, as it was once observed of their ancestors, that "all the people worshipped God, and the King."

Twenty-seven articles were drawn up and agreed to for the re-organization of the Mosaic worship. Sundry regulations were also made concerning polygamy, divorce, marriage, moral relations, civil and political relations, useful professions, loans among Israelites, and loans between Israelites and those who are not Israelites.

On the 2d of March the Grand Sanhedrin again sat, and passed a law for the condemnation of usury among the Jews. A most animated discourse was delivered in the Hebrew tongue by M. David Sintzheim, President of the Grand Sanhedrin. Translations of the discourse, in French and Italian, were afterwards read to the members assembled. A copy of this discourse, and of the whole of the proceedings of the Sanhedrin, have been preserved in a publication of considerable interest, a small volume, lately published, entitled "New Sanhedrin, and Causes and Consequences of the French Emperor's Conduct towards the Jews," written, we believe, by William Hamilton Reid. To this work we refer our readers for all the information necessary on this interesting subject.

Flattering, however, as these proceedings are to the Jews on the continent, it is certain that their brethren on this side the water look upon the conduct of the House of Israel in France, Italy, Holland, &c. with a jealous and suspicious eye. And it must be confessed, that, to secure the blessings and rights of citizens, they have made sacrifices and concessions, which seem but ill to accord with the due observance of that law, which subjoins, that if a man offend in one point, he is guilty of all. That the restoration promised to this people is to be considered of a moral and political nature, we think cannot be doubted. Such, indeed, was the opinion of the learned Bishop Warburton. Whether the regulations and decrees that have been passed in their favour in France are to be considered as the commencement of this restoration, time alone can determine. This much is evident, that in the restoration of Israel it is said, that every man should possess his own vine and his own fig-tree; but if the Jews are either prohibited the occupation, or excused the cultivation of land, this can never be the case; and this consideration, among others, seems to have suggested an idea to Bonaparte, that his Jewish subjects ought to be constrained to assist in the cultivation of the land, and in furnishing their quota of active conscripts for the defence of his dominions and of their own property. Their improved state, on the continent, in a political point of view, seems not to have been attended with a correspondent degree of moral regeneration; and the French Emperor appears still to be dissatisfied with their way of life. The last decree issued, concerning them, was the 17th of March, 1808, which forbids them, indiscriminately, to pursue their speculations, and excuse themselves from honest labour. To partake of the fruits of the earth, in his large dominions, they must also till the ground. The rich are called upon to purchase rural property, and to abandon the low pursuits of sordid avarice. This decree also annuls all obligations for loans made by Jews to minors, without the sanction of their guardians; to married women, without the consent of their husbands; or to military men, without the authority of their superior officers. Bills granted by French subjects to Jews cannot be demanded, unless their holders prove that the full value was given without any fraud. All debts accumulated by interest above five per cent. are to be reduced by the courts of law; if the interest growing on the capital exceed twenty-three per cent. the contract is to be declared usurious. No Jew is to be allowed to trade without a patent, which patent is to be granted to such individuals only who produce a certificate to the Prefects that they are no usurers. These regulations are to be continued during ten years only, "in the hope, that, after that period, there will be no difference between the moral character of the Jews and the other citizens of the empire." If the contrary shall appear, the law will be continued in force. It is doubtful, whether the faith of the children of Israel in Bonaparte, as their reigning Messiah, will not be a little staggered by these regulations. Bonaparte has had the following return made to him of the number of Jews in all the different parts of the habitable globe, viz. in the Turkish empire one million; in Persia, China, and India, on the east and west of the Ganges, three hundred thousand; and in the west of Europe, Africa, and America, one million seven hundred thousand; making an aggregate population of three millions. One-third of this number are already under the dominion of the French empire. For an account of the Jewish ceremonies, &c. see the late Mr. David Levi's work on that subject.

The following is a summary of their religious creed:—1. That God is the creator and active supporter of all things. 2. That God is ONE, and eternally unchangeable. 3. That God is incorporeal, and cannot have any material properties. 4. That God shall eternally subsist. 5. That God is alone to be worshipped. 6. That whatever has been taught by the prophets is true. 7. That Moses is the head and father of all contemporary doctors, and of all those who lived before, or shall live after him. 8. That the law was given by Moses. 9. That the law shall always exist, and never be altered. 10. That God knows all the thoughts and actions of men. 11. That God will reward the observance, and punish the breach of his laws. 12. The Messiah is to come, though he tarry a long time. 13. That there shall be a resurrection of the dead when God shall think fit. These doctrines, commonly received by the Jews to this day, were drawn up about the end of the eleventh century, by the famous Jewish rabbi, Maimonides.

In England, in former times, the Jews, and all their goods, belonged to the chief lord where they lived; and he had such an absolute property in them, that he might sell them; for they had not liberty to remove to another lord without leave. They were distinguished from the Christians in their lives, and at their deaths; for they had proper judges and courts, where their causes were decided. By stat. Edward I. the Jews, to the number of 15,000, were banished out of England; and never returned, till Oliver Cromwell re-admitted them. Whenever any Jew shall present himself to take the oath of abjuration, in pursuance of the 10 George III. c. 10, the words—upon the true faith of a Christian—shall be omitted out of the oath, in administering it to such persons; and the taking the oath, by persons professing the Jewish religion, without these words, in like manner as Jews are admitted to give evidence in the courts of justice, shall be deemed a sufficient taking of the abjuration-oath. If Jewish parents refuse to allow their Protestant children a maintenance suitable to their fortune, the Lord Chancellor, upon complaint, may make such order therein as he may think proper.

JEWS *harp*, in music, an instrument well known among the lower classes in this country, but almost the only musical instrument made use of by the inhabitants of the island of St. Kilda.

IGNATIA, in botany, a genus of the Pentandria Monogynia class and order.—Natural order of Luridæ. Apocineæ, Jussieu. Essential character: calyx five-toothed; corolla funnel-form, very long; fruit one-celled, many seeded. There are two species, viz. I. amara, and I. longiflora.

IGNITION, in chemistry, is that illumination, or emission of light, produced in bodies by exposing them to a high temperature, and which is not accompanied by any other chemical change in them. It may be distinguished from combustion, a process in which there is also the emission of light and heat. Combustion is the result, not of mere increase of temparature in the body which suffers it, but of the chemical action of the air, or of a principle which the air contains: hence combustible substances are alone suspectible of it, and when the process has ceased, the body is no longer combustible. Ignition is an effect of the operation of caloric alone; it is wholly independent of the air; all bodies, at least solid and liquid substances, are equally susceptible of it, and if it has ceased, from a reduction of temperature, it may be renewed by the temperature being again raised. The point of temperature at which the first stage of ignition takes place, or at which bodies arrive at a red heat, appears to be the same in all, and is supposed to be about 800° of Fahrenheit. By raising the temperature, the illumination becomes brighter, and the red light acquires a mixture of yellow rays. At length, by still increasing it, we come to the white heat, which is the highest state of ignition. Aeriform fluids are not brought into a state of illumination by heat. The phenomena are produced not only by the application of heat, but likewise by friction and attrition.

JIB, in naval affairs, the foremost sail of a ship, being a large stay-sail, extended from the outer end of the bowsprit, prolonged by the jib-boom, towards the fore-top-mast-head. In cutters and sloops, the jib is on the bowsprit, and extends towards the lower mast-head. The jib is a sail of great command with any side wind, but especially when the ship is close-hauled, or has the wind upon her beam; and its effort in turning her head to leeward is very powerful, and of great utility, particularly when the ship is working through a narrow channel. Jib-boom is a continuation of the bowsprit forward, being run out from the extremity in a similar manner to a top-mast on a lower-mast, and serving to extend the bottom of the jibs and the stay of the fore-top-gallant-mast.

JIGGER, in naval affairs, a machine consisting of a piece of rope, five feet long, with a block at one end, and a sheave at the other, used to hold on the cable when it is heaved into the ship, by the revolution of the windlass. This is particularly useful, when either slippery with mud or ooze, or when it is stiff and unwieldy, in both which cases it is very difficult to stretch it back from the windlass by hand, which, however, is done with facility and expedition by means of the jigger.

ILEX, in botany, *holly*, a genus of the Tetrandria Tetragynia class and order.—Natural order of Dumosæ. Rhamni, Jussieu. Essential character: calyx four-toothed; corolla wheel-shaped; style none; berry four-seeded. There are sixteen species. This genus consists of small trees or shrubs, with alternate leaves, evergreen, toothed, or thorny; and axillary, many-flowered peduncles. I. aquifolium, common holly, is usually from twenty to thirty feet in height, though it sometimes exceeds sixty feet; the trunk is covered with a greyish bark, and those trees which are not lopped, or browzed by cattle, are commonly furnished with branches the greatest part of their length, forming a sort of cone. Mr. Millar says, the difference of sexes in the flowers of the holly was first observed by his father. In his garden at Streatham, in Surrey, he had many of these trees, which, before he had possession of the place, were shorn into round heads: he emancipated them from their slavery, pruned them, and trained up leading shoots. Seemingly glad to be released from their shackles, they quickly rewarded him with this discovery concerning the nature of their flowers, which he communicated to the Royal Society. He perfectly recollects having carefully attended to the flowering of these trees during several seasons, and having uniformly observed hermaphrodite flowers on some, and male flowers on others: in the former, the anthers were different from those in the male flowers, and appeared to be effete, and there never was a single male flower mixed with the hermaphrodite, or a hermaphrodite with the males, or any flower except the two here described.

The holly makes an impenetrable fence, and bears cropping well, nor is its verdure, or the beauty of its scarlet berries, ever observed to suffer from the severest of our winters. Mr. Evelyn's impregnable holly-hedge, four hundred feet in length, nine feet high, and five in diameter, has been much celebrated by himself, Ray, and others.

The wood of this tree is the whitest of all hard woods, and used by the inlayer, especially under thin plates of ivory. The mill-wright, turner, and engraver, prefer it to any other: it also makes the best handles and stocks for tools, flails, the best riding rods, and carters' whips; bowls, chivers, and pins for blocks; Mr. Millar says it is made into hones for setting razors; that the wood, taking a fine polish, is proper for several kinds of furniture; that he has seen the floor of a room laid in compartments with this and mahogany, which had a very pretty effect.

It is much used with box, yew, and white thorn, in the small trinkets and other works, carried on in and about Tunbridge, commonly called Tunbridge ware.

Sheep and deer are fed during the winter with the croppings. Birds eat the berries. The bark fermented, andafterwards washed from the woody fibres, makes the common bird lime. Forty or fifty varieties depending on the variegations of the leaves or thorns, and the colour of the berries all derived from this one species, are raised by the nursery gardeners for sale, and were formerly in great esteem; but since the old taste of filling gardens with shorn evergreens has been laid aside, they are less regarded; a few however of the most lively varieties have a good effect in the winter season.

ILIUM, in anatomy, the third and last of the small intestines. See ANATOMY.

ILLECEBRUM, in botany, a genus of the Pentrandria Monogynia class and order. Natural order of Holoraceæ. Amaranthi, Jussieu. Essential character: calyx five-leaved, cartilaginous; corolla none; stigma simple; capsules five valved, one seeded. There are twenty-one species, natives of North and South America and the West India Islands.

ILLICIUM, in botany, a genus of the Polyandria Polygynia class and order. Natural order of Coadunatæ. Magnoliæ, Jussieu. Essential character: calyx six-leaved; petals twenty-seven; capsules several, disposed in a circle; bivalve, one-seeded. There are two species, *viz.* I. anisatum, yellow-flowered aniseed tree; and I. floridanum, red-flowered aniseed tree. Both these plants bear a great resemblance to each other. Thunberg doubts their being distinct species. The whole of the first mentioned plant, especially the fruit, has a pleasant aromatic smell, and a sweetish subacrid taste. In China it is in frequent use for seasoning dishes, especially such as are sweet. In Japan they place bundles and garlands of the aniseed tree in their temples before their idols, and on the tombs of their friends. They also use the powdered bark as incense to their idols. A branch put into the decoction of tetraodon hispidum is supposed to increase the virulence of the poison. The bark finely powdered is used by the public watchmen to make a chronometer, or instrument for measuring the hours, by slowly sparkling at certain spaces in a box, in order to direct when the public bells are to sound.

ILLUMINATING, a kind of miniature painting, anciently much practised for illustrating and adorning books. Besides the writers of books, there were artists, whose profession was to ornament and paint manuscripts, who were called illuminators; the writers of books first finished their part, and the illuminators embellished them with ornamented letters and paintings. We frequently find blanks left in manuscripts for the illuminators, which were never filled up. Some of the ancient manuscripts are gilt and burnished in a style superior to later times. Their colours were excellent, and their skill in preparing them must have been very great The practice of introducing ornaments, drawings, emblematical figures, and even portraits, into manuscripts, is of great antiquity. Varro wrote the lives of 700 illustrious Romans, which he enriched with their portraits, as Pliny attests in his "Natural History." Pomponius Atticus, the friend of Cicero, was the author of a work on the actions of the great men amongst the Romans, which he ornamented with their portraits, as appears in his life by Cornelius Nepos. But these works have not been transmitted to posterity. There are, however, many precious documents remaining, which exhibit the advancement and decline of the arts in different ages and countries. These inestimable paintings and illuminations display the manners, customs, habits, ecclesiastical, civil and military, weapons, and instruments of war, utensils and architecture of the ancients; they are of the greatest use in illustrating many important facts relative to the history of the times in which they were executed. In these treasures of antiquity are preserved a great number of specimens of Grecian and Roman art, which were executed before the arts and sciences fell into neglect and contempt. The manuscripts containing these specimens form a valuable part of the riches preserved in the principal libraries of Europe. The Royal, Cottonian, and the Harleian Libraries, as also those in the two universities in England, the Vatican at Rome, the Imperial at Vienna, the Royal at Paris, St. Mark's at Venice, and many others. A very ancient MS. of Genesis, which was in the Cottonian Library, and almost destroyed by a fire in 1731, contained 250 curious paintings in water colours. Twenty-one fragments, which escaped the fire, are engraven by the society of antiquarians of London. Without mentioning others, we may observe, that Mr. Strutt has given the public an opportunity of forming some judgment of the degree of delicacy and art with which these illuminations were executed, by publishing prints of a prodigious number of them, in his "Regal and Ecclesiastical Antiquities of England," and "View of the Customs, &c. of England." In the first of these works we are presented with the genuine portraits, in miniature, of all the kings, and several of the queens of England, from Edward the Confessor to Henry VII. mostly in their crowns and royal robes, together with the portraits of many other eminent persons of both sexes. The illuminators and painters of this period seem to have been in possession of a considerable number of colouring materials, and to have known the arts of preparing and mixing them, so as to form a great variety of colours: for in the specimens of their miniature paintings that are still extant, we perceive not only the five primary colours, but also various combinations of them. Though Mr. Strutt's prints do not exhibit the bright and vivid colours of the originals, they give us equally a view, not only of the persons and dresses of our ancestors, but also of their customs, manners, arts and employments, their arms, ships, houses, furniture, &c. and enable us to judge of their skill in drawing. The figures in those paintings are often stiff and formal; but the ornaments are in general fine and delicate, and the colours clear and bright, particularly the gold and azure. In some of these illuminations the passions are strongly painted. After the introduction of printing, this elegant art of illuminating gradually declined, and at length was quite neglected.

IMAGE, in optics, is the appearance of an object made either by reflection or refraction. In all plane mirrors, the image is of the same magnitude as the object, and it appears as far behind the mirror as the object is before it. In convex mirrors, the image appears less than the object; and farther distant from the centre of the convexity than from the point of reflection. By the following rule, the diameter of an image projected in the base of a convex mirror may be found. "As the distance of the object from the mirror is to the distance from the image to the glass, so is the diameter of the object to the diameter of the image."

IMAGINATION, a power or faculty of the mind, whereby it conceives and forms ideas of things communicated to it by the outward organs of sense.

IMITATION, in literary matters, the act of doing, or striving to copy after, or become like to another person or thing.

IMITATIVE, in music, a term applicable to that music which is composed in imitation of the effects of some of the operations of nature, art, or human passion, as the rolling of thunder, swiftness of lightning, agitation of the sea, bellowing of the winds or waves, &c. Imitation is likewise a technical term, for a studied resemblance of melody between the several passages of the harmonical parts of a composition.

IMMATERIAL, something devoid of matter, or that is pure spirit: thus, God, angels, and the human soul, are immaterial beings.

IMMEMORIAL, in law, an epithet given to the time or duration of any thing whose beginning we know nothing of. In a legal sense, a thing is said to be of time immemorial, or time out of mind, that was before the reign of King Edward II.

IMMENSITY, an unlimited extension, or which no finite and determined space, repeated ever so often, can equal.

IMMERSION, that act by which any thing is plunged into water, or other fluid. See FLUID.

IMMERSION, in astronomy, is when a star or planet is so near the sun, with regard to our observations, that we cannot see it; being as it were enveloped and hidden in the rays of that luminary. It also denotes the beginning of an eclipse of the moon, or that moment when the moon begins to be darkened, and to enter into the shadow of the earth; and the same term is also used with regard to an eclipse of the sun, when the disk of the moon begins to cover it. In this sense emersion stands opposed to immersion, and signifies the moment wherein the moon begins to come out of the shadow of the earth, or the sun begins to show the parts of his disk which were hid before.

Immersion is frequently applied to the satellites of Jupiter, and especially to the first satellite, the observation whereof is of so much use for discovering the longitude. The immersion of that satellite is the moment in which it appears to enter within the disk of Jupiter, and its emersion the moment when it appears to come out.

The immersions are observed from the time of the conjunction of Jupiter with the sun, to the time of his opposition; and the emersions from the time of his opposition to his conjunction.

IMMUTABILITY, one of the divine attributes, founded on the absolute perfection of the Deity.

The immutability of God is two-fold, physical and moral. The first consists in this, that the divine essence does not, nor possibly can, receive any alteration; and the moral immutability is founded on the perfection of his nature, whereby he always wills the same things, or such as are best on the whole.

IMPALED, in heraldry, when the coats of a man and his wife, who is not an heiress, are borne in the same escutcheon, they must be marshalled in pale; the husband's on the right side, and the wife's on the left: and this the heralds call baron and feme, two coats impaled.

If a man has had two wives, he may impale his coat in the middle between theirs; and if he has had more than two, they are to be marshalled on each side of his, in their proper order.

IMPALPABLE, that whose parts are so extremely minute that they cannot be distinguished by the senses, particularly by that of feeling.

IMPARLANCE, is a petition in court, for a day to consider or advise what answer the defendant shall make to the action of the plaintiff; being a continuance of the cause till another day, or a larger time given by the court, which is generally till the next term.

IMPASSIBLE, that which is exempt from suffering, or cannot undergo pain or alteration. The stoics place the souls of their wise men in an impassible or imperturbable state.

IMPATIENS, in botany, a genus of the Syngenesia Monogynia class and order. Natural order of Corydales. Gerania, Jussieu. Essential character; calyx two-leaved: corolla five-petalled, irregular, with a cowled nectary; capsule superior, five-valved. There are twelve species, of which I. balsamina, garden balsam, is an annual plant, about a foot and a half in height, dividing into many succulent branches; leaves long and serrate; the flowers come out from the joints of the stem, upon slender peduncles, an inch in length, each sustaining a single flower. In its wild state it is two feet, or more, in height, round, hispid, juicy, with a white stem, and ascending branches. It is a native of the East Indies, China, Cochin-China, and Japan; the Japanese use the juice prepared with alum for dyeing their nails red. By culture this plant is very much enlarged, and becomes very branching. Mr. Millar tells us, he has seen the stem seven inches in circuit, and all the plants large in proportion, branched from top to bottom, loaded with its party-coloured flowers, thus forming a most beautiful bush. The varieties which cultivation has produced in this elegant flower are numerous.

I. noli tangere, common yellow balsam, is also an annual plant; during the day the leaves are expanded, but at night they hang pendent, contrary to what is observed in most plants, which, from a deficiency of moisture, or a too great perspiration from heat, commonly droop their leaves in the day-time. When the seeds are ripe, upon touching the capsule they are thrown out with considerable force: hence the Latin name "*impatiens*," and "*noli tangere*." The whole plant is considerably acrid, and no quadruped, except perhaps the goat, will eat it.

IMPEACHMENT, is the accusation and prosecution of a person in parliament, for treason, or other crimes and misdemeanors. An impeachment, before the Lords, by the Commons of Great Britain, is a presentment to the most high and supreme court of criminal jurisdiction, by the most solemn grand inquest of the whole kingdom. A commoner cannot be impeached before the lords for any capital offence, but only for high misdemeanors; but a peer may be impeached for any crime. The articles of impeachment are a kind of bills of indictment, found by the house of commons, and afterwards tried by the lords, who are, in cases of misdemeanors, considered not only as their own peers, but as the peers of the whole nation. By stat. 12. and 13 Wm. c. 2. no pardon under the great seal shall be pleadable to an impeachment by the commons in parliament; but the king may pardon after conviction.

IMPEACHMENT of *waste*, signifies a restraint from committing of waste upon lands and tenements; and therefore he that has a lease, without impeachment of waste, has by that a property or interest given him in the houses and trees, and may make waste in them without being impeached for it; that is, without being questioned, or demanded any recompense for the waste done.

IMPEDIMENTS, in law, persons under impediments are those within age, under coverture, *non compos mentis*, in prison, or beyond seas; who, by saving in our laws, have time to claim and prosecute the right, after the impediments removed, in case of fines levied, &c.

IMPENETRABILITY, in philosophy, that property of body whereby it cannot be pierced by another; thus, a body, which so fills a space as to exclude all others, is said to be impenetrable. Or, by impenetrability is meant, the faculty which a body has of excluding every other body from the place that it occupies, in such manner that two bodies placed in contact can never occupy less space than that which they filled when they were separate. The impenetrability of solid bodies does not require to be proved, it strikes us at first view; but fluids, having their particles perfectly moveable in every direction, and yielding to the slighest pressure, their impenetrability does not manifest itself so perceptibly as that of solid bodies. Taking the air for an example: so long as this fluid is not enclosed in something, its extreme mobility causes it to admit a free passage to all bodies which are moved through it; but in this case it is properly displaced, and not penetrated; for, if the air be included within the sides of a vessel, and another body be then presented to take its place, without suffering it to escape, it will exercise its impenetrability in the same manner as solid bodies. It is easy to be convinced of this by the aid of a very simple experiment, which any one may make: it consists in plunging a vessel vertically, with the orifice downwards, in another vessel filled with water to a certain height: the surface of the water, corresponding with the orifice of the first vessel, is depressed as this vessel itself descends; and this depression may be rendered more sensible by means of a little plate, or slip of cork, placed so as to float upon the surface of the water; nevertheless, this water is not excluded by the air occupying the immersed vessel; it is always raised within it by a certain quantity, which augments as the vessel is immersed to a greater depth: but it is sufficiently evident that this ascension is occasioned by the circumstance that the air is a compressible fluid, and therefore its volume is contracted into a smaller space, by the effect of the compression excited upon it by the surrounding water on all parts, in virtue of its weight. We must here notice a difficulty which appears to result from this, that when we have mingled certain bodies, the volume of the mixture is less than the sum of the volumes taken separately. This happens, for example, when we mix equal parts of alcohol and water; the same also obtains, when we mingle, by fusion, copper with zinc, in order to form the compound metal called brass: it is then observed, that the density of the mixture is augmented by about its tenth part. This apparent penetration is owing to the circumstance, that the moleculæ of the two bodies, in consequence of their respective formation, generally approach one another more than in the two bodies taken separately; there hence results, in the figure of the pores, such a change as diminishes the space equal to the sum of these pores. On the contrary, in the alloy of silver with copper, a kind of rarefaction is produced, such that the volume of the mixture is larger than the sum of the volumes of the two bodies, previous to fusion.

IMPERATIVE, one of the moods of a verb, used when we would command, entreat, or advise: thus, *go, read, take pity, be advised,* are imperatives in our language.

IMPERATORIA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: fruit roundish, compressed, gibbose in the middle, surrounded by a margin; petals inflex, emarginate. There is but one species, *viz.* I. ostruthium, master-wort, the root of which is thick, running obliquely in the ground; it is fleshy, aromatic, and has a strong acrid taste, biting the tongue and mouth; the leaves arise immediately from the root, having foot-stalks seven inches long, divided into three very short ones at the top, each sustaining a trilobate leaf, indented on the border; the foot-stalks are deeply channeled, and when broken emit a rank odour; the flower stalks rise two feet high, dividing into two or three branches, each terminated by a pretty large umbel of white flowers, whose petals are split; these are succeeded by oval compressed seeds, resembling those of dill, but larger. Linnæus observes, that the floral leaves are opposite, that there is a petiolary, membranaceous, ventricose, stipule, one within another: It is a native of many parts of the Alps, Austria, Syria, Tyrol, Silesia, and Dauphine.

IMPERFECT, something that is defective, or that wants some of the properties found in other beings of the same kind: thus mosses are called imperfect plants, because almost all the parts of fructification are wanting in them; and for the like reason is the appellation imperfect given to the fungi and submarine plants.

IMPERFECT *numbers,* such whose aliquot parts taken together do either exceed, or fall short of that whole number of which they are parts: they are either abundant or deficient. Thus 12 is an abundant imperfect number, because the sum of its parts $1 + 2 + 3 + 4 + 6 = 16$, which is greater than 12. But 10 is a deficient imperfect number, because $1 + 2 + 5 = 8$ only, which is less than 10.

IMPERSONAL *verb*, in grammar, a verb to which the nominative of any certain person cannot be prefixed; or, as others define it, a verb destitute of the two first and primary persons.

IMPETIGENES, in medicine, descriptive of those disorders, which, from a general bad habit, manifest themselves principally, by disfiguring the skin and external parts of the body.

IMPETUS, in mechanics, the force with which one body impels or strikes another.

IMPLEAD, to sue or prosecute by course of law.

IMPLICATION, in law, is where the law implies something that is not declared between parties in their deeds and agreements, and when our law gives any thing to a man, it gives, by implication, whatever is necessary for enjoying it. An implied contract is such, where the terms of agreement are not expressly set forth in words, but are such as reason and justice dictate, and which therefore the law presumes that every man undertakes to perform. Estates often arise by implication in a will, and sometimes in a deed; but they are more readily implied in the former than in the latter, in which the words must be more strict.

IMPONDERABLE *substances*. See SUBSTANCES, *imponderable*.

IMPORTATION, the act of bringing goods into a country from foreign parts. It has generally been considered, that for any country to carry on a profitable trade, it is necessary that the value of the goods sent out of it should be greater than that of the articles imported: this, however, is a very erroneous axiom, unless it is understood with great limitations. All articles of merchandize, imported merely for re-exportation, and also such as are used or worked up in British manufactures, are far from being hurtful to their commerce, and may even, in many respects, be deemed of equal profit with their own native commodities. It is therefore an excess of such importations alone, as are either for mere luxury, or mere necessity, or for both together, which is disadvantageous to the country, and not such importations as, like many of theirs, consist of raw silk, Spanish wool, cotton, wool and yarn, mohair, flax and hemp, oils, potash, dyeing stuffs, naval stores, &c. either used in their ship-building, or worked up in their manufactures, a principal part of which are for exportation: neither can their importations of East India goods and colonial produce, which are chiefly designed to be afterwards exported, be deemed unprofitable, but are, on the contrary, some of the most lucrative branches of their foreign trade. The following statement of the total value of the imports of England, in the year 1354, furnishes a good comparison with their present magnitude.

		L.	*s.*	*d.*
1831	Fine cloths, at 6*l.* per cloth, which, with the customs, come to	11,083	12	0
397¾	Hundred weight of wax, at 40*s.* per hundred weight, which, with the customs, come to .	815	7	5
1829½	Tons of wine, at 40*s.* per ton, which, with the customs, come to	3,841	19	0
	Linen cloth, mercery, grocery, and all other wares	22,943	6	10
	On which the customs were	285	18	3
	Total	38,970	3	6

At this period, and for a long time after, foreigners were the principal importers of goods in that country; and as it was thought that many of them, after disposing of their merchandize there, returned with the value in money to their own country, which was deemed a serious injury, many laws were made against carrying out of the realm any gold or silver, either in coin, plate, or bullion; and merchant strangers were compelled to give security, that they would lay out all the money they received for the wares they imported in English merchandize, to be exported. These injudicious restrictions have been long since done away, and, excepting the prohibition of some foreign manufactures, the import trade of that country is probably as free as the regulations necessary to secure the payment of heavy duties on almost every article of trade will admit. Total official value of the imports of Great Britain in the year 1800.

	L.	s.	d.
Port of London .	18,843,172	2	10
The Out Ports . .	9,514,642	11	20
England	28,357,814	14	8
Scotland	2,212,790	11	8
	30,570,605	6	4

In 1801	L 32,795,556
1802	31,441,318
1803	27,992,464
1804	92,201,490
1805	30,344,628
1806	28,835,907
1807	29,556,330

These sums are the official value of goods imported, which is very different from the real value; as an instance, which may serve for every case, the official value of the imports for 1807, 29,556,330*l.*; but the real value, according to the average of the last three years, is 53,500,990*l.*

IMPOSTHUME, a collection of matter or pus in any part of the body, either owing to previous inflammation of the part, or a translation of it from some other part.

IMPOSSIBLE *roots*, in algebra. To discover how many impossible roots are contained in any proposed equation, Sir Isaac Newton gave this rule in his algebra, *viz.* Constitute a series of fractions, whose denominators are the series of natural numbers, 1, 2, 3, 4, 5, &c. continued to the number showing the index or exponent of the highest term of the equations, and their numerators the same series of numbers in the contrary order; and divide each of these fractions by that next before it, and place the resulting quotients over the intermediate terms of the equation; then, under each of the intermediate terms, if its square multiplied by the fraction over it be greater than the product of the terms on each side of it, place the sign +; but if not, the sign —; and under the first and last term place the sign +. Then will the equation have as many imaginary roots as there are changes of the underwritten signs from + to —, and from — to +. So for the equation $x^3 - 4x^2 + 4x - 6 = 0$, the series of fractions is $\frac{3}{1}, \frac{2}{2}, \frac{1}{3}$: then the second, divided by the first, gives, $\frac{2}{6}$ or $\frac{1}{3}$, and the third divided by the second gives $\frac{1}{3}$ also; hence these quotients, placed over the intermediate terms, the whole will stand thus:

$$\begin{array}{cccc} & \frac{1}{3} & \frac{1}{3} & \\ x^3 & -4x^2 & +4x & -6. \\ + & + & - & + \end{array}$$

Now because the square of the second term, multiplied by its superscribed fraction, is $\frac{16}{3} x^4$, which is greater than $4x^4$, the product of the two adjacent terms, therefore the sign + is set below the second term; and because the square of the third term, multiplied by its over written fraction, is $\frac{16}{3} x^2$, which is less than $24x^2$, the product of the terms on each side of it; therefore the sign — is placed under that term; also the sign + is set under the first and last terms. Hence the two changes of the underwritten signs + + — +, the one from + to —, and the other from — to +, show that the given equation has two impossible roots. When two or more terms are wanting together, under the place of the first of the deficient terms write the sign —, under the second the sign +, under the third —, and so on, always varying the signs, except that under the last of the deficient terms must always be set the sign +, when the adjacent terms on both sides of the deficient terms have contrary signs. As in the equation,

$$\begin{array}{cccccc} x^5 & +ax^4 & * & * & * & +a^5=0, \\ + & + & - & + & - & + \end{array}$$

which has four imaginary roots.

IMPOSTS, in architecture, the capitals of pillars, or pilasters, which support arches. An impost, sometimes called chaptrel, is a sort of a plinth, or little corniche, which crowns a pier, and supports the first stone whence an arch or vault commences. The imposts are conformable to their proper orders. The Tuscan has only a plinth; the Doric has two faces crowned; the Ionic, a larmier, or crown over the two faces, and its mouldings may be carved; the Corinthian and Composite have a larmier, frieze, and other mouldings. See ARCHITECTURE.

IMPOTENCY, in the ecclesiastical law, signifies an inability of generation, or propagating the species, which is a cause of divorce a *vinculo matrimonii*, as being merely void, and therefore needs only a sentence declaratory of its being so.

IMPRESSING *men.* The power of impressing seamen for the sea-service, by the King's commission, has been a matter of some dispute, and submitted to with great reluctance, though it has very clearly and learnedly been shown by Sir

Michael Foster, that the practice of impressing, and granting power to the Admiralty for that purpose, is of a very ancient date, and has been uniformally continued, by a regular series of precedents, to the present time, whence he concludes it to be part of the common law. The difficulty arises from hence, that no statute has expressly declared this power to be in the crown, though many of them very strongly imply it. The statute 2 Richard II. c. 4, speaks of mariners being arrested and retained for the king's service, as of a thing well known and practised without dispute, and provides a remedy against their running away. By statute 2 and 3 Philip and Mary, c. 16, if any waterman, who uses the river Thames, shall hide himself during the execution of any commission for pressing for the king's service, he is liable to heavy penalties. By statute 5 Elizabeth, c. 6, no fisherman shall be taken by the queen's commission to serve as a mariner; but the commission shall be first brought to two justices of the peace, inhabiting near the sea coast where the mariners are to be taken, to the intent that the justices may choose out and return such a number of able bodied men as in the commission are contained, to serve her majesty. And by statute 7 and 8 William, c. 21; 2 Anne, c. 6; 4 and 5 Anne, c. 19; 13 George II. c. 17, especial protections are allowed to seamen in particular circumstances, to prevent them from being impressed. All which do most evidently imply a power of impressing to reside somewhere; and if any where, it must, from the spirit of our constitution, as well as from the frequent mention of the king's commission, reside in the crown alone. The Liverymen of London claim an exemption from being impressed; but, by a late decision of the Court of King's Bench, this exemption is denied. Landmen, entering into the merchant service, and apprentices, are exempt for two years from the impress, and all apprentices to the sea-service under eighteen.

IMPRESSION denotes the edition of a book, regarding the mechanical part only: whereas edition, besides this, takes in the care of the editor, who corrected or augmented the copy, adding notes, &c. to render the work more useful.

IMPRISONMENT, is the restraint of a man's liberty under the custody of another, and extends not only to a gaol, but a house, stocks, or where a man is held in the street, or any other place; for in all these cases the party so restrained is said to be a prisoner, so long as he hath not his liberty freely to go about his business, as at other times. None shall be imprisoned but by the lawful judgment of his peers, or by the law of the land.

IMPROPRIATION, is properly so called, when a benefice ecclesiastical is in the hands of a layman; and appropriation, when in the hands of a bishop, college, or religious house; though sometimes these terms are confounded. It is said there are three thousand eight hundred and forty-five impropriations in England.

IMPULSE, in mechanics, the single and instantaneous action or force by which a body is impelled, in contradistinction to the application of continued forces.

INACCESSIBLE, something that cannot be come at, or approached, by reason of intervening obstacles, as a river, rock, &c. It is chiefly used in speaking of heights and distances. See SURVEYING.

INARCHING, in gardening, is a method of grafting, commonly called grafting by approach, and is used when the stock intended to graft on, and the tree from which the graft is to be taken, stand so near, or can be brought so near, that they may be joined together. The method of performing it is as follows: take the branch you would inarch, and having fitted it to that part of the stock where you intend to join it, pare away the rind and wood on one side, about three inches in length. After the same manner cut the stock or branch in the place where the graft is to be united, so that the rind of both may join equally together; then cut a little tongue upwards in the graft, and make a notch in the stock to admit it; so that when they are joined, the tongue will prevent their slipping, and the graft will more closely unite with the stock. Having thus placed them exactly together, tie them with some bass, or other soft tying; then cover the place with grafting clay, to prevent the air from entering to dry the wound, or the wet from getting in to rot the stock: you should also fix a stake in the ground, to which that part of the stock, together with the graft, should be fastened, to prevent the wind from breaking them asunder, which is often the case when this precaution is not observed. In this manner they are to remain about four months, in which time they will be sufficiently united, and the graft may then be cut from the mother tree, observing to slope it off close to the stock; and if at this time you cover the joined parts with fresh grafting clay, it will be of great service to the graft.

IN AUTER DROIT, in another's right, as where executors or administrator sue for a debt or duty, &c. of the testator or intestate.

INCEST, is the carnal knowledge of persons within the Levitical degrees of kindred. These, by our law, are totally prohibited to marry with each other; and sentence of divorce, in such case, is only declatory of the illegality of the marriage, for the marriage itself is void *ab initio*.

INCH, a well known measure of length, being the twelfth part of a foot, and equal to three barley-corns in length. See MEASURE.

INCH *of candle*, or sale by inch of candle. See CANDLE.

INCHASING. See ENCHASING.

INCIDENCE, in mechanics, denotes the direction in which one body strikes on another. See MECHANICS and OPTICS.

It is demonstrated that the angle of incidence is equal to the angle of reflection, and that they both lie in the same plane. That the sines of the angles of incidence and refraction are to each other, either accurately or nearly, in a given or constant ratio: that from air to glass, the sine of the angle of incidence is to the sine of the angle of refraction as 14.9.

INCIDENT, signifies a thing necessarily depending upon another as more principal. For instance, a court baron, is an incident to a manor, and a court of pye-powder, to a fair, so inseparably, that they cannot be severed by grant.

INCINERATION, in chemistry, a term applied to the burning of vegetables for the sake of their ashes: it is usually referred to the burning of kelp on the coasts for making mineral alkali.

INCLINATION, is a word frequently used by mathematicians, and signifies the mutual approach, tendency, or leaning of two lines, or two planes, towards each other, so as to make an angle. Inclination of a right line to a plane, is the acute angle which that line makes with another right line drawn in the plane through the point where the inclined line intersects it, and through the point where it is also cut by a perpendicular, drawn from any point of the inclined line. Inclination of the axis of the earth, is the angle which it makes with the plane of the ecliptic; or the angle contained between the planes of the equator and ecliptic. Inclination of a planet, is an arch of the circle of inclination, comprehended between the ecliptic and the plane of a planet in its orbit. See ASTRONOMY.

INCLINED *plane*, in mechanic, sone that makes an oblique angle with the horizon. If a force, with a given direction, supports a weight upon an inclined plane, that force is to the weight as the sine of the inclination of the plane to the sine of the angle which is made by the line in which the force acts, and the line perpendicular to the plane. See MECHANICS.

INCLOSURES. Any person who shall wilfully or maliciously demolish, pull down, or otherwise destroy or damage, any fence raised or made for dividing or inclosing any common, waste, or other lands, in pursuance of any act of parliament, or shall cause or procure the same to be done, shall be guilty of felony, and transported for seven years. Prosecution to be commenced in eighteen months after the offence committed.

INCOMBUSTIBLE. Something that cannot be burnt, or consumed by fire. Authors talk much of an incombustible cloth, made of the asbestus. See ASBESTUS.

INCOMBUSTIBLES, *simple*. See SUBSTANCES, *simple*.

INCOME *tax*, a direct contribution of a certain proportion of the annual gains of individuals for the public service, which has recently become an important branch of the revenue of Great Britain. An attempt was made in 1702 to levy a tax of this description; but it proved very unproductive, and therefore was discontinued. Towards the end of the year 1798, Mr. Pitt proposed, in lieu of the additional assessed taxes, a general tax on income, whether arising from land, personal property, or from any profession, office, trade, or other employment. The act was passed 9th January, 1799; and the duties imposed by it were ten per cent. on all incomes of 200*l.* per annum and upwards, and lesser proportions on incomes between that amount and 60*l.* per annum, which paid a one-hundred and twentieth part, or ten shillings per annum: incomes below 60*l.* a year were wholly exempt. The great object of this tax was, to raise a considerable proportion of the public supplies within the year, and to liquidate within a short time what might be further raised by loan; with the latter view, the payment of the interest, and redemption of the capital, of part of the loans for the years 1798, 1799, and 1800, was charged on the produce of the tax; but it being a tax, which, from its commencement, had been very unpopular, both from its weight and the disclosure of the circumstances of individuals with which it was attended, it was repealed in April, 1802, and the charges upon it transferred to the Convolidated Fund.

In 1803 the income tax was revived, with some alterations in the mode of collecting it, under the title of the property tax: the rate at which it was now imposed was 5 per cent. on all incomes above 150*l.* per annum, and lesser proportions on incomes between that amount and 60*l.* per annum. In 1805 it was increased to 6¼ per cent.; and in 1806 it was raised to the original rate at which it had been imposed, or 10 per cent., while the scale of lesser rates was made to comprehend all incomes amounting to 50*l.* per annum. By this means, and by deducting the tax on the dividends of the public funds at the Bank, and abolishing most of the former abatements and exemptions, the sum raised by it has been considerably augmented, the estimated produce being as follows:

1804 at 1*s.* in the pound	*L.* 4,650,000
1805 at 1*s.* 3*d.* ditto........	5,937,500
1806 at 2*s.*.......ditto........	11,500,000

An income tax, if it could be so regulated as to bear a just proportion to the different modes in which the incomes of individuals arise, and did not extend to such amounts of income as are absolutely necessary for subsistence, would become the most equitable, as well as the most productive mode of taxation.

INCOMMENSURABLE, a term in geometry, used where two lines, when compared to each other, have no common measure, how small soever, that will exactly measure them both. And in general two quantities are said to be incommensurable, when no third quantity can be found that is an aliquot part of both. Such are the diagonal and side of a square; for though each of those lines have infinite aliquot parts, as the half, the third, &c. yet not any part of the one, be it ever so little, can possibly measure the other, as is demonstrated in prop. 117. lib. x. of Euclid.

Incommensurable *numbers*, are such as have no common divisor that will divide them both equally.

INCOMPLETE, in botany, a term used to denote the sixteenth class of the Linnæn "methodus calycina," consisting of plants whose flowers want either the calyx or petals.

INCORPORATION, *power of.* To the erection of any corporation the King's consent is necessary, either impliedly or expressly given: the King's implied consent is to be found in corporations which exist by force of the common law, to which the former kings are supposed to have given their concurrence; of this sort are all bishops, parsons, vicars, churchwardens, and some others, who, by common law, have ever been held to have been corporations by virtue of their office. Another method of implied consent is with regard to all corporations by prescription; such as the city of London, and many others, which have existed as corporations for time immemorial; for though the members thereof can show no legal charter of incorporation, yet, in cases of such high antiquity, the law presumes there once was one, and that, by variety of accidents, which a length of time may produce, the charter is lost or destroyed. The methods by which the King's consent is expressly given are either by act of parliament or charter; but the immediate creative act is usually performed by the King alone, in virtue of his royal prerogative. See further, Joint Stock.

INCREMENT, is the small increase of a variable quantity. Sir Isaac Newton calls these increases "moments," and observes, that they are proportional to the velocity or rate of increase of the flowing or variable quantities, in an indefinitely small time. The notation of increment is different by different authors. The method of increments is a branch of analytics, in which a calculus is founded on the properties of successive values of variable quantities, and their differences, or increments. It is nearly allied to the doctrine of fluxions, and, in truth, arises out of it. Of the latter the great Newton was the inventor; of the former we have different treatises by Dr. Taylor, Mr. Emerson, and others. We shall give Mr. Emerson's observations on the distinction between the method of increments and fluxions. "From the method of increments," he says, "the principal foundation of the method of fluxions may be easily derived; for, as in the method of increments, the increment may be of any magnitude, so in the method of fluxions it must be supposed infinitely small; whence all preceding and successive values of the variable quantity will be equal, from which equality the rules for performing the principal operations of fluxions are immediately deduced. That I may give the reader," continues he, "a more perfect idea of the nature of this method: suppose the abscissa of a curve be divided into any number of equal parts, each part of which is called the increment of the abscissa, and imagine so many parallelograms to be erected thereon, either circumscribing the curvilineal figure, or inscribed in it; then the finding the sum of all these parallelograms is the business of the method of increments. But if the parts of the abscissa be taken infinitely small, then these parallelograms degenerate into the curve; and then it is the business of the method of fluxions to find the sum of all, or the area of the curve. So that the method of increments finds the sum of any number of finite quantities; and the method of fluxions the sum of any infinite number of infinitely small ones: and this is the essential difference between these two methods."

Again: "There is such a near relation between the method of fluxions and that of increments, that many of the rules for the one, with little variation, serve also for the other. And here, as in the method of fluxions, some questions may be solved, and the integrals found, in finite terms; whilst in others we are forced to have recourse to infinite series for a solution. And the like difficulties will occur in the method of increments, as usually happen in fluxions. For whilst some fluxionary quantities have no fluents but what are expressed by series, so some increments have no integrals but what infinite series afford; which will often, as in fluxions, diverge and become useless." By means of the method of increments, many curious and useful problems are easily resolved, which scarcely admit of a solution in any other way. As, suppose several series of quantities be given, whose terms are all formed according to some certain law which is given; the method of increments will find out a general series, which comprehends all particular cases, and from which all of that kind may be found. The method of increments is also of great use in finding any term of a series proposed: for the law being given by which the terms are formed, by means of this general law the method of increments will help us to this term, either expressed in finite quantities, or by an infinite series. Another use of the method of increments is to find the sum of series, which it will often do in finite terms. And when the sum of a series cannot be had in finite terms, we must have recourse to infinite series; for the integral being expressed by such a series, the sum of a competent number of its terms will give the sum of the series required. This is equivalent to transforming one series into another, converging quicker: and sometimes a very few terms of this series will give the sum of the series sought. See Emerson's Increments.

INCUBUS, or *night mare*, in medicine, the name of a disease, which consists in a spasmodic contraction of the muscles of the breast, usually happening in the night, and attended with a very painful difficulty of respiration and great anxiety.

INCUMBENT, a clerk diligently resident on his benefice with cure; and called incumbent of that church, because he does or ought to apply himself sedulously to discharge the duty of his cure.

INCURVATION *of the rays of light*, their bending out of a rectilinear or straight course, occasioned by refraction.

INDEFINITE, or INDETERMINATE, that which has no certain bounds; or to which the human mind cannot affix any. Des Cartes makes use of this word in his philosophy instead of infinite, both in numbers and quantities, to signify an inconceivable number, or a number so great that an unit cannot be added to it; and a quantity so great as not to be capable of any addition. Thus, he says, the stars visible and invisible are in number indefinite; and not as the ancients held infinite; and that quantity may be divided into an indefinite number of parts, not an infinite number.

INDEFINITE is also used, in the schools, to signify a thing that has but one extreme; for instance, a line drawn from any point and extended infinitely.

INDEFINITE, in grammar, is understood of nouns, pronouns, verbs, participles, articles, &c. which are left in an uncertain indeterminate sense, and not fixed to any particular time, thing, or other circumstance.

INDENTED, in heraldry, is when the out-line of an ordinary is notched like the teeth of a saw.

INDENTED *line*, in fortification, the same with what the French engineers call redent; being a trench and parapet running out and in, like the teeth of a saw; and is much used in irregular fortification.

INDENTURE, is a writing, containing a conveyance between two or more, indented or cut unevenly, or in and out, on the top or side, answerable to another writing that likewise comprehends the same words. Formerly, when deeds were more concise than at present, it was usual to write both parts on the same piece of parchment, with some words or letters written between them, through which the parchment was cut, either in a straight or indented line, in such a manner as to leave half the word on one part, and half on the other; and this custom is still preserved in making out the indentures of a fine. But at last, indenting only hath come into use, without cutting through any letters at all, and it seems at present to serve for little other purpose than to give name to the species of the deed.

INDEPENDENTS, or CONGREGATIONALISTS, in church history, a sect of Protestant Dissenters, which first made its appearance in Holland in the year 1616. Mr. John Robinson appears to have been the founder of this sect. The appellation of Independents was applied to, and adopted by, this denomination of Christians, from their maintaining that all Christian congregations are so many independent religious societies, having a right to be governed by their own laws, without being subject to any further or foreign jurisdiction. This term was publicly acknowledged in the year 1644, by those English Dissenters, who held similar sentiments respecting church government to the Independents in Holland; but on account of the ill use that many made of the term, by a perversion of its original meaning and religious designation, the English Independents renounced it, and adopted that of Congregationalists, or Congregational brethren. The term Independent is still, however, applied to various sects of Protestant Dissenters, and seems justly applicable to almost every sect of nonconformists in this country.

The doctrines of the Independents are the same as those of the BROWNISTS. It is said, that the only difference between these sects was, that the Brownists were illiberal in their views concerning other denominations, while the Independents entertained enlarged conceptions of church communion, and allowed that other churches, though different from them in points of discipline, might properly be called Christian churches. It is, however, to be feared that the Independents, properly so called, being Calvinists as to points of faith, do not cherish very liberal sentiments concerning the salvation of those who differ from them in most of their articles of belief. A spirit which seems to be a natural effect of the creed of the Geneva Reformer. See BROWNISTS and PRESBYTERIANS.

INDETERMINATE, in general, an appellation given to whatever is not certain, fixed, and limited; in which sense it is the same with indefinite.

INDETERMINATE *problem*, is that which admits of many different solutions and answers, called also an unlimited problem. In questions of this kind, the number of unknown quantities concerned is greater than the number of the conditions and equations by which they are to be found; from which it happens, that generally some other conditions or quantities are assumed, to supply the defect, which, being taken at pleasure, give the same number of answers as varieties in those assumptions. If, for instance, it were required to find the value of two square numbers, whose difference is equal to a, a given quantity. Here if x^2 and y^2 denote the squares, then $x^2-y^2=a$, which is only one equation for finding two quantities. Now, by assuming some other unknown quantity, as z, so that $z=x+y=$ the sum of the roots; then is $x=\frac{z^2+a}{2z}$, for

$$x^2-y^2=a$$
$$x^2+2xy+y^2=z^2$$
$$2x^2+2xy=z^2+a$$
$$z=\frac{z^2+a}{2x+2y}=\frac{z^2+a}{2z}.$$

And by the same mode $y=\frac{z^2+a}{2z}$, which are the two roots having the difference of their squares equal to a given quantity a, and are expressed by means of an assumed quantity z; so that there will be as many answers to the question, as there can be taken values of the indeterminate quantity z.

Mr. Leslie, in the transactions of the Royal Society of Edinburgh, has given a paper on this subject, the object of which is to resolve the complicated expressions which we obtain in the solution of indeterminate problems into simple equations, and this is done by means of a principle, which, though extremely simple, admits of a very extensive application. Let $A\times B$ be any compound quantity equal to another, $C\times D$, and let m be any rational number assumed at pleasure; it is manifest that, taking equimultiples, $A\times m\,B=C\times m\,D$. If, therefore, we suppose that $A=m\,D$, it must follow that $m\,B=C$, or $B=\frac{C}{m}$. Thus two equations of a lower dimension are obtained. If these be capable of further decomposition, we may assume the multiples n and p, and form four equations still more simple. By the repeated application of this principle, an higher equation, admitting of divisors, will be resolved into those of the first order, the number of which will be one greater than that of the multiples assumed. For example, resuming the problem at first given, *viz.* to find two rational numbers, the difference of the squares of which shall be a given number. Let the given number be the product of a and b; then by hypothesis, $x^2-y^2=ab$; but these compound quantities admit of an easy resolution, for $\overline{x+y} \times \overline{x-y} = a \times b$. If therefore we suppose $x+y=ma$, we shall obtain $x-x=\frac{b}{m}$, where m is arbitrary, and if rational, x and y must also be rational. Hence the resolution of these two equations gives the values of x and y, the numbers sought, in terms of m, *viz.* $x=\frac{m^2a+b}{2m}$, and $y=\frac{m^2a-b}{2m}$

INDEX, in anatomy, the same with the fore finger. See FINGERS.

INDEX, in arithmetic and algebra, shows to what power any quantity is involved, and is otherwise called exponent. See EXPONENT.

INDEX *of a logarithm*, that which shows of how many places the absolute number, belonging to a logarithm, doth consist; and of what nature it is, whether an integer or fraction. Thus, in this logarithm, 2.523421, the number 2 standing on the left hand of the point is called the index; because it shows that the absolute number, answering to the above logarithm, consists of three places: for the number is always one more than the index. If the absolute number be a fraction, then the index of the logarithm hath a negative sign, marked thus, $\bar{2}.523421$. See LOGARITHM.

INDEX *of a globe*, the little style or gnomon, which being fixed on the pole of the globe, and turning round with it, points out the hours upon the hour circle. See GLOBE.

INDIA *rubber*. See CAOUTCHOUC.

INDICATIVE, in grammar, the first mood, or manner, of conjugating a verb, by which we simply affirm, deny, or ask something.

INDICTION, in chronology, a cycle of fifteen years. See CHRONOLOGY.

INDICTMENT, is a written accusation of one [illegible] more persons, of a crime or misdemea[illegible] preferred to, and presented on oath b[illegible] jury. An indictment may be found on the oath of one witness only, unless it be for high treason, which requires two witnesses; and unless in any instance it is otherwise specially directed by acts of parliament. The sheriff of every county is bound to return to every session of the peace, and every commission of oyer and terminer, and of general gaol delivery, twenty-four good and lawful men of the county, some out of every hundred, to enquire, present, do, and execute all those things, which, on the part of our lord the King, shall then and there be commanded therein. As many as appear upon this pannel are sworn of the grand jury, to the amount of twelve, at the least, and not more than twenty-three, that twelve may be a majority. This grand jury is previously instructed in the articles of their enquiry, by a charge from the judge on the bench. They then withdraw from court, to sit and receive indictments, which are preferred to them in the name of the King, but at the suit of any private prosecutor; and they are only to hear evidence on behalf of the prosecution; for the finding an indictment is only in the nature of an enquiry or accusation, which is afterwards to be tried and determined; and the grand jury are only to enquire, upon their oaths, whether there be sufficient cause to call upon the party to answer it.

The grand jury may not find part of an indictment true, and part false; but must either find a true bill, or ignoramus, for the whole; and if they take upon them to find it specially, or conditionally, or to be true for part only, and not for the rest, the whole is void, and the party cannot be tried upon it, but ought to be indicted anew.

All capital crimes whatsoever, and all kinds of inferior crimes, which are of a public nature, as misprisions, contempts, disturbances of the peace, oppressions, and all other misdemeanours whatsoever, of a public evil example, against the common law, may be indicted, but no injuries of a private nature, unless they in some degree concern the King. And generally, where a statute prohibits a matter of public grievance to the liberties and security of a subject, or commands a matter of public convenience, as the repairing of the common streets of the town, &c., every disobedience of such statute is punishable, not only at the suit of the party grieved, but also by way of indictment, for contempt of the statute, unless such method of proceeding shall manifestly appear to be excluded by it. Yet, if the party offending have been fined in an action brought by the party (as it is said he may in every action, for doing a thing prohibited by statute,) such fine is a good bar to the indictment, because by the fine the end of the statute is satisfied; otherwise he would be liable to a second fine for the same offence.

If several offenders commit the same offence, though, in law, they are several offences in relation to the several offenders, yet they may be joined in one indictment; as if several commit a robbery or murder.

No indictment for high treason, or misprision thereof, (except indictments for counterfeiting the King's coin, seal, sign, or signet,) nor any process or return thereupon, shall be quashed for mis-reciting, mis-spelling, false or improper Latin, unless exception concerning the same be taken, and made in the respective court where the trial shall be, by the prisoner or his council assigned, before any evidence given in open court on such indictment; nor shall any such mis-reciting, mis-spelling, false or improper Latin, after conviction on such indictment, be any cause of stay, or arrest of judgment; but nevertheless any judgment on such indictment shall be liable to be reversed on writ of error, as formerly. An indictment accusing a man in general terms, without ascertaining the particular fact laid to his charge, is insufficient; for no one can know what defence to make to a charge which is uncertain, nor can plead it in bar on abatement of a subsequent prosecution: neither can it appear, that the facts given in evidence against a defendant, on such a general accusation, are the same of which the indictors have accused him; nor can it judicially appear to the court what punishment is proper for an offence so loosely expressed.

No indictment can be good, without expressly showing some place wherein the offence was committed, which must appear to have been within the jurisdiction of the court.

There are several emphatical words of art, which the law has appropriated for the description of an ,offence which no circumlocution will supply; as feloniously, in the indictment of any felony; burglariously, in an indictment of burglary, and the like. And an indictment on the black act, for shooting at any persou, must charge that the offence was done wilfully and maliciously.

By 10 and 11 William, c. 23, it is enacted that no clerk of assize, clerk of the peace, or other person, shall take any money of any person, bound over to give evidence against a traitor or felon, for the discharge of his recognizance, nor take more than two shillings for drawing any bill of indictment against any such felon, or pain of five pounds to the party grieved, with full costs. And if he shall draw a defective bill, he shall draw a new one gratis, on the like penalty. With respect to drawing indictments for other misdemeanors, not being treason or felony, no fee is limited by the statute, the same therefore depends on the custom and ancient usage.

Every person charged with any felony or other crime, who shall on his trial be acquitted, or against whom no indictment shall be found by the grand jury, or who shall be discharged by proclamation for want of prosecution, shall be immediately set at large in open court, without payment of any fee to the sheriff or gaoler; but in lieu thereof, the treasurer, on a certificate signed by one of the judges or justices, before whom such prisoner shall have been discharged, shall pay, out of the general rate of the county or district, such sum as has been usually paid, not exceeding thirteen shillings and four-pence.

By these words, immediately set at large, the reader must not understand that this actually takes place immediately after the throwing out of the bill. It is usually done after the assizes or sessions are over, and when the judge or justices proceed to the gaol-delivery, as it is called. This affords an opportunity for the preferring a new indictment against the party, if there should be occasion; and it is upon this ground, that the detention of a prisoner, after rejecting the indictment by the grand jury, is countenanced. It is, however, in many cases, a hardship. The sheriffs of London, in A. D. 1808, Sir Richard Phillips, Knt. and Mr. Alderman Smith, very much to their credit, endeavoured to procure the judges at the Old Bailey to discharge prisoners immediately, but the practice having long continued as above stated, the judges have been averse to altering it.

Upon a certificate of an indictment being found, for an assult or other misdemeanor, and much more for a felony, at the sessions, a warrant is issued, on the application of the prosecutor, to take the party into custody, and he may be held to bail by a justice of the peace, or a judge; and it is usual, in expectation of such a warrant, to put in bail, and obtain a supersedeas to the warrant previously. This was not formerly the practice, upon indictments or informations in the court of King's Bench. An act has passed to enable the court to issue warrants, and hold to bail, upon indictments or informations filed. This act is principally objectionable, as it may be used as the means of harassing persons, prosecuted harshly and vindictively by the Attorney Genera for libels, &c. It is either a useless act, since the justice of the country has been safely conducted for centuries without it, or it is an act of great importance to the liberty of the subject.

But an action cannot be brought by the person acquitted against the prosecutor of the indictment, without obtaining a copy of the record of his indictment and acquittal; which, in prosecutions for felony, it is not usual to grant, if there be the least probable cause to found such prosecution upon; for it would be a very great discouragement to the public justice of the kingdom, if prosecutors, who had a tolerable ground of suspicion, were liable to be sued at law whenever their indictments miscarried. But an action on the case, for a malicious prosecution, may be founded on such an indictment whereon no acquittal can be, as, if it be rejected by the grand jury, or be coram non judice, or be insufficiently drawn; for it is not the danger of the plaintiff, but the scandal, vexation, and expense, upon which this action is founded. However, any probable cause for preferring it is sufficient to justify the defendant, provided it do not appear that the prosecution was malicious. And it is necessary to show something more than the mere not prosecutis, in order to raise the inference of malice.

INDIGESTION. See MEDICINE.

INDIGO, a dye prepared from the leaves and small branches of the *indigofera tinctoria*. See the next article.

Indigo is distinguished into two kinds, the true and the bastard. Though the first is sold at a higher price on account of its superiority, it is usually advantageous to cultivate the other, because it is heavier. The first will grow in many different soils; the second suceeds best in those which are most exposed to the rain. Both are liable to great accidents. Sometimes the plant becomes dry, and is destroyed by an insect frequently found on it; at other times, the leaves, which are the valuable part of the plant, are devoured in the space of twenty-four hours by caterpillars. This last misfortune, which is but too common, has given occasion to the saying, "that the planters of indigo go to bed rich, and rise in the morning totally ruined." This production ought to be gathered in with great precaution, for fear of making the farina that lies on the leaves, and is very valuable, fall off by shaking it. When gathered, it is thrown into the steeping-vat, which is a large tub filled with water. Here it undergoes a fermentation, which in twenty-four hours at furthest is completed. A cock is then turned to let the water run into the second tub, called the mortar or pounding tub. The steeping-vat is then cleaned out, that fresh plants may be thrown in; and thus the work is continued without interruption. The water which has run into the pounding tub is found impregnated with a very subtle earth, which alone constitutes the dregs, or blue substance, that is the object of this process, and which must be separated from the useless salt of the plant, because this makes the dregs swim on the surface. To effect this, the water is forcibly agitated with wooden buckets that are full of holes, and fixed to a long handle. This part of the process requires the greatest precautions. If the agitation be discontinued too soon, the part that is used in dyeing, not being sufficiently separated from the salt, would be lost. If, on the other hand, the dye were to be agitated too long after the complete separation, the parts would be brought together again, and form a new combination; and the salt reacting on the dregs would excite a second fermentation, that would alter the dye, spoil its colour, and make what is called burnt indigo. These accidents are prevented by a close attention to the least alterations that the dye undergoes, and by the precaution which the workmen take to draw out a little of it from time to time in a clean vessel. When they perceive that the coloured particles collect by separating from the rest of the liquor, they leave off shaking the buckets, in order to allow time to the blue dregs to precipitate to the bottom of the tub, where they are left to settle till the water is quite clear. Holes made in the tub, at different heights, are then opened one after another, and this useless water is let out. The blue dregs remaining at the bottom having acquired the consistence of a thick muddy liquid, cocks are then opened, which draw it off into the settler. After it is still more cleared of much superfluous water in this third and last tub, it is drained into sacks; from whence, when water no longer filters through the cloth, this matter now becomes of a thicker consistence, and is put into chests, where it entirely loses its moisture. At the end of three months the indigo is fit for sale.

It is used, in washing, to give a bluish colour to linen: painters also employ it in their water colours; and dyers cannot make fine blue without indigo. The ancients procured it from the East Indies; in modern times it has been transplanted into America. The cultivation of it, successively attempted at different places, appears to be fixed at Carolina, St. Domingo, and Mexico. That which is known under the name of Guatimala indigo, from whence it comes, is the most perfect of all.

Indigo may be obtained from the merium tinctorium, and the isatis tinctoria or woad; a plant cultivated and even found wild in England. When arrived at maturity, this plant is cut down, washed, dried hastily in the sun, ground in a mill, placed in heaps, and allowed to ferment for a fortnight. It is then well mixed, and made up into balls, which are piled upon each other, and exposed to the wind and sun. In this state they become hot, and exhale a putrid ammoniacal smell. The fermentation is promoted, if necessary, by sprinkling the balls with water. When it has continued for a sufficient time, the woad is allowed to fall to a coarse powder; in which state it is sold as a dye-stuff. By treating woad nearly in the same manner with the indigofera, indigo has been obtained from it by different chemists.

Indigo is a soft powder of a deep blue, without either taste or smell. It undergoes no change, though kept exposed to the air. Water, unless kept long upon it, does not dissolve any part of it, nor produce any change. When heat is applied to indigo, it emits a bluish red smoke, and at last burns away with a very faint white flame, leaving behind it the earthy parts in the state of ashes. Neither oxygen nor the simple combustibles have any effect upon indigo, except it is in a state of solution; and the same remark applies to the metallic bodies. The fixed alkaline solutions have no action on indigo, except it is newly precipitated from a state of solution. In that case, they dissolve it with facility. The solution has at first a green colour, which gradually disappears, and the natural colour of the indigo cannot be again restored. Hence we see that the alkalies, when concentrated, decompose indigo. Pure liquid ammonia acts in the same way. Even carbonate of ammonia dissolves precipitated indigo, and destroys its colour; but the fixed alkaline carbonates have no such effect. Lime-water has scarcely any effect upon indigo in its usual state; but it readily dissolves precipitated indigo. The solution is at first green, but becomes gradually yellow. When the solution is exposed to the air, a slight green colour returns, as happens to the solution of indigo in ammonia, but it soon disappears.

The action of the acids upon indigo has been examined with most attention; it certainly exhibits the most important phenomena. When diluted sulphuric acid is digested over indigo, it produces no effect, except that of dissolving the impurities; but concentrated sulphuric acid dissolves it readily. One part of indigo, when mixed with eight parts of sulphuric acid, evolves heat, and is dissolved in about twenty-four hours. According to Haussman, some sulphurous acid and hydrogen gas are evolved during the solution. If so, we are to ascribe them to the mucilage and resin which are doubtless destroyed by the action of the concentrated acid.

The solution of indigo is well known in this country by the name of liquid blue, or sulphate of indigo. While concentrated it is opaque and black: but when diluted it assumes a fine deep blue colour; and its intensity is such, that a single drop of the concentrated sulphate is sufficient to give a blue colour to many pounds of water. Bergman ascertained the effect of different re-agents on this solution with great precision. Dropt into sulphurous acid, the colour was at first blue, then green, and very speedily destroyed. In vinegar it becomes green, and in a few weeks the colour disappears. In weak potash it becomes green, and then colourless. In weak carbonate of potash, there are the same changes, but more slowly. In ammonia, and its carbonate, the colour becomes green, and then disappears. In a solution of sugar, it became green, and at last yellowish. In sulphate of iron, the colour became green, and in three weeks disappeared. In the sulphurets the colour was destroyed in a few hours. Realgar, white oxide of arsenic, and orpiment, produced no change. Black oxide of manganese destroyed the colour completely. From these and many other experiments it was inferred, that all those substances which have a very strong affinity for oxygen give a green colour to indigo, and at last destroy it. Hence it is imagined, that indigo becomes green, by giving out oxygen. Of course it owes its blue colour to that principle.

INDIGOFERA, *Indigo*, or *Indicum*, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx spreading; keel of the corolla, with an awl-shaped spreading spur on each side; legume linear. There are thirty-five species. The indigos are shrubs under shrubs, or herbs; the leaves are in some few cases simple, in more ternate, in most unequally pinnate; the leaflets in some jointed and awned at the base, as in phaseolus; stipules distinct from the petiole; peduncles axillary, one or two-flowered, in spikes or racemes. The herb in most of the species yields a blue dye, which is not peculiar to this genus, many plants of this natural class abounding with the blue colouring matter.

INDIVIDUAL, in logic, a particular being of any species, or that which cannot be divided into two or more beings equal or alike.

The usual division in logic is made into genera, those genera into species, and those species into individuals.

INDIVISIBLE, among metaphysicians. A thing is said to be indivisible absolute, absolutely indivisible, that is, a simple being, and consists of no parts into which it may be divided. Thus God is indivisible in all respects, as is also the human mind, not having extension or other properties of body.

INDIVISIBLES, in geometry, the elements or principles into which any body or figure may be ultimately resolved; which elements are supposed infinitely small: thus a line may be said to consist of points, a surface of parallel lines, and a solid of parallel and similar surfaces; and then, because each of these elements is supposed indivisible, if in any figure a line be drawn through the elements perpendicularly, the number of points in that line will be the same as the number of the elements; whence we may see, that a parallelogram, prism, or cylinder, is resolvable into elements or indivisibles, all equal to each other, parallel and like to the base; a triangle into lines parallel to the base, but decreasing in arithmetical proportion; and so are the circles which constitute the parabolic conoid, and those which constitute the plane of a circle, or surface of an isosceles cone. See INFINITESIMALS.

A cylinder may be resolved into cylindrical curve surfaces, having all the same height, and continually decreasing inwards, as the circles of the base do on which they insist.

The method of indivisibles is only the ancient method of exhaustions, a little disguised and contracted. It is found of great use in shortening mathematical demonstrations, of which take the following instance, in the famous proposition of Archimedes, viz. that a sphere is two thirds of a cylinder circumscribing it.

Suppose a cylinder, an hemisphere, and an inverted cone (Plate Miscel. VI. fig. 13) to have the same base and altitude, and to be cut by infinite planes, all parallel to the base, of which $d g$ is one. It is plain the square of $d h$ will be every where equal to the square of $k c$ (the radius of the sphere) the square $h c = e h$ square; and consequently, since circles are to one another as the squares of the radii, all the circles of the hemisphere will be equal to all those of the cylinder, deducting thence all those of the cone; wherefore, the cylinder, deducting the cone, is equal to the hemisphere; but it is known that the cone is one third of the cylinder, and, consequently, the sphere must be two-thirds of it. Q. E. D.

INDORSEMENT, in law, signifies any thing written upon the back of a deed or other instrument. On sealing of a bond, the condition of the bond may be indorsed, and then the bond and indorsement shall both stand together. In order to the executing a justice of the peace's warrant in another county, it must be indorsed by some justice in such other county, which is commonly called backing the warrant. It is customary also to indorse the receipt of the consideration-money upon a deed; or an assignment of a lease may sometimes be made by indorsement. Indorsement is also that act by which the holder of a bill of exchange, or promissory note, payable to order, transfers such instrument, and his interest therein, to some other person, who is then termed the indorsee, and who, by such transfer and assignment, renders himself responsible for presenting such instrument, and using all due diligence to obtain payment of the acceptor or maker.

INDUCTION is the giving a clerk, instituted to a benefice, the actual possession of the temporalities belonging to it, in the nature of livery of seisin. It is performed by a mandate from the bishop to the archdeacon, who commonly issues out a precept to some other clergyman to perform it for him; which being done, the clergyman who inducts him indorses a certificate of his induction on the archdeacon's mandate, and they who were present testify the fact under their hands. And by this the person inducted is in full and complete possession of all the temporalities of his church.

INEBRIANTS, a term derived from the Latin, and applied to that class of substances that affect the nerves in a particular and agreeable manner, and through them alter and disturb the functions of the mind. They are divided into natural and artificial: the former are chiefly in use among oriental nations; to the latter Europeans have recourse. Natural inebriants, are opium, in use in Turkey and the East; peganum harmala, Sirian rue; of this the seeds are chiefly used: maslac of the Turks, or bangue of the Persians, prepared from the dust of the male flower of hemp; bangue of the Indians, from the leaves of the hibiscus abelmoschus; seeds of various species of the datura, or thorny apple: penang, or betel, of the Indians; roots of black henbane; hyoscyamus physaloides; berries of the nightshade; leaves of millefoil; tobacco. Artificial inebriants are, fermented liquors from farinaceous seeds; wines and spirits drawn by distillation. See Drunkenness.

INERTIA *of matter*, in philosophy, is defined by Sir Isaac Newton to be a passive principle, by which bodies persist in a state of motion or rest, receive motion in proportion to the force impressing it, and resist as much as they are resisted. It is also defined by the same author to be a power implanted in all matter, whereby it resists any change endeavoured to be made in its state. See Mechanics.

All bodies preserve or continue, as of themselves, in their state of rest, or of uniform motion in a right line, in such manner, that a body at rest cannot move without being solicited or urged by some force; neither can the rectilinear and uniform motion of a body be changed without the action of a foreign cause.—That want of aptitude which bodies have, of producing in themsleves a change in their actual state, is called inertia. Now it is known that a body, whose state may be changed by the action of a foreign force, cannot give way to that effect, otherwise than by itself altering the state of that force; that is to say, by itself taking away a part of its motion. It has hence been concluded, that the continuance of a body in its state of repose, or of uniform motion, was itself the effect of a real force which resided in that body; and this force has been viewed, sometimes, as a resistance, in so far as it opposed itself to the action of the other force, which changed the state of that body, and sometimes as an effort, in so far as it tended to carry with it the change in the state of the other force.

The celebrated Laplace has proposed a more precise and natural manner of contemplating inertia. To conceive in what it consists, suppose a body in motion to meet with a body at rest: it will communicate to it a part of its motion; in such manner, that if the first have, for example, a mass double to that of the second, in which case its mass will be two-thirds of the sum of the masses, the velocity which it will retain will be also two-thirds of that which it had at first; and as the other third, which it has yielded to the second body, employs itself upon a mass of only half the magnitude of the former, the two bodies will both have the same velocity after the shock.

The effect of inertia is reduced, therefore, to the communication made by one of these bodies to the other, of a part of its motion; and since this latter cannot receive, but in consequence of the other's losing, this loss has been attributed to a resistance exercised by the body receiving the motion. But in the instance before us, it is very nearly as in the motion of an elastic fluid, contained in a vessel from which we would open a communication to another vessel which should be empty; this fluid would introduce itself by its expansive force into the second vessel, until it became uniformly distributed in the capacities of the two vessels: in like manner, a body when it strikes another does nothing else, if we may so express ourselves, than pour into this latter a part of its motion; and there is no more reason to suppose a resistance in this case than in the examples we have just cited. It is true, that, when we strike with the hand a body at rest, or whose motion is less rapid than that of the hand, we imagine that we experience a resistance; but the illusion proceeds from this, that the effect is the same with regard to the hand, as though it were at rest, and was struck by the body with a motion in a contrary direction.

INFAMY, in law, which extends to forgery, perjury, gross cheats, &c. disables a man to be a witness or a juror; but a pardon of crimes restores a person's credit, to make him a good evidence.

INFANCY, the first stage of life. In a medical and political view, extending from birth to about the seventh year. Like every other stage of life, it is subject to its peculiar diseases, even in the healthiest state of the constitution, and under the best and most natural control. But from a too generally inherent debility, produced by the common consequences of polished and fashionable life, added either to maternal neglect, or a superabundance of maternal assiduity and anxiety, it is also exposed to diseases of great variety and violence, from which it would otherwise be exempt.

The natural infirmity of infant life exposes it at all times, and in all situations, to a mortality far exceeding that of any other stage: but from the powerful effect of such accessary causes, in conjunction with the impure air of crowded towns and cities, we are often called upon to contemplate this mortality, trebled or quadrupled beyond its appropriate ratio; and to behold more than half the natives of a place die within the narrow term of the first three years of life, instead of the greater part of them reaching the age of twenty-five or thirty, and, of course, living to become husbands and wives, and giving birth to generations, which are thus cut off along with themselves.

What then are the best means of diminishing this melancholy and sweeping mortality? There cannot be a more important question, either in medicine or in politics. To offer all that is worthy of notice in the latter view, would be to engage in a much longer and a more speculative discussion than the limits of the present article, or even of the present work, would allow. We shall confine ourselves, therefore, in what we shall have further to advance upon the subject, to the point of medical and domestic attention alone; and shall beg leave, upon this restricted scale, to propose such hints as may have a tendency to remove a considerable part of the evils of which we complain. In doing this, we shall first notice what ought to be the treatment of infants in a state of health, and, secondly, in a state of disease.

Treatment of Infants in Health.

The two primary objects of attention on the birth of an infant are warmth and cleanliness. The last has lately been opposed, but certainly without due consideration. The limbs and body of an infant when first born are generally covered over with a mealy mucous matter, which appears to be a feculent deposit from the amnios, or fluid, in which he was immersed antecedently to his birth. "This coating, or covering," we are told, "which the infant obtains in the womb, is surely not put there for nothing. Be assured that nature has some wise and necessary design, or purpose, in the matter; for it adheres, and it adheres most firmly, to his skin; and, if left to itself, in a certain period after birth it dries, and forms a crust, and gradually scales off, in the economy of nature, and leaves the skin it covered *heal* and healthful, and capable to bear every common or necessary freedom."

The natural indolence of nurses will be much obliged to this writer, who has acquired, and for various reasons deservedly acquired, considerable popularity, for this novel and extraordinary advice; an advice, than which nothing can be much more pernicious, and which we feel ourselves, therefore, compelled to combat by a few cursory remarks.

This coating, we are told, is not placed over the skin for nothing; and we are desired to rest assured, that nature has some wise and necessary design or purpose in the matter. But what is this wise and necessary design? If not put over the skin for nothing, for what is it put there? These are important questions; but there is not a single hint in the writer's entire book that may serve as an answer to them. We believe, however, and have much reason to believe, that it is put there for nothing; that the deposit of this mucous coating is a mere accident, resulting from a casual change in the state or proportion of the amnios; and not designed by nature to answer any necessary purpose whatever. If nature really designed any useful purpose by such a deposit, we should find her producing it uniformly in the same quantity and quality. But while many infants are born without any such deposit whatever, the covering that surrounds others differs materially, both in its nature and proportion, sometimes being diffused over the whole body, at others confined to particular parts of it; sometimes being a white, thick, pultaceous mass, derived alone from the amnios, and at others a pitchy tenacious fluid, chiefly derived from the discharge of meconium. Yet be it what it may, we are told that our nurses "have nothing to do but to take the infant's skin as nature gives it them; nothing to do but to dry it in the most kind and gentle manner, with the receiver, or a piece of old soft spongy cloth, warmed at the fire, and then proceed to clothe him." Yet if they have nothing to do but to take the skin as nature gives it them, they ought not to dry it, for nature gives the skin to them moist; they ought not to clothe it, for nature gives it to them without covering; and the young of many other animals, though wholly unfurnished with ready-made dresses against their birth, are born just as naked and unfledged as the human infant. Above all, they ought not to clean it, either with the receiver, or a piece of old spongy cloth; for this is to destroy the very foundation of the author's new system, which consists in its not being cleaned by any means, not even by "soap and water, or plain water, or any other substance whatever." Now certainly, if the body of an infant may be rubbed with the receiver, which is usually flannel, or even with a piece of old cloth, there is no reason why he may not be rubbed with a little warm water, which has a far nearer approach to the nature of his prenascent element, than either of these substances, and is far less rough and uncomfortable to its tender and delicate skin.

We shall only offer another remark. Though the author be not able to tell us what good purpose nature designs by diffusing over the body a coating of mealy or viscid mucus, we can easily point out to him what bad purpose nature herself would accomplish by our suffering it to remain there after birth: and we will do it in his own words. "If left to itself, says he, at a certain period after birth it dries, and forms a crust, and gradually scales off." And it is for this very reason it ought to be removed: a dry crust and scurf, covering the hard and thickened skin even of an adult, must necessarily be productive of the double mischief of excoriating the cuticle, and obstructing the matter of perspiration: how much more then must this double mischief be augmented, when applied to the soft and tender cuticle of an infant: how extensively must its delicate skin become inflamed by such harsh and perpetual pressure; how continually exposed to cutaneous eruptions, from the acrimonious humour into which its obstructed matter of perspiration will be converted by this very obstruction itself.

Let us close by observing, that wherever this kind of tenacious covering is found, as it sometimes is, spread in an unusual quantity over the bodies of other animals, the mother of the young commonly removes it by washing and wiping it away with her own tongue and saliva, or by encouraging the new born animal to roll itself on the grass or straw, or whatever other substance may be the bed that first receives it: thus teaching to mankind a lesson of cleanliness, which, instead of despising, they will do well to follow. Cleanliness, indeed, from the commencement of life to its termination, may truly be said to be next to godliness; its influence upon the mind is equal to that upon the body. The pleasurable sensation it excites is of no ordinary character; it is a powerful prophylactic against disease; it exhilarates the animal spirits, and gives a feeling of moral dignity to the meanest and most indigent. A habit of cleanliness cannot be commenced too soon, nor persevered in too punctiliously.

The next point to be attended to in the treatment of infants, is that of lactation or suckling.

There is generally too much eagerness in putting the child to the breast, who is often worried to suck, before he becomes actuated by the instinctive principle of nature, or before the mother finds her breasts sufficiently filled with milk to satisfy his desire. In consequence of which the mother is as much and as vainly fatigued as the infant, passes a restless night, and is harassed with a renewal of after pains, from which she would otherwise have escaped.

It is generally about the third day, after child-bed, that both are fully prepared; though it sometimes happens that the infant has a desire to suck, and the mother to suckle, within twenty-four hours from the time of delivery. While again the same mutual propensity will not in other cases occur till a week or a fortnight, or even longer, from the same period. In the latter case the infant should be supported by dilute gruel, a dilute solution of tops and bottoms, with or without a little cow's milk, according as he seems best to relish it; and if he appear in good health, no idea should be entertained of providing a wet nurse, till time has fully demonstrated that the mother will be incapable of supporting him herself.

This maternal support is a duty so imperative, that it should only be relinquished under the following circumstances: 1. Suppression of milk. 2. Extreme delicacy, or disease of constitution, by which it may not be supplied in proper quantity or quality. 3. The indulgence in such a routine of fashionable amusements, as may render the mother incapable of fulfilling her task with punctuality and satisfaction to her child.

This last conduct is unpardonable, but it is nevertheless common, and we are afraid will be so in the present day, notwithstanding all that can be urged to the contrary, whether by divines or physicians; and all that we attempt to do is to guard against the mischievous effects of such a conduct: for if, in this respect, the mother remains deaf to the voice of nature, and the languishing desire of her own offspring, we are fully convinced that all we, or any other body of physiologists, could urge, would be in vain; neither would she be persuaded though one rose from the dead. We will just observe, however, that the practice of repelling milk from a full breast is at times dangerous, and often accompanied with abscesses, that are more inconvenient, last longer in the cure, and are succeeded by far more injury to the polish and harmony of the form, than the suckling a large family

Let us add another reason; the human body is so constituted, that one part assists another in the operations of nature: consequently there is a necessity for reciprocal action and rest. Whilst the womb, lately in a state of distention for many months, is thus allowed rest sufficient, it recovers its former tone. Whereas, where there is an annual repetition of pregnancy, the parts so distended sooner lose their elasticity, and become at length, perhaps, diseased, which especially happens in cases where the original habit has been weakly.

The following is a reason that concerns the public, whatever influence it may have on the gay and the careless. The hired nurse, anxious to save as much as possible from her own wages, not only weans her own child, but puts him at board on the cheapest terms she can find; in consequence of which, innutrition, or poverty of food, too generally terminates his life, or leaves him habitually diseased, a permanent burden on his parents, and on the public.

Hireling nurses, however, under all the cases we have mentioned, must be resorted to, when the person is in a situation to endure the expense. The young and the healthy should be selected, with a full breast of milk, and that milk as nearly as may be of the age of the foster child. Where the circumstances of the parents, or the infant's own antipathy, which sometimes occurs, or any other equally insurmountable objection intervenes, the next consideration is to provide a substitute for the child's natural diet.

From the experiments of physicians on milks we have the following results.

Of cream, the milk of sheep affords most; then the human, the goat's, the cow's, the ass's, and the mare's, progressively.

Of butter, the sheep's affords most; then the goat's, the cow's, and human, progressively.

Of cheese, the sheep's gives most; then the goat's, the cow's, the ass, and human milk, the mare's gives the least.

Of sugar, most is extracted from the mare's milk; then from the human, the ass's, the goat's, the sheep's and last of all, the cow's.

It should hence seem that human milk has more saccharine matter than any other milk, excepting mare's; more cream than any other excepting sheep's, and at the same time that it yields less butter or cheese than any, excepting mare's It appears, moreover, from the experiments of other animal chemists, that the butter of human milk, instead of being solid like that of the goat and cow, is a fluid of the subsistence of cream, and cream which is nearly the consistency of that obtained from ass's and mare's milk.

It follows, that upon the whole, mare's and ass's milks have a nearer resemblance to human, than the milk of any other animal that has undergone a proper course of experiments: and that in case of extreme debility of the organs of digestion, mare's or ass's milk is the best substitute for that of human milk.

Let these therefore in cases of debility be resorted to: but in cases of health, and especially of good substantive organs, we may be less particular. Diluted cow's milk, intermixed with a small quantity of farinaceous food, will generally prove the most convenient nutriment. Cow's milk, however, is far less sweet, or has far less saccharine matter than human, and hence the mixture now recommended should be enriched with some addition of sugar. The chief point of attention is, that the farinaceous matter, whether in the form of pap, or gruel, be sufficiently dilute, and free from lumps. It is a difficult thing to make nurses believe that fluid food alone can produce solid nutriment, notwithstanding the example daily before them of the beneficial result of maternal milk; and hence it is almost impossible to prevent them from making the infant food too thick and pulpy. Where rusks, or tops and bottoms, are used, they should be first boiled in water till perfectly softened, and then pressed with a spoon through a fine strainer; nor should pap or gruel be ever made use of without a similar process. Cordials, aperients, and opiates, should be equally avoided in a state of health. They are all medicines, and should never be employed but when called for by disease; nature, in her ordinary functions, demands nothing of the kind: the food prepared by herself is equally bland and simple.

In the clothing of children, warmth and simplicity are the two points to be studied.

The great and natural use of clothes is for the purpose of warmth, and the looser and softer the substance is by which this warmth is communicated, the better. But, amongst other refinements, that of giving neatness to the attire of children has been one productive of very great evils. To brace and dress an infant forms a particular business, and thus the real intention of clothing has been lost sight of. Besides their tightness, children are also often hurt by their quantity. After birth, a child is in a sort of feverish state during the first five or six days; it should, therefore, be kept cool, instead of being laid close to the mother, who is commonly in the same state, and fed, as both too frequently are, with heating cordials, which add to their uneasiness.

Most of the deformities of children are occasioned by improprieties in their dress. An attempt to give neatness to the form renders pressure necessary; and where a part is weak, and the pressure greater than on the neighbouring parts, such part will naturally yield to the impulse, and deformity will ensue. Without entering therefore into any criticism on the particular kinds of dress, all that is required is, that the child be kept warm, and the dress sit easy on every part.

Sleep is at all times necessary to health; in infancy it is particularly so; for the stimuli of air and light alone are sufficient to exhaust the system in an hour or two. Yet order is one of the first laws of nature; and habit is its best foundation. After the first few days, therefore, of mere introduction to a new world, and a new mode of existence, the periods of sleep should submit to some degree of regulation. An infant thatisallowed to sleep through nearly the whole of the day, will usually be a very troublesome companion to its mother through the whole of the night. It has had more than a sufficiency of rest, and cannot be made to sleep, till it again becomes tired and exhausted. Then comes the nurse, with her nostrums and her lullabies; her cradle, her cordials, and her anodynes. The whole are useless in a state of health, and many of them most pernicious. The fault is all her own; it proceeds alone from a want of regular periods of sleep and wakefulness.

The situation of children requires at first air of a moderately warm temperature; after which they may be gradually inured to a colder atmosphere, without any danger to their health. Too much warmth, however, is as prejudicial as the opposite extreme, and the more to be dreaded, as every time they are brought to the open air they are exposed to the danger of catching cold. But it is not merely a cold air that is to be avoided, it is air that is confined, and at the same time loaded with moisture. A confined damp air is the cause of many of the diseases by which children are afflicted; and to this state of the atmosphere the children of the poorer classes are particularly exposed. Too much caution cannot be used by parents in superintending this part of the treatment of their offspring. When sent abroad, under the care of servants, they are often kept too long exposed to the inclemencies of the weather, and frequently allowed to sit or lie on the damp ground; or they are kept carelessly in the arms of a servant, exposed to a current of air, the consequnce of which, when brought from the confinement of a warm room, must be mischievous. To avoid the danger of cold, then, much attention should be paid to the dress, and not allow the period of their exposure to be too long at a time. They should, however, be carried out at least once a day, when the weather permits, and that generally about mid-day, and, if possible, into fields, or squares, or other exposed situations.

The same caution that is necessary in carrying them out should be applied to the conduct within doors. The nursery should be the largest and best aired room in the house. When children sleep in a cradle, they should not be wrapped up too closely, particularly so, as they are usually laid in with their clothes on. Neither when they are further grown should more than one child sleep in the same bed. In short, the proper regulation is, to keep the child as much as possible in one pure, equal temperature, avoiding every thing that is damp and unwholesome; and, if this equality of atmosphere cannot be preserved in our own country, to take care at least, that the transitions from heat to cold be not made too suddenly; by which attention, all the evils arising from this source will be avoided.

Exercise is natural to man, and the desire of it is coeval with existence; nay, it may be said to precede it; for the motions of the child in the womb show, that it is with difficulty retained in a passive state. Infants, therefore, ought never to be at rest but when alseep, and this motion is of the first importance; it will atone for several defects in nursing, and is absolutely necessary for the health, strength, and growth of children.

The first exercise that children usually receive, and which they ought to receive, is that of being dandled in the arm, or moved gently up and down, which tends much to assist digestion. Rubbing them with the hand is also highly useful at this period of life, particularly along the back-bone, which occasions the child to stretch itself, and to exhibit different signs of muscular exertion, expressive of the satisfaction it receives.

As children increase in growth, their exercise should be proportionally augmented, and the nurse should endeavour to give them as much motion with her arm as possible. A proper nurse knows the method of doing this, and requires no specific directions.

As soon as a child is able to be put on its feet, it should be allowed to make use of them. Every member acquires strength in proportion as it is exercised; and children, by being accustomed to support themselves, will soon acquire strength for the purpose. Children also begin to use their feet by degrees, and by this gradual attempt, all the dangers hinted at by writers, of their legs becoming crooked, or unable to support the body, are avoided.

Among the poorer classes, it is very common to allow children to sit or lie in one posture for a length of time: this is a practice much to be condemned. By the want of exercise, the health of children suffers, a relaxation of the system ensues, and rickets and other diseases are induced. The constitution of man evidently shows him at all times designed for exercise; and the regular circulation of the fluids cannot proceed without its assistance. Arguments, indeed, may be drawn from the structure of every part of the animal economy of man; and, where exercise is neglected, none of the animal functions can be duly executed, and the constitution, in general, therefore, must soon be seriously affected.

The early and rigorous confinement of children at day-schools merits to be particularly reprobated. To prevent trouble to the parent, the infant is often sent to school, perhaps for seven or eight hours on a stretch, at a period of life when it can learn little or nothing, and when its time would be more properly spent in exercises or diversions. Nor does the mind suffer less from this evil than the body. The fixing it to one object so prematurely, provided it can really be made to learn any thing at all, not only weakens the faculties, but is apt to produce an aversion, on the part of the child, to study at that time of life when study would be useful. Even the immuring such a number of children in a confined room, as we often meet with in little day-schools, by vitiating the atmosphere, and corrupting the air, must lay the seeds of disease, and not unfrequently occasion infection. If sent early to school, the time of learning should never be long, and should be alternated with proper diversions and exercises suited to their period of life.

The only argument in favour of an early education is, the advantage of an early entrance of children into the world, and of their being able to provide for themselves. That this may be proper in one respect, and in certain classes of society, we shall readily admit; but if the constitution be to be ruined at an early period, twice as much will be lost as gained by this deceitful system. The truth of such a remark is strongly confirmed by what we every day observe in manufacturing towns, where life is seldom protracted beyond its middle age, and little enjoyed, even if it should be, from the sickly constitution entailed on its possessor by this early industry.

Even exercise within doors is not sufficient to effect the good purposes derived from it in the open air, particularly in a country situation, where the various exhalations and fragrances of the surrounding scenery add usually to the salubrity of the employment. Children, instead of being checked in regard of wholesome play, should be at all times encouraged in it. This advice is particularly necessary in respect to girls, who are, in general, too much confined by their injudicious mothers, and thus are not only weak and debilitated in their general habit, but acquire most of those diseases peculiar to their sex. No injury can take place from suffering them to run about, without unnecessary restraint. Dancing, if not carried to excess, is of excellent service to young persons; it cheers the spirits, promotes perspiration, strengthens the limbs, and at the same time gives a much better grace to the person, than a constant employment at needle-work, or even an acquisition of the general and various accomplishments that constitute modern female educations; which, however, would by no means be impeded by giving scope to exercise.

A popular writer well observess, that

"an effeminate education will infallibly spoil the best constitution, and if boys are brought up in a more delicate manner than even girls ought to be, they will never be men." The same author, with great justice, applauds the practice, of late introduced, of teaching boys the military exercise, as not only an admirable mean of strengthening their body and limbs, but of inspiring them with early ideas of courage, and educating them so that they may, at a future period, be ready and able to defend their country in case of emergency.

To uniform exercise, add the use of the cold bath: it will prove an admirable auxiliary, and may be even a substitute for exercise where it cannot be duly obtained; and if the salt-water bath can be had, it is certainly preferable. By general immersion, the body is braced and strengthened, the general circulation increased, and all stagnation in the smaller vessels prevented. The commencement of this practice early will be the means of preventing the appearance of many constitutional diseases. It cannot be too much inculcated, and has been in use from time immemorial with those nations, who have been most distinguished for the enjoyment of health and vigour of constitution. No prejudices, therefore, of the mother or nurse, should prevent the use of this salutary prophylactic; and even where it cannot be employed to its full extent, still the extremities should be every day bathed in cold water, and afterwards well dried, and the skin well rubbed. In this view, boys, instead of being prevented by their fond and fearful mothers, should, on every account, be encouraged to learn and practise the salubrious and useful exercise of swimming.

Diseases of Infants.

The diseases of infantile life are very numerous, and some of them very complicated. It would be absurd to attempt a discussion of the whole of these within the limits of a narrow, and what is merely designed as a popular, essay. We shall confine ourselves, therefore, to those alone, which are more common or more manageable, and a general knowledge of the nature of which may enable the mother to co-operate with the intention of the medical practitioner, whom she may find it expedient to consult. These we shall arrange under the heads syncope; retention of meconium; jaundice; costiveness; looseness; acidity, and flatulence; thrush; cutaneous eruptions; dentition; convulsions; and rickets, For the rest, we must refer the reader to their regular classification, under the article Medicine.

The process of birth is, at times, attended with difficulty and danger, and especially exhaustion to the child, as well as to the mother: and as the latter, upon delivery, experiences occasionally syncope, or fainting, so does the former not unfrequently: its life, when first born, appears feeble and uncertain, and the only proof of animation is derived from the pulsation of the navel-string. Generally the infant soon recovers from this state, and without relapse. But at times the syncope continues four hours; the infant gasps faintly, and then evinces no sensible appearance of respiration for ten minutes, or even longer; occasionally the face is languid and pale, but sometimes suffused with blood: this attack may also repeatedly recur.

The only remedies here are gentle stimulants and cordials. The nostrils and temples, as well as the hands and feet, may be rubbed with a little volatile salt, and as soon as swallowing is practicable, a little wine may be administered, containing a few drops of volatile tincture of valerian. These remedies may be repeated every two or three hours till recovery take place: after which, stools should be obtained by means of a clyster, or a tea-spoonful of castor oil.

The name of meconium is given to the first contents of the bowels of children, consisting of a black, pitchy matter, highly tenacious. This usually passes away within a day or two after birth, and if retained beyond this period, proves the source of very troublesome complaints.—This substance, it is clear, whatever be its cause or intention, is no longer useful after the child is born, and should be discharged as soon as possible; to which, from its own irritating nature, there is constantly a tendency. But, in certain cases, from the torpor of the bowels, or its own unusually viscid or clammy state, this discharge is delayed, and irritation, pain, and griping ensue. If the first milk, therefore, do not prove laxative, and bring it away, a tea-spoonful of castor oil should be given once, or oftener, till the bowels be disburdened, and the symptoms of uneasiness entirely cease.

It has been common, indeed, even at birth, antecedently to its discharge, to administer a gentle laxative for this purpose; nor can there be any objection to that practice, however reprobated by some physicians. A little syrup of roses will generally be sufficient; or, in the country, a little fresh whey and honey.—Should a stronger laxative be required, then the castor oil may be recommended, or a watery infusion of rhubarb cannot fail to answer the effect. But should they be slow in producing the ease and freedom from pain for which they are intended, and no stools have been procured for twelve or fourteen hours after birth, a clyster may be thrown up, and repeated at the distance of a few hours, which will answer every purpose, and the discharge once begun, and the bowels brought into action, the meconium will gradually pass off, for several days, without any further trouble.

Jaundice is a disease to which infants, at birth, are very subject, and may be said to take place always to a certain degree. It is easily known by the tinge of the skin, and more particularly the saffron hue of the eye. The nails, however, are not here coloured, as with adults; but the yellowness of the complexion gradually increases, as in other cases.

This disorder is evidently the effect of a viscid matter obstructing the gall ducts; in order to remove which, a gentle emetic is required. That generally preferred, is the tartarised wine of antimony, in the dose of a single drop or two; and it has the advantage of also passing downwards. In giving vomits, however, at this period, there is often much danger, and instead of the tartarised antimony, which is rather uncertain in its operation, three or four grains of ipecacuanha will be safer, which should be followed the next day with the same quantity of rhubarb. Where the symptoms do not seem to yield, the same plan should be continued every other day, till the yellowness begin to disappear, which it generally does in about a week. In this complaint, the mere opening the bowels does not seem entirely sufficient to remove the colour of the skin. Even at times, along with the former treatment, some addition of saponaceous or soapy medicines becomes necessary, as two or three drops of prepared kali; while, to assist its operation, both the warm bath and friction of the stomach may be conjoined.

On this subject it may be farther observed, that no tinge is communicated to the child from the mother, though she have been afflicted with the disease during pregnancy; but at the same time, if it continue with her after her delivery, and she suckle her child, the true jaundice will be communicated to the infant, and the disease remain, till it be either weaned or the mother recover.

There are few infants, even under the most favourable circumstances of management, that will reach the termination of the first six, or even the first three months, without some morbid affection of the bowels. The diseases of this tribe are, chiefly, costiveness, looseness, acidity, and flatulence.

Of these the first is not very frequent: it exists nevertheless occasionally, in a very great and even alarming degree; sometimes derived from the constitution of the mother, and sometimes as an idiopathic affection. In the former case we may be always under less apprehension; in the latter case the constipation is occasionally so severe, and accompanied with so much pain, and even spasm, as to threaten an inflammation of the bowels, if not speedily removed. As instantaneous applications, the best remedies are fomentations of hot water, or camomile decoction, to the belly; doses of calomel, from one to three grains, according to the age of the patient, given by the mouth, and injections of the common enematic decoction, with a little sweet oil, and a solution of neutral salt. This complaint usually proceeds from too rapid an absorption of the more fluid parts of the chyle, by the bibulous mouths of the lacteals, in consequence of which the part that remains is too compact and solid to be forced away by the common peristaltic action. This morbid activity of absorption should be next attended to, to prevent a recurrence of the disease; and occasional doses of rhubarb, alternating with castor oil, is perhaps the best method that can be pursued to obtain this object.

Looseness, or diarrhœa, is, however, a much more common complaint among infants than costiveness. It is often connected with vomiting; and both arise most frequently from one of these three causes; unwholesome food, moist cold air, or the sudden disappearance of some cutaneous eruption. From which ever of these it proceeds, it ought not to be hastily stopped; certainly not till the offensive matter, on which it depends, be totally removed. Where joined with a vomiting, an emetic ought to be the first step; after that the use of rhubarb and absorbents may be ventured on, and continued, with an occasional emetic, till the first passages be completely cleared of any irritation which may keep up the disease. If it continue after a sufficient perseverance in this plan, light cordials and opiates should be interposed. If the purging be connected with toothing, or attended with fever, though it continue obstinate, it requires much caution. For, in this case, so far from being a disease, it may, perhaps, be considered itself as a remedy, in preventing the occurrence of more dangerous symptoms. Keeping the discharge merely within bounds is the proper mode of proceeding, and the chalk julep will be the best remedy; when, the bowels being once cleared, and the irritation removed, the treatment will be much regulated by the appearance of the stools. These have been distinguished into sour, clayey, watery, bloody, and fetid.

The last kind, when it occurs, requires the use of a powerful purgative, such as senna-tea, if the child be old enough to bear it. Blood is seldom mixed with the stools but towards the end of the disease, and an occasional streak of it is of little consequence. Watery stools, where combined with greenness, or an appearance of curdled matter, are best removed by a gentle emetic, and a warm purge. Slimy stools, with an appearance of hiccup, should be treated with magnesia and other absorbents, warmed by the addition of a little grated nutmeg. White and clayey stools are best corrected by a drop or two of the water of kali, mixed with the preceding aperients. A soap clyster will likewise be useful, if the complaint be attended with much griping; nor is some light cordial to be withheld; and fomenting the belly with a little warm brandy, or a decoction of camomile-flowers and white poppy-heads, will be a great assistance to the other parts of the treatment.

Wherever purgative medicines are used for children, the form of compounding them is a material circumstance. They should always possess the addition of aromatics, especially those of the carminative kind, as a little ginger, pounded cardamum seeds, dill or aniseseed water. The pain is hereby relieved, the healthy action of the mouths of the lacteals renewed, and the morbid irritation of the secernments of the intestines diminished.

Improper food is the common cause of infantile diarrhœas: either an acetous fermentation is excited in the stomach, or the gastric juice is changed in its nature, and secretes an acid of its own. Other derangements of the bowels may proceed from the use of improper diet: but acidity from one or other of these causes is the common effect. The chief proof of acidity is in the green colour of the evacuations: these are at the same time usually accompanied with pain, and watery in their consistence. If the pain be extreme, the legs rigidly drawn up towards the belly, and the ejections small in quantity, but very frequent, and a mere watery discharge, or intermixed with slime or mucus alone, the disease is then called watery gripes. This, however, is a complaint of the lower and larger intestines rather than of the stomach or digestion itself, and of course evinces less proof of acidity, which is peculiarly dependent upon the stomach.

Acidity is also said to be evinced by the regurgitations of curdled milk; but this is not strictly correct. The milk of all animals is curdled, in a state of the most perfect health, before it becomes digested, or rather perhaps during the very process of digestion. We cannot now enter into the question, why this change should be necessary: it is enough to state it to be a fact, and to caution the mother against loading the stomach of her child with aperients or absorbent earths, merely because of such curdled regurgitations. The regurgitation is usually the simple effect of superabundance, and the curdled appearance a proof of healthy digestion. The stimulus of superabundance in infancy, as well as in the other stages of life, frequently excites hiccup; an affection peculiarly useful to infants, as the action hereby produced enables the stomach to discharge its contents, both through the mouth and into the duodenum. But if the regurgitated food be not only curdled, but evince an acid smell, and especially if the breath itself betray such a smell independently of regurgitation, we have then a sufficient proof of the existence of acidity in the stomach from one of the two causes now enumerated, and should apply ourselves to remedy it.

The first point is to get rid of the acid, or other irritating matter, that actually exists in the intestinal canal; and the second is to prevent the formation of fresh matter of the same kind. The former intention is best accomplished by aperients; and, of all aperients, by calomel, either alone, or in conjunction with small doses of rhubarb; the latter, by changing the nature of the morbid action of the secernments of the stomach or intestines, and recovering them to their accustomed secretions. This is best produced by gentle stimulants, as dill, aniseseed or cinnamon water, and especially sal volatile, of which two or three drops may be given at a dose, and which answers the double purpose of stimulant, and a corrector of acidity. If the former be employed, they should be combined with magnesia, chalk, or other absorbent earths, or the aromatic confection, which is an excellent preparation for this purpose.

The use of opiates, after the removal of the peccant matter, may often prove highly serviceable; but it requires a skill so delicate, and a judgment so practised, to determine the time, and apportion the dose, that we dare not recommend opium in any shape as a domestic medicine; it should be alone administered under the advice of a judicious practitioner.

Flatulence, or wind, is rather a symptom of disease than a disease in itself. It is an attendant upon all the complaints we have just noticed, and as it commenced, so it will terminate, with them. Yet, though a mere symptom, it is often found so troublesome, whatever be the disorder or state of the bowels on which it is dependent, as to require specific attention. And here, in conjunction with the tribe of cordial stimulants just enumerated, we would strenuously advise the application of warm, stimulating liniments to the belly, which should be rubbed over it with easy, but long repeated friction; for the friction of a warm hand alone is serviceable, and usually affords palpable relief even in a short time. If it do not yield to this plan, injections of a decoction of camomile flowers with a little ginger, or a few cardamum seeds, should conjoin, and be repeated daily. Here also, as in the case of simple acidity, the food should be changed, if the child be weaned: and even in extreme cases, if he be not weaned, provided there be sufficient suspicion that the milk of the nurse or mother, how well soever it may stand the test of examination, be the productive cause.

When diarrhœas proceed from a moist unwholesome atmosphere; or from a sudden suppression of any cutaneous eruption; it follows, without further instruction, that the only chance of removing the complaint is, in the first instance, by removing the child into a healthier atmosphere; and in the second, by exciting the skin to a new efflorescence.

Another disorder, and frequently a very serious one, originating from a deranged state of the first passages, is thrush. That it arises hence there can be no doubt, as it has been known to seize every infant in a family, in which mismanagement or a want of attention to them took place, from accidental causes; and to disappear as soon as the proper attention was resumed. It is evidently a disease of debility, connected with a predominant acidity, by the continuance of which the complaint is aggravated. It generally takes place in the first month, but may be entirely avoided under proper treatment.

This complaint first appears in the corners of the lips, spreading over the tongue and cheeks, in the form of little white specks. Increasing in number and size, they run more or less together, according to their malignancy, and compose a thin white crust, which at last extends over the whole inside of the mouth, from the lips to the gullet, and even the stomach itself, and reaches at times through the whole length of the intestines, producing a redness at the fundament. When this crust falls off, it is succeeded by others, often of a darker colour; and the same appearance successively recurs till the disease depart.

It is sometimes preceded by sleepiness for a week or two. It is commonly without fever, which only supervenes in its progress, in the same manner as hectic fever is produced in other cases, from the increasing debility of the system. Care should be taken that the child do not catch cold.

The chief source of this disease seems to be indigestion, from whatever cause it may be produced; and therefore bad milk, unwholesome food, or even weakness of the stomach itself, are sufficient to produce it. These causes evidently give rise to acrimony, which particularly affects the small glands of the membrane lining the stomach and bowels. Hence, on the principle of relaxation of these organs, a tea-spoonful of cold water, taken every morning, has been reckoned a useful preventive; and this joined with a due attention to the excretions, will often fully succeed.

The principle of cure in this disease is simple and plain. The state of the bowels is the cause; and in this state is, at the same time, attended with a certain degree of acrimony. The first step, therefore, is to open the bowels, where costiveness prevails, by means of any of the laxatives enumerated in the preceding diseases.

The antimonial wine has been particularly preferred by some physicians; and then correcting the acrimony by means of any of the testaceous or shell powders, or, which is better, common magnesia. Where the bowels are already in a loose state, instead of the above practice, as the child is generally weakly, two or three grains of the compound powder of contreyerva may be administered;

and as the disease declines a little rhubarb should be superadded, which will strengthen the bowels by its astringency and at the same time correct their acrimony. When the disorder is removed, the child's health will be restored by some tonic or strengthening remedies, as a tea-spoonful of camomile tea, or a few drops of the compound tincture of gentian, well diluted. These medicines should be given two or three times a day, the bowels kept regularly open, and the testaceous powder not entirely relinquished, but occasionally administered. Where the disease appears very malignant, instead of the bitters recommended, a decoction of the bark, with the aromatic confection, will be preferable.

In the use of absorbents, or testaceous powders, the dose cannot be precisely regulated, but must be increased or diminished according to the effects. Three or four grains may be given three or four times in the day: and when these medicines are employed, the diet of the nurse should also claim attention, and her usual quantity of malt liquor be diminished.

Besides this general treatment of thrush, it has been also common to make applications to the part, in order to hasten the exfoliation, or scaling, of the surface. Such applications, however, are highly improper, on the first attack of the disease, or till nature shows an actual disposition or tendency to this separation. By beginning with such applications too early, they only increase the soreness of the surface, and by rudely clearing it of the aphthous matter, give a deceitful appearance of amendment. It is proper, however, that the child's mouth should at all times be kept clean, particularly if much foulness prevail, and there be an appearance of thick sloughs. Of the several preparations that have been used for this purpose, borax has gained a decided preference; and it may be mixed up with sugar, in the proportion of one part of the former to seven of the latter. A small portion of this composition may be put on the child's tongue, which will dissolve and be conveyed to the other parts of the mouth; or it may be made up into a paste with honey, which is a better form. No violent rubbing of the parts affected should ever be allowed to take place, as it will both give unnecessary pain to the child, and extend the duration of the disease, by producing a new growth of the same morbid spots on the surface.

The skin and cuticle of infants is peculiarly delicate and irritable, and the action of the air alone upon them, whenever there is a change in the temperature of the atmosphere, is almost always, and sometimes altogether sufficient to produce efflorescences of some kind or other. Hence it is not to be wondered at, that they are subject to a variety of cutaneous eruptions or rashes.

The first eruption that is generally noticeable is the red-gum, or red-gown, as it was formerly called, and perhaps ought to be called still; the strophulus intertinctus of authors. It consists in a papulous efflorescence of small spots, confined to the face and neck; or in some cases extending to the hands and legs, and even the whole body, in the form of large patches. It sometimes appears in small pustules, filled with a limpid, purulent, or yellow liquor; and frequently turns dry and horny, and scales off without giving any further trouble. Another appearance it assumes is like small pin heads, of a pearl colour, and not transparent. Yet, whatever be its appearance, it is evidently the effect of intestinal acrimony, connected with the delicate state of the skin, and determination of the blood to wards it. Hence all that is wanted is an attention to the state of the bowels, and the use of testaceous powders in conjunction with cordials or antimonials; while the child should be kept moderately warm, that the eruption may not be suppressed.

It may be observed here, that the state of the bowels and skin have a sympathetic connexion, and the bowels, when disordered, are sensibly relieved by an appearance of eruption on the skin. Hence such eruptions, instead of being suddenly repelled, should rather be encouraged, and even, if disappearing, should be invited to return.

The next variety of rashes or papulous eruptions, worthy our attention, are those denominated milk-blotches, crusta lactea, or strophulus volaticus, by authors; some of whom, however, contend, that the eruptions under these names have a trifling difference from each other. It may be so; but the difference is not worth pointing out at present. It generally occurs in infants of an irritable skin, and appears most commonly on the forehead and the scalp, extending half-way over the face, in the form of large loose scabs. In the progress of the disorder, these scabs much resemble the smallpox when blackened, and at times continue to disfigure the child for several months. Though at last they assume this dark appearance, they begin as white vesicles, with a watery discharges, and great itching of the affected parts.

In this complaint, very little needs to be done. Where the case, however, is severe, an occasional drain by a blister between the shoulders, or behind the ears, will answer the good purpose of transferring, and consequently abating, the irritation and itching. The same effect will attend washing the parts with warm beer and butter, where the discharge is very hot and acrid; and the tar-ointment has been employed with equal benefit in the same view.

The duration of the complaint is generally judged of from the state of the urine: and where this discharge is turbid or fetid, the disorder is seldom of long continuance. It generally ceases when the child has cut a few teeth: should it, however, be obstinate, of which there are a few examples, the Harrowgate, or any other sulphureous water, natural, or artificial, will have a good effect.

This eruption has sometimes been improperly mistaken for the venereal disease; but its spontaneous disappearance is a proof that it has no sort of connection with siphilis of any kind.

The tooth-rash affords several varieties, all of which belong to the strophulus tribe, and rank under the strophulus confertus.

The first we shall enumerate is not altogether peculiar to this period. It much resembles the itch, and is most frequent in its appearance about the face and neck, though not exclusively confined to these parts. It has often, from its appearance, been mistaken for the real itch; but it differs so far, that it is of a most salutary tendency, and even sometimes critical in its nature, as preventing, at this juncture, serious effects to the child.

No particular treatment is necessary, except merely avoiding cold, and keeping the bowels soluble.

The next tooth-rash, at this period, is one that greatly resembles flea-bites, having a depressed point in the middle of the elevated spot. This disorder, in some instances, recurs, uniformly, just before the appearance of a tooth, and when cut disappears. Here, in respect to treatment, the same observation applies as in the former case.

A third species appears in the form of measles, and is often mistaken for them. Some degree of sickness generally precedes its appearance, but there is, at the same time, little or no fever. It usually continues very florid for a few days, and when disappearing, does not dry off like the measles.

The treatment here is very simple. The testaceous powders may be employed, with the addition of a little nitre and compound powder of contreyerva; and as the disease declines, a little rhubarb, or other laxative, may be given for a day or two.

A fourth species of tooth-rash is one, which, though appearing like the former, soon spreads into large spots, at first of a bright red, and afterwards of a darker hue, similar to the purple spots that appear in typhus fevers, though this be entirely of a different nature. Some fever generally attends the eruption, followed frequently by small round tumours on the legs, which, softening in a few days, seem as if inclined to suppurate, though this never takes place.

Like the former, the treatment is simple: and an attention to the state of the bowels is the only direction to be given. Should the tumours not easily subside, a decoction or injections of the bark may be found useful.

The next species of tooth-rash somewhat resembles the rash of scarlet fever, and is very rare. It is always preceded by sickness, fever, and a disordered state of the bowels; but these symptoms disappear as soon as the eruption is complete, which shows evidently its critical nature of preventing a train of worse maladies.

Such indeed is the variety in the tooth-rashes of children, that it would be almost endless to enumerate them; a variety, arising from differences of constitution, and other circumstances, with which we are unacquainted. But whenever an eruption appears at this period, the safest plan is, to consider it as connected with the effort of toothing. If our judgment be correct, the complaint will decay as soon as the tooth is protruded; and if it be not, its nature will be easily ascertained. By attending to the state of the bowels, as already pointed out, all danger of such eruptions will be avoided; and the more they are treated on the ground of being an effort of the constitution to relieve itself, by an increased action towards the surface, the more will the safety of the child be consulted. It is of consequence, therefore, in order to silence the clamours of nurses on this head, to point out, that no danger follows their appearance; that, on the contrary, the child is benefited by them; and that nature should be allowed to finish her own work.

Urticaria, or nettle-rash, is a papulous disease, which generally occurs to children under two years of age. In its appearance it is always sudden, and is often very troublesome. The child generally begins to scream before the cause of its illness is known, and, on examining its body and limbs, a resemblance so like the stinging of nettles is every where conspicuous, from which the disease has its name.

This complaint is generally preceded by a slight fever; some degree of sickness and pain in the head are also felt, particularly if the child have been exposed to cold.

The nettle-rash of children may be considered as a very simple disease, compared with that of adults. Its disappearance being often as sudden as its attack, it does not require that serious treatment necessary to more advanced age. When it seems obstinate, a few grains of the compound powder of contreyerva, or ipecacuanha, may be administered two or three times a day, with the addition of two or three drops of compound spirit of ammonia. In the mean time, the state of the bowels, as in other papulæ, will require proper attention.

But if the eruption be very general, and the weather somewhat cold, it may not be an improper precaution to confine the child a day or two to bed, so that there may be no danger of the rash being repelled.

The last variety of infantile rash we shall mention is, a phlyctenous or watery eruption, consisting of blisters of different sizes, somewhat like scalds or burns, which continue out several days, and attend both bowel-complaints and toothing. It seems of a beneficial nature. It is chiefly conspicuous on the belly, ribs and thighs. The vesicle or bag contains a sharp acrid liquor, which, where the bag is large, should be discharged by the puncture of a needle.

Little is here necessary in the way of treatment. The state of the bowels will entirely regulate what is to be done. If the child be costive, the laxatives already prescribed will answer every purpose, with the addition of the testaceous powders: and if the belly be loose, and the infant low and debilitated, then the light cordials, previously recommended, will be necessary.

One of the most critical periods of infancy, and to which the greatest attention ought to be paid, is that of toothing, or dentition. A continued irritation is kept up on the constitution, for a great length of time, whereby the latent seeds of disease of an hereditary nature are often unfolded, which might otherwise have lain dormant, and done, perhaps, no injury to the general health. Hence, cough, fever, rickets, and various forms of scrophula, may be traced, in their first appearance, from this period.

It has been observed, in judging of the ease or difficulty of dentition, that weakly and rickety children cut their teeth most readily. Many circumstances have an influence in this respect, as the number of teeth that protrude themselves at once, and the particular sort. Thus, where two or three teeth germinate at a time, the irritation on the gums must be much more considerable, than where there is only one; and there will be more difficulty in the protrusion of the large back-teeth than in the fore or eye-teeth, the surface or points of which are better armed for cutting.

It has also been observed, that infants cut their teeth more readily in winter than in summer; and that all children, who possess, naturally, a loose belly, suffer least from the complaints of this period.

The time of toothing generally commences between the fifth and tenth months, and the process of the first toothing continues till about eighteen or twenty months after birth. The usual number of the teeth at this time cut is sixteen. The process begins in the lower jaw, two of the front or middle teeth are usually first cut, which are followed by the two corresponding ones in the upper jaw; next, after some intermission, come the four adjoining teeth; then follow the two double-teeth, or grinders, at an interval of some weeks; then the teeth in the lower jaw, called canine or dog teeth; and lastly, the two corresponding ones in the upper jaw, called the eye-teeth. About the seventh year appears a new set of teeth, and about the twentieth, the two inner grinders, or wisdom-teeth, unless these, as sometimes happens, are protruded at the first toothing.

That the teeth of the lower jaw are most forward may be naturally expected, from their being less deep in the sockets, and their points thinner and sharper than the others.

Though this be the usual progress of protrusion in strong healthy children, yet in those more debilitated the progress is both slower and more irregular. Thus the teeth are in many first cut in the upper jaw, nor do the contiguous ones appear always at the same time. Wherever there is much pain and irritation at first, the same may be expected to recur, or continue, during the whole period of toothing.

The morbid symptoms that attend dentition are very numerous; they may be arranged as simply affecting the part, or as connected with the system in general.

Of the former, the usual appearances are, an increase of saliva discharged in the form of slaver. The gums are swelled, tense, and hot, while the cheeks display a circumscribed redness. Of the latter, or general symptoms, the most common are, cutaneous eruptions, particularly on the face and scalp; the state of the belly is irregular, though most commonly a looseness attends it, with stools of various colour and consistence. Considerable watchfulness prevails, and when the child procures sleep, it is interrupted by startings and spasms. The secretion of the urine is attended with the same irregularity; sometimes it is unduly increased, at other times diminished, and the appearance is equally varied, being either of a milky colour, or depositing a brownish sediment. Sometimes mucous matter is mixed with the urine, and where there is pain in making water, the irritation of the bladder is taken off by it as well as the general fever. In all cases the child is subject to shrieking-fits, and its fingers are often thrust into its mouth. The feet and hands are also occasionally known to swell, though it be by no means a frequent occurrence, and only takes place where the bowels are in a costive state. Transient numbness of the legs and arms is also an occasional, but not a frequent, affection at this time. When these general symptoms are long continued, and prove severe on the constitution, they are often succeeded by an affection of the lungs, with cough and difficult breathing, and the attack of convulsions, general fever, scrophula, and atrophy, or consumption. A more rare effect of them is the formation of water in the head.

Difficult toothing, as a species of inflammatory disease, is to be treated as such. Besides keeping the body open by gentle purgatives, as well as by clysters, especially where there is a retention of urine, the skin should be relaxed, and gentle sweats produced by diluting drinks, and also by administering small quantities of tartarised antimonial wine, or James's powders. A discharge should likewise be encouraged by a blistering-plaster behind the ears, or on the back; and on the first appearance of inflammation, a leech should be applied under each ear. A moderate looseness, being beneficial in toothing, should rather be encouraged than checked. In fevers, from this cause, from fifteen to twenty drops of spirits of hartshorn, in a spoonful of water, may be given to advantage every four hours, in five or six doses; and where costiveness does not prevent, three or four drops of laudanum may be added to each dose.

Rubbing the gums with a little fine honey three or four times a day, and giving the child a crust of bread, roll of liquorice-root, wax-candle, or coral, to indulge the disposition for chewing which then presents itself, will afford ease; but the only means to be depended on is, scarification with a lancet; which takes off the tension of the gums, with scarcely any pain, and gives almost instantaneous relief to the child. The finger nail, or a sharp-edged sixpence, are sometimes used for this little operation, but are clumsy substitutes; the lancet, in a proper hand, is infinitely preferable. Here, as in many other cases, from the nerve being braced by exercise in the open air, and the use of the cold bath, the dangers attendant on toothing will be much removed, and the child better able to support this painful and dangerous process, to which, and its concomitant disorders, so many children fall victims.

A frequent attendant upon dentition is convulsions. As this alarming symptom usually proceeds from the teeth cutting through the nervous membrane covering the jaw immediately under the gums, the scarification already recommended is not only useful to prevent this occurrence, but has, in many cases, saved the infant's life, after the most dangerous symptoms have taken place. It can never do harm, and may even be of service, though the fits should not proceed from toothing. Sometimes it will be necessary to repeat the lancing two or three times, which may always be done with perfect safety, and with almost certain success.

Lancing will also, in a great measure, prevent what is frequent in toothing, namely, ulcerated gums. When these take place, they should be touched with honey, rendered astringent and moderately rough by roch-allum and white vitriol, while the body is kept open.

We proceed to the very common complaint of convulsions; these are either symptomatic, produced by worms or dentition, or precursive of the measles, small-pox, or other eruptive fever; in which case, they are not necessarily to be regarded in an unfavourable view; or they are an original complaint, arising from a morbid affection of the brain, or nervous fluid. Whatever stimulates the nerves in an immoderate degree may induce convulsions, as may also an irritation of the stomach or bowels, which is certainly either the predisposing or immediate cause of most of the convulsions of children.

We have already mentioned, that, for some months after birth, children should be confined to breast milk. Where this is not the case, and the food is made too thick and pasty, convulsions are very frequent, from the indigestion which naturally ensues. The bowels are thus disordered by occasioning their contents to turn pasty, and cleave to their coats, so as to prevent the due adoption of the nutritious part of the aliment. Any offensive load, whether from the quality or quantity of food, excites a morbid secretion, and that this is a cause of convulsions may be known, from their being preceded by nausea, costiveness, or purging, pale countenance, swollen belly, and perturbed sleep. Repeated purges, particularly of castor-oil, or calomel, with some light cordial, will be necessary and useful. Veal tea, mixed with milk, is the best nutriment; and if all farinaceous food be avoided, the convulsions may often hereby, alone, be prevented from appearing.

The children of the poor are not unfrequently afflicted with convulsions from foul air, and want of cleanliness in their skin and dress, a most extensive source of disease.

In convulsions arising from the irritation or foulness of the stomach and bowels, these must be cleansed as already mentioned; after which, if they appear to continue, spasmodic remedies must be administered, such as spirit of hartshorn, tincture of castor, rectified oil of amber, or two or three drops of laudanum. Bathing the feet in warm water, and friction all over the body, with camphor liniment, are likewise very useful.

When convulsion is a primary disease, proceeding immediately from the brain, bleeding, blistering, and purging, are requisite; and also bathing the feet in warm water, friction of the legs, and rubbing the soles of the feet with the compound spirit of ammonia. In delicate children, chalybeate water may be useful; and where those of two or three years old are subject to slight and frequent fits, issues, or setons in the neck or between the shoulders, should be made, and kept open for a length of time.

Another, and the most serious, species of original convulsion, is attended with an unmeaning countenance, and constant stare and motion of the eyes, followed by a temporary deafness or blindness, and sometimes a loss of intellect. If water in the head be not suspected, and the common nervous medicines, with purges and blisters, have no effect, recourse must be had to repeated vomits, and bleeding with leeches; where the body continues in a good state, the water of prepared kali may be beneficial as a diuretic. Much benefit has also been derived from a free use of musk, whether by the mouth or in the form of injections. When this sort of convulsion attacks young children, it terminates very soon, and too often fatally, especially if connected with water in the head.

After all, alarming as convulsions are, they are by no means either so generally fatal or injurious to the system as is commonly believed. Their number is far over-stated in the bills of mortality; many children, in particular, being said to die under them, who are really the victims of other disorders. An immediate and proper application will seldom fail to relieve the child, and as this may be necessary before professional assistance can be obtained, mothers, and those who have the care of children, in such situations, should so far understand the subject, as to enable them to give the immediate aid required. With this view, in addition to what has already been said, we may observe, that where the irritation proceeds from the bowels, the readiest remedy will be a soap clyster, with two or more tea-spoonfuls of salt, and afterwards the purgatives, as before directed. But when the child falls suddenly into a convulsion, after sucking or feeding, and the bowels have been before regular, the irritation may be supposed to exist in the stomach; especially when there is an unusual paleness indicating sickness, or a considerable blackness, with an appearance of suffocation, symptoms which may arise either from an overloaded stomach, or a small piece of indigested food irritating, and perhaps plugging up the inferior aperture of the stomach. Here, without waiting for a regular emetic, some immediate means may be tried to produce vomiting, as irritating the gullet with the finger or a feather, or throwing in a little smoke of tobacco, if it be at hand; any of which will provoke instant vomiting, and, by relieving the stomach of the cause of oppression, put an end to the fit. This will be the better and more easily accomplished, if the child be in the mean time supported by a hand placed under its stomach and belly. In every case it is necessary to clear the bowels; and in most cases this is best accomplished by pretty brisk doses of calomel.

The next infantile disease we shall notice is hydrocephalus, or watery head.—This is divided into external and internal. In the former, which is a very rare occurrence, the fluid lies on the surface of the brain; in the latter, much deeper, and within the ventricles, which, from the mass of water they contain, are much distended, and often distend to a monstrous size the entire cranium.

External hydrocephalus, which sometimes appears immediately after birth, is a very distressing, and generally a very fatal disorder. A succession of blisters to different parts of the cranium offers the best chance of cure.

Internal hydrocephalus seldom takes place before two, or after ten or twelve years of age. It may proceed from external injuries, from schirrous tumours, and excrescences within the scull, from a watery state of the blood, a diminished secretion of urine, a suddenly checked perspiration, or some lingering disease; and there are not wanting instances of its being hereditary; or, perhaps, it may be oftener referred to scrophula than to any other cause.

In young children it frequently begins with cough, a quick pulse, difficult respiration, flushed cheeks, a discharge from the nose and eyes, with continual heat and costiveness. The child often puts its hand to its head; and, during sleep, picks its nose, and grinds its teeth; the eyes are impatient of light, the vision imperfect, the countenance unmeaning, the hands tumid, and the fingers clinched. The most decided symptoms, however, are an inclination to lie on the back, a dislike to be moved, an increase of pain on the head being raised, and an almost continual drowsiness.

Though generally fatal, there are many instances of cures being effected by medicines; of which, those most worthy trying are, stimulant embrocations, blisters applied to the head and neck, active purgatives and diuretics, with the external use of mercurial ointment. Strong sneezing powders, as white hellebore, or the compound powder of asarum, have often been recommended, as well as electricity; fox-glove, too, has been known to succeed, in conjunction, as it should, in this disease, always be given, with small doses of calomel. By the use of this conjoint plan, persevered in for a long time, and accompanied with frictions upon the scalp and spine of strong camphorated liniment, the writer of this article has seen many cases yield, which were pronounced by several practitioners altogether intractable.

The last infantile disorder we shall notice is that of rickets. These generally show themselves, whenever they occur, between six months and two years of age. Rickets are evidently a disease of debility, and hence, whatever tends to debilitate, predisposes the constitution to their attack. On this account they are often apt to arise from unhealthy parents, and especially mothers who pass a sedentary life, in unwholesome air, and feed on a weak and watery diet; or from an improper nursing of children themselves, especially from their being kept wet, dirty, in a close damp air, and without due exercise. Hence they are most common among the children of poor people in manufacturing towns, the disease having, in fact, never appeared in this country till manufactures began to flourish. Children begotten by men at a late period of life, or by those afflicted with the gout, gravel, or other chronic diseases, or who have suffered much from venereal complaints, are also very subject to rickets.

The disease first shows itself in a softness and flabbiness of the flesh; the child's countenance becomes bloated or very florid, the belly and head enlarged, and the body debilitated; the pulse is quick and feeble, and the appetite and digestion bad. The teeth frequently rot early and fall out; the wrists and ankles become unusually thick; the spine or back-bone assumes an unnatural shape; the breast is often deformed; and the bones of the arms and legs grow crooked.

Weakness and relaxation being the cause of this disorder, its remedy must, of course, consist in promoting digestion, and in bracing and strengthening the solids. Hence nourishing, and especially animal food, with a little port wine, is the proper diet. Air and exercise are indispensably necessary; the cold bath, and, if possible, of salt-water, will be of essential service, especially in summer; but it should not be entered on without previous purging. Frictions afterwards, with flannel and aromatic powders, or liniments, or the fumes of frankincense, mastic, or amber, especially on the back and belly, will contribute to strengthen the habit. Bark, columbo, steel, and tincture of myrrh, are also to be recommended, where they can be employed. If the child be of a gross habit, gentle emetics, with warm and active aperients, will be of use; it being necessary to reduce the tympanum of the belly, and to strengthen the action of the intestinal canal. Though this complaint be seldom suddenly vanquished, yet, by attention to regimen, and particularly to air and exercise, in conjunction with the medical plan now prescribed, it will generally be overpowered by degrees.

INFANT. From the observations daily made on the actions of infants, as to their arriving at discretion, the law and customs of every country have fixed upon particular periods, on which they are presumed capable of acting with reason and discretion; in our law the full age of man or woman is twenty-one years. The ages of male and female are different for different purposes: a male at twelve years of age may take the oath of allegiance; at fourteen, is of years of discretion, and therefore may consent or disagree to marriage, may choose his guardian, and if his discretion be actually proved, may make his testament of his personal estate; at seventeen may be a procurator, or an executor; and at twenty-one is at his own disposal, and may alien his lands, goods, and chattels. A female at seven years of age may be betrothed or given in marriage; at nine, is entitled to dower: and at twelve, is of years of maturity, and therefore may consent or disagree to marriage, and, if proved to have sufficient discretion, may bequeath her personal estate; at fourteen is at years of legal discretion, and may choose a guardian; at seventeen may be executrix; and at twenty-one, may dispose of herself and her lands. An infant is capable of inheriting, for the law presumes him capable of property; also an infant may purchase, because it is intended for his benefit, and the freehold is in him till he disagree thereto, because an agreement is presumed, it being for his benefit: and because the freehold cannot be in the grantor contrary to his own act, nor can be in abeyance, for then a stranger would not know against whom to demand his right; and if at his full age the infant agree to the purchase, he cannot afterwards avoid it; but if he die during his minority, his heirs may avoid it; for they shall not be bound by the contracts of a person, who wanted capacity to contract. As to infants being witnesses, there seems to be no fixed time at which children are excluded from giving evidence; but it will depend in a great measure, on the sense and understanding of the children, as it shall appear on examination in court.

An infant is not bound by his contract to deliver a thing; so if one deliver goods to an infant upon a contract, &c., knowing him to be an infant, he shall not be chargeable in trover and conversion, or any other action, for them; for the infant is not capable of any contract but for necessaries; therefore such delivery is a gift to the infant; but if an infant, without any contract, wilfully take away the goods of another, trover lies against him. Also, it is said, that if he take the goods under pretence that he is of full age, trover lies, because it is a wilful and fraudulent trespass. Infants are disabled from contracting for any thing but necessaries for their person, suitable to their degree and quality, and what is necessary must be left to the jury.

An infant, knowing of a fraud, shall be as much bound as if of age. But it is held, that this rule is confined to such acts only as are voidable, and that a warrant of attorney, given by an infant, being absolutely void, the court will not confirm it, though the infant appeared to have given it, knowing it was not good, and for the purpose of collusion.

As to acts of infants being void, or only voidable, there is a difference between an actual delivery of the thing contracted for, and a bare agreement to deliver it; the first is voidable, but the last absolutely void. As necessaries for an infant's wife are necessaries for him, he is chargeable for them, unless provided before marriage; in which case he is not answerable, though she wore them afterward. An infant is also liable for the nursing of his lawful child. Where goods are furnished to the son, he is himself liable, if they be necessaries. If tradesmen deal with him, and he undertakes to pay them, they must resort to him for payment; but if they furnished the infant on the credit of his father, the father only is liable. With respect to education, &c. infants may be charged, where the credit was given, *bona fide*, to them. But where the infant is under the parents' power, and living in the house with them, he shall not be liable even for necessaries.

If a tailor trust a young man under age for clothes, to an extravagant degree, he cannot recover; and he is bound to know whether he deals at the same time with any other tailor.

A promissory note given by an infant for board and lodging, and for teaching him a trade, is valid, and an action will lie for the money. And debts contracted during infancy are good considerations to support a promise made, when a person is of full age to pay them; but the promise must be express. A bond, without a penalty, for necessaries, will bind an infant; but not a bond with a penalty. Legacies to infants cannot be paid either to them or their parents. An infant cannot be a juror, neither can he be an attorney, bailiff, factor, or receiver.

By the custom of London, an infant unmarried and above the age of fourteen, if under twenty-one, may bind himself apprentice to a freeman of London, by indenture, with proper covenants, which covenants, by the custom of London, will be as binding as if of age.

If an infant draw a bill of exchange, yet he shall not be liable on the custom of merchants, but he may plead infancy, in the same manner as he may to any other contract.

An action on an account stated will not lie against an infant, though it be for necessaries.

INFANTRY, in military affairs, denotes the whole body of foot soldiers.

INFINITE, that which has neither beginning nor end: in which sense God alone is infinite. See God.

Infinite, or Infinitely, *great line*, in geometry, denotes only an indefinite or indeterminate line, to which no certain bounds, or limits, are prescribed.

Infinite *quantities*. The very idea of magnitudes infinitely great, or such as exceed any assignable quantities, does include a negation of limits: yet, if we nearly examine this notion, we shall find that such magnitudes are not equal among themselves, but that there are really, besides infinite length and infinite area, three several sorts of infinite solidity; all of which are *quantitates sui generis*, and that those of each species are in given proportions.

Infinite length, or a line infinitely long, is to be considered either as beginning at a point, and so infinitely extended one way, or else both ways from the same point; in which case the one, which is a beginning infinity, is the one half of the whole, which is the sum of the beginning and ceasing infinity; or, as may be said of infinity, *a parte ante* and *a parte post*, which is analogous to eternity in time and duration, in which there is always as much to follow as is past, from any point or moment of time: nor doth the addition or subduction of finite length, or space of time, alter the case either in infinity or eternity, since both the one or the other cannot be any part of the whole. As to infinite surface, or area, any right line, infinitely extended both ways on an infinite plane, does divide that infinite plane into equal parts, the one to the right, and the other to the left of the said line; but if from any point, in such a plane, two right lines be infinitely extended, so as to make an angle, the infinite area, intercepted between those infinite right lines, is to the whole infinite plane as the arch of a circle, on the point of concourse of those lines as a centre, intercepted between the said lines, is to the circumference of the circle; or, as the degrees of the angle to the three hundred and sixty degrees of a circle: for example, right lines meeting at a right angle do include, on an infinite plane, a quarter part of the whole infinite area of such a plane.

But if two parallel infinite lines be supposed drawn on such an infinite plane, the area intercepted between them will be likewise infinite; but at the same time will be infinitely less than that space, which is intercepted between two infinite lines that are inclined, though with never so small an angle; for that, in the one case, the given finite distance of the parallel lines diminishes the infinity in one degree of dimension; whereas in a sector, there is infinity in both dimensions: and consequently the quantities are the one infinitely greater than the other, and there is no proportion between them.

From the same consideration arise the three several species of infinite space or solidity; for a parallelopiped, or a cylinder, infinitely long, is greater than any finite magnitude, how great soever; and all such solids, supposed to be formed on given bases, are as those bases in proportion to one another. But if two of these three dimensions are wanting, as in the space intercepted between two parallel planes infinitely extended, and at a finite distance, or, with infinite length and breadth, with a finite thickness, all such solids shall be as the given finite distances one to another; but these quantities, though infinitely greater than the other, are yet infinitely less than any of those wherein all the three dimensions are infinite. Such are the spaces intercepted between two inclined planes infinitely extended; the space intercepted by the surface of a cone, or the sides of a pyramid, likewise infinitely continued, &c. of all which, notwithstanding the proportions one to another, and to the τὸ πᾶν, or vast abyss of infinite space (wherein is the locus of all things that are or can be; or to the solid of infinite length, breadth and thickness, taken all manner of ways) are easily assignable; for the space between two planes is to the whole as the angle of those planes to the three hundred and sixty degrees of the circle. As for cones and pyramids, they are as the spherical surface intercepted by them is to the surface of the sphere, and therefore cones are as the versed sines of half their angles to the diameter of the circle: these three sorts of infinite quantity are analogous to a line, surface, and solid; and, after the same manner, cannot be compared, or have no proportion the one to the other.

INFINITESIMALS, among mathematicians, are defined to be infinitely small quantities. In the method of infinitesimals, the element, by which any quantity increases or decreases, is supposed to be infinitely small, and is generally expressed by two or more terms, some of which are infinitely less than the rest, which being neglected as of no importance, the remaining terms form what is called the difference of the proposed quantity. The terms that are neglected in this manner, as infinitely less than the other terms of the element, are the very same which arise in consequence of the acceleration, or retardation, of the generating motion, during the infinitely small time in which the element is generated: so that the remaining terms express the elements that would have been produced in that time, if the generating motion had continued uniform: therefore those differences are accurately in the same ratio to each other as the generating motions or fluxions. And hence, though in this method infinitesimal parts of the elements are neglected, the conclusions are accurately true, without even an infinitely small error, and agree precisely with those that are deduced by the method by fluxions.

In order to render the application of this method easy, some analogous principles are admitted, as that the infinitely small elements of a curve are right lines, or that a curve is a polygon of an infinite number of sides, which, being produced, give the tangents of the curve; and by their inclination to each other measure the curvature. This is as if we should suppose, when the base flows uniformly, the ordinate flows with a motion which is uniform for every infinitely small part of time, and increases or decreases by infinitely small differences at the end of every such time.

But however convenient this principle may be, it must be applied with caution and art on various occasions. It is usual, therefore, in many cases, to resolve the element of the curve into two or more infinitely small right lines; and sometimes it is necessary, if we would avoid error, to resolve it into an infinite number of such right lines, which are infinitesimals of the second order. In general, it is a postulatum in this method, that we may descend to the infinitesimals of any order whatever, as we find it necessary; by which means, any error that might arise in the application of it may be discovered and corrected by a proper use of this method itself. See Maclaurin's Fluxions.

INFLAMMATION. See MEDICINE and SURGERY.

INFLAMMATION, in chemistry, is combustion attended with flame: under the article COMBUSTION, we have referred to the spontaneous inflammation of certain bodies, in peculiar circumstances, and likewise to the combustion of living individuals in the human species. We shall in this place mention some of the causes of spontaneous inflammation. The heat produced by friction; the slacking of lime when in contact with combustible matter; the fermentation of hay, dunghills, &c. are well known. Many vegetable substances, highly dried and heaped together, will heat, scorch, and at last burst in a flame. A mixture of linseed, or rape oil, with almost any dry vegetable fibre, as hemp, cotton, matting, &c. and still more if united to certain carbonaceous matters, will in time, if in a warm place, burst out into a flame. To this circumstance many alarming and destructive fires are to be imputed, which at the time were supposed to have been occasioned by wilful crime. In 1781 a large magazine of hemp was destroyed, in this way, at Constradt: and in the summer of 1794 an accident of this sort happened at Gainsborough, with a bale of yarn accidentally soaked in rape oil, which, after remaining in the warehouse for several days, began to smoke, and finally to burst out into a most violent flame. A similar accident happened at Bombay. A bottle of linseed oil had been thrown down in the night, the oil had penetrated into a chest of coarse cotton cloth, and in the morning the cloth was found reduced nearly to a cinder, and the wood of the chest completely charred in the inside. An experiment was immediately made to ascertain the true cause: a piece of the same cloth was dipped in the same sort of oil, and shut up in a box, and in three hours it was found scorching hot, and on opening the box it burst into a flame. Hence the spontaneous combustion of wool, or woollen yarn, which has sometimes happened when large quantities have been kept in heaps without the access of fresh air. The oil with which it is dressed seems to be the chief cause of combustion. Wheaten flour and charcoal reduced to powder, and heated in large quantities, have been known to take fire spontaneously.

The cases of the spontaneous human combustion have never been satisfactorily accounted for; the facts themselves seem to be well authenticated; two are recorded in the Philosophical Transactions, and referred to under COMBUSTION. They ought, however, to hold out a lesson of warning to those habitually given to excess with regard to spirituous liquors; for, in every case, the subjects of this terrible calamity were drunkards, whose favourite liquor was alcohol, in the shape of brandy, gin, &c.

INFLECTION, or *point of inflection*, in the higher geometry, is the point where a curve begins to bend a contrary way.—See FLEXURE.

There are various ways of finding the point of inflection; but the following seems to be the most simple. From the nature of curvature it is evident, that while a curve is concave towards an axis, the fluxion of the ordinate decreases, or is in a decreasing ratio, with regard to the fluxion of the absciss; but, on the contrary, that the said fluxion increases, or is in an increasing ratio to the fluxion of the absciss, where the curve is convex towards the axis; and hence it follows that those two fluxions are in a constant ratio at the point of inflection, where the curve is neither concave nor convex. That is, if $x =$ the absciss, and $y =$ the ordinate then $\dot{x}$ is to $\dot{y}$ in a constant ratio, or $\frac{\dot{x}}{\dot{y}}$ or $\frac{\dot{y}}{\dot{x}}$ is a constant quantity. But constant quantities have no fluxion, or their fluxion is equal to nothing; so that in this case the fluxion of $\frac{\dot{x}}{\dot{y}}$ or of $\frac{\dot{y}}{\dot{x}}$ is equal to nothing, And hence we have this general rule: *viz.* put the given equation of the curve into fluxions; from which equation of the fluxions find either $\frac{\dot{x}}{\dot{y}}$ or $\frac{\dot{y}}{\dot{x}}$; then take the fluxion of this ratio or fraction, and put it equal to 0 or nothing; and from this last equation find also the value of the same $\frac{\dot{x}}{\dot{y}}$ or $\frac{\dot{y}}{\dot{x}}$: then put this latter value equal to the former, which will be an equation, from whence, and the first given equation of the curve, x and y will be determined, being the absciss or ordinate answering to the point of inflection in the curve. Or, putting the fluxion of $\frac{\dot{x}}{\dot{y}}$ equal to 0, that is $\frac{\ddot{x}\dot{y} - \dot{x}\ddot{y}}{\dot{y}^2} = 0$, or $\ddot{x}\dot{y} - \dot{x}\ddot{y} = 0$, or $\ddot{x}\dot{y} = \dot{x}\ddot{y}$, or $\dot{x} : \dot{y} :: \ddot{x} : \ddot{y}$, that is, the second fluxions have the same ratio as the first fluxions, which is a constant ratio; and therefore if $\dot{x}$ be constant, or $\ddot{x} = 0$, then shall $\ddot{y}$ be $= 0$ also; which gives another rule, *viz.* take both the first and second fluxions of the given equation of the curve, in which make both $\ddot{x}$ and $\ddot{y} = 0$, and the resulting equations will determine the values of x and y, or absciss and ordinate, answering to the point of inflection.

To determine the point of inflection in curves, whose semi-ordinates C M, C *m* (Plate Miscel. VII. fig. 13 and 14.) are drawn from the fixed point C; suppose C M to be infinitely near C *m*, and make *m* H = M *m*; let T *m* touch the curve in M. Now the angles C *m* T, C M *m*, are equal; and so the angle C *m* H, while the semi-ordinates increase, does decrease, if the curve is concave towards the centre C, and increases, if the convexity turns towards it. Whence this angle, or, which is the same, its measure, will be a minimum or maxmium, if the curve has a point of inflection or retrogression; and so may be found, if the arch T H, or fluxion of it, be made equal to 0, or infinity.—And in order to find the arch T H, draw *m* L, so that the angle T *m* L be equal to *m* C L; then if C $m = y$, $m\,r = x$, *m* T $= \dot{t}$, we shall have $y : \dot{x} :: \dot{t} : \frac{t\ddot{x}}{y}$. Again, draw the arch H O to the radius C H; then the small right lines *m r*, O H, are parallel; and so the triangles O L H, *m* L *r*, are similar; but because H I is also perpendicular to *m* L, the triangles L H I. *m r*, are also similar: whence $\dot{t} : \dot{x} :: \ddot{y}$; $\frac{\dot{x}\ddot{y}}{t}$; that is, the quantities *m* T, *m* L, are equal. But H L is the fluxion of H *r*, which is the distance of C $m = y$; and

H L is a negative quantity, because while the ordinate C M increases, their difference r H decreases; whence $\dot{x}\,x + \dot{y}\,y - \dot{y}\,\dot{y} = 0$, which is a general equation for finding the point of inflection, or retrogradation.

INFLECTION, in grammar, the variation of nouns and verbs, by declension and conjugation. See GRAMMAR.

INFLORESCENCE, in botany, a term used to denote the mode of flowering; the manner in which flowers are supported on their foot-stalks. The various modes in which flowers are joined to the plant by the peduncles or foot-stalk are expressed by different terms. See BOTANY.

The various modes of flowering are applicable to those flowers which proceed from the angle formed by the leaves and branches, as is the case in most instances, and to such also as terminate the stem and branches. In the first case, flowers are termed "axillaries," that is, proceeding from the arm-pit of the leaf: in the latter "terminales," that is, the terminating the branches. Inflorescence affords a characteristic mark, by which to distinguish the species of plants, but is not used as a generic difference.

INFLUENZA, in medicine, a species of contagious catarrh, so named, because it was supposed to be produced by a peculiar influence of the stars. The phenomena of contagious catarrhs have been much the same with those of the simple kind, but the disease has always been particularly remarkable for this, that it has been the most widely and generally spreading epidemic known. It has seldom appeared in any one country of Europe, without appearing successively in most of the others.

IN FORMA PAUPERIS. When any man, who has a just cause of suit, either in Chancery, or any of the courts of common law, will come before the Lord Keeper, Master of the Rolls, either of the Chief Justices, or Chief Baron, and make oath that he is not worth five pounds, his debts paid, either of the said judges will, in his own proper court, admit him to sue in *forma pauperis*, or as a poor man, and he shall have counsel, clerk, or attorney, assigned him, to do his business, without paying any fees.

INFORMATION, in law, may be defined an accusation or complaint exhibited against a person for some criminal offence. It differs principally from an indictment in this, that an indictment is an accusation found by the oath of twelve men, but an information is only the allegation of the officer who exhibits it. Informations are of two kinds; first, those which are partly at the suit of the king, and partly at the suit of a subject; and secondly, such as are only in the name of the king: the former are usually brought upon penal statutes, which inflict a penalty on conviction of the offender, one part to the use of the king, and another to the use of the informer, and are a sort of *qui tam*, or popular actions, only carried on by a criminal instead of a civil process. Informations that are exhibited in the name of the king alone are also of two kinds; first, those which are truly and properly his own suits, and filed *ex officio* by his own immediate officer, the Attorney General; secondly, those in which, though the King is the nominal prosecutor, yet it is at the relation of some private person, or common informer, and they are filed by the Master of the Crown-office, under the express direction of the court. And when an information is filed in either of these ways, it must be tried by a petit jury of the county where the offence arises; after which, if the defendant be found guilty, he must resort to the Court of King's Bench for his punishment.—Common informers, by 18 Elizabeth, c. 5, are to pay costs in case of failure of suit upon informations, unless the judge certifies that there was a reasonable cause for prosecuting.

INFUSION, in chemistry, is the maceration of any substance in water, or any other liquid, hot or cold, in order to extract its soluble parts. The liquid thus impregnated is called an infusion. Infusion differs from maceration, in being continued for a longer time, and it can only be employed for substances which do not easily ferment or spoil. See PHARMACY.

INFUSORIA, in natural history, the fifth order of the class Vermes, in the Linnæan system. They are simple microscopic animalcules. There are three divisions:

A, with external organs, of which there are five genera, *viz.*

Branchionus,	Trichoda,
Cercaria,	Vorticella.
Leucopera,	

B, without external organs, flattened; four genera:

Colpoda,	Gonium,
Cyclidium,	Parmecium.

C, without external organs round: six genera:

Bacillaria,	Monas,
Bursaria,	Vibrio,
Enchelis,	Volvox.

This order, Infusoria, is scarcely distinguished from the Intestina and Mollusca by any other character, than the minuteness of the individuals belonging to it, and their appearance in animal and vegetable infusions, where we can discover no traces of the manner in which they are produced. The process, by which their numbers are sometimes increased, is no less astonishing than their first production. Several of the genera often seem to divide spontaneously into two or more parts, which become new and distinct animals. The volvox, and some of the vorticellæ, are remarkable for their continual rotatory motion, supposed to be intended for the purpose of straining their food out of the water: while other species of the vorticella resemble fungi or corallines in miniature. In some individuals of this order, the very singular property is exhibited of retaining the vital principle when perfectly dried; after being kept for years in a cabinet, they may be resuscitated at pleasure, by restoring them to their proper fluid.

INGOT, in the arts, is a small bar of metal made of a certain form and size, by casting it in hollowed iron or brass plates, called ingot moulds. The term is chiefly applied to the small bars of gold and silver, intended either for coining or exportation to foreign countries.

INHALER, a machine used for steaming the lungs with the vapour of hot water, for the cure of a cough, cold, inflamed throat, &c.

INHERITANCE, in law, is a perpetuity in lands or tenements to a man and his heirs; and the word inheritance, is not only intended where a man has lands or tenements by descent, but also every fee-simple, or fee-tail, which a person has by purchase, may be said to be an inheritance, because his heirs may inherit it. Inheritances are corporeal or incorporeal. Corporeal inheritances relate to houses and lands, which may be touched or handled; and incorporeal hereditaments are rights issuing out of, annexed to, or exercised with corporeal inheritances, as advowsons, tithes, annuities, offices, commons, franchises, privileges, and services. There are several rules of inheritances of lands, according to which estates are transmitted from ancestor to heir; *viz.* 1. That inheritances shall lineally descend to the issue of the person last actually seized, *in infinitum*, but shall never lineally ascend. 2. Where there are two or more males in equal degree, the eldest only shall inherit; but the females altogether. 3. The lineal descendants, *in infinitum*, of any person deceased, shall represent their ancestor; that is, shall stand in the same place as the person himself would have done had he been living: thus the child, grand-child, or great grand-child, (either male or female) of the eldest son succeeds before the younger son, and so *in infinitum*. 4. On failure of issue of the person last seized, the inheritance shall descend to the blood of the first purchaser. 5. The collateral heir of the person last seized must be his next collateral kinsman of the whole blood. 6. In collateral inheritances, the male stocks shall be preferred to the female, unless where lands are descended from a female: thus the relations on the father's side are admitted *in infinitum* before those on the mother's side are admitted at all, and the relations of the father's father before those of the father's mother, and so on.

INJECTION, in surgery, the forcibly throwing certain liquid medicines into the body by means of a syringe, tube, clyster-pipe, or the like.

Injection, *anatomical*, the filling the vessels with some coloured substance, in order to make their figures and ramifications visible.

INJUNCTION, in law, is a prohibitory writ, restraining a person from committing or doing a thing which appears to be against equity and conscience. An injunction is usually granted for the purpose of preserving property in dispute pending a suit; as to restrain the defendant from proceedings at the common law against the plaintiff, or from committing waste, or doing any injurious act. Injunctions issue out of the courts of equity in several instances: the most usual injunction is to stay proceedings at law; as if one bring an action at law against another, and a bill be brought to be relieved either against a penalty, or to stay proceedings at law, on some equitable circumstances, of which the party cannot have the benefit at law. In such case the plaintiff in equity may move for an injunction, either upon an attachment, or praying a dedimus, or praying a farther time to answer; for it being suggested in the bill, that the suit is against conscience, if the defendant be in contempt for not answering, or pray time to answer, it is contrary to conscience to proceed at law in the mean time, and therefore an injunction is granted of course; but this injunction only stays execution touching the matter in question, and there is always a clause giving liberty to call for a plea to proceed to trial, and for want of it to obtain judgment; but execution is stayed till answer, or farther order. The methods of dissolving injunctions are various.

INK, *common writing*. The preparation of common writing ink is a subject of great importance in technical chemistry. A good ink is of a proper consistence to flow freely from the pen, of a full deep black, so permanent as to remain for a number of years without materially fading or becoming illegible, dries very soon after writing with it, and does not considerably corrode or soften the pen. The basis of all the common writing inks is the fine black, or dark blue precipitate, formed by the addition of vegetable astringents, and particularly the soluble part of the gall-nut, to a solution of iron, generally the sulphate. But as this, if diffused in water alone, would subside in a short time, and leave the supernatant liquor nearly without colour, the precipitate is kept suspended, by thickening the water with gum arabic, or any other gum mucilage, which also gives the ink the due consistence, and enables it to trace a fine stroke on the paper, without running. These materials, therefore, that is, gall-nuts, green vitriol, (sulphate of iron) gum arabic, and water, are all that are necessary for the composition of ink; and if they are of good quality, and properly proportioned to each other, every other addition usually made adds very little to its perfection.

It is not well ascertained how soon the present kind of writing ink came into use. It has certainly been employed for many centuries in most European countries; but the ancient Roman inks were, for the most part, of a totally different composition, being made of some vegetable carbonaceous matter like lamp-black diffused in a liquor. The Chinese, and many of the inks used by the Oriental nations, are still of this kind.

On the subject of the common writing ink, Dr. Lewis ("Commerce of Arts") has so full and so accurate an investigation, and his experiments are so simple and well devised, that little else can be added to the subject in a technical point of view. For a fuller chemical inquiry into the nature of the atramentous precipitate, the reader is referred to the articles GALLIC ACID and IRON.

Dr. Lewis first endeavoured to ascertain the best proportion between the galls and the sulphate of iron, to render the ink permanent; for it is to be observed, that with almost any proportions, if the entire quantity be sufficient, the ink will be fine and black at first; but many of these inks, if kept for some time, especially exposed to light and air, will grow brown and fade, and the letters made with it will become nearly illegible.

By trying different proportions of galls and sulphate of iron, it was found, that when about in equal quantities (the galls being powdered, and boiled fully to extract their soluble parts) they appeared to be mutually saturated, so that the mixed liquors would receive no additional blackness from a further dose of one or the other.

This, however, was only a rough approximation to accuracy, for the same effect was produced when either substance was also in a small degree superior in quantity to the other. But Dr. Lewis found that an ink, with equal parts of the two, though very black at first, changed to a yellowish brown, upon exposure to the sun and air only for a few days. This was again blackened by washing with fresh gall infusion, and hence it appears in fair inference that the galls are a perishable substance, so that to insure durability, a much greater proportion must enter into the ink than is required for mere saturation in the first instance. Thus it was found that two parts of galls and one of vitriol make a much more durable ink than with equal parts, and three of galls with one of vitriol was still more durable. When the galls were increased beyond this point, the colour was indeed quite permanent, but it was not of so full a black.

The proportion of water or other liquid to the solid ingredients will admit of great variation. One part of vitriol, three of galls, and fifty parts of water, gave an ink black enough for common use; but the finest and blackest was made when only ten of water were employed; nor was any deficiency in the gallic acid observed after fifteen years, though the water was scarcely more than sufficient to cover the galls, and therefore could hardly be supposed capable of extracting all the soluble part of them; and though the vitriol, from its greater solubility, would probably be dissolved entirely, and thus be in greater proportion than usual. Other liquors besides water were tried. Of these, white wine and vinegar appeared to answer somewhat better;

but any considerable proportion of spirit of wine, or brandy, obviously did harm, owing to the insolubility of the sulphate of iron (as of all the other sulphates) in alcohol, and therefore its diminished solubility in any liquor is in proportion to the alcohol it contains. A decoction of logwood used instead of water sensibly improved the beauty of the colour.

Instead of galls other astringents were employed, such as sloes, oak-bark, tormentil root, &c.; but though they all gave a good blue black, with the salt of iron, none of them was equal to the gall-nut in this respect.

Other salts of iron were also substituted to the sulphate. The muriate and nitrate of iron nearly equalled the sulphate in colour, but proved too corrosive to the paper, and as they were in no respect preferable to the sulphate, there is no reason for abandoning it.

Imagining that there must be some excess of sulphuric acid in common ink, to which the fading might be imputed, Dr. Lewis tried to neutralize it by lime and alkalies, but with manifest injury, the colour being rendered thereby extremely fugitive. Another ingenious idea for avoiding the supposed excess of acid was, to separate the black atramentous precipitate, wash it, and again diffuse it with water thickened with gum. This, indeed, makes a very good ink, but with the capital defect of not remaining so long suspended in the liquor, and especially of not fixing itself to the paper like common ink, but rather only slightly adhering like a weak gum varnish, and was readily washed off by water. Hence it appears that the acid of the salt of iron acts as a kind of mordant, or intermede, between the atramentous precipitate and the paper, and causes a degree of chemical union between them; a real advantage which this species of ink possesses over all the lamp-black, or China inks, which, indeed, are rather black varnishes.

With regard to the gummy ingredient, the effect of which is rather mechanical, it was found that any other gum-mucilage would answer as well; but not glue, isinglass, nor animal jelly of any kind. Besides, as these latter putrify by keeping, this alone would be a strong objection.

Sugar is sometimes added to ink. It makes it flow somewhat easier from the pen, and gives it when dry a gloss which is admired by some. It has this quality, however, of making it very slow in drying, which in most cases is an inconvenience.

On account of the great improvements to the black atramentous dye produced by adding sulphate of copper, some have recommended this addition to common ink, which is composed of the same materials; but it does not appear that the same advantage is here obtained, and Dr. Lewis thinks it an useless addition.

From the above observations, Dr. Lewis gives the following receipt for the composition of ink: put into a stone or glass bottle, or any other vessel, three ounces of finely powdered galls, one ounce of green vitriol, one ounce of logwood finely rasped or bruised, one ounce of gum-arabic, and a quart of soft water; shake the bottle well, and let the ingredients stand in a moderately warm place for a week or ten days, shaking it frequently in the day. It is then fit for use; but a little before it is put into the ink-stand, it is better to shake the bottle, that the colour may be more uniformly diffused.

To prevent the ink from moulding, Hoffman recommends half a dozen cloves to be bruised with the gum-arabic, and put into the bottle. This appears a useful addition. Instead of water alone, where a very fine ink is wanted, white wine, or vinegar and water, may be used.

If the ink be wanted for use in a very short time, the galls and logwood may be boiled for half an hour in the water, adding a little more to supply the waste, and the decoction while hot strained off through a cloth, and the gum arabic and cloves, and the sulphate of iron, both in fine powder, added to the decoction when in the bottle and shaken. The ink will then be fit for use almost immediately after the latter ingredients are dissolved. It will be improved by adding to the bottle some pieces of gall-nut coarsely bruised. Ink kept in a close bottle is always rather pale; but it blackens by exposure to air in a few hours; and probably in this way the colour is somewhat more durable than if it were brought by previous exposure to its full colour at once.

It has been mentioned that sugar renders ink slow in drying. Advantage is ingeniously taken of this property in enabling it to give one, and sometimes two impressions on soft paper, when strongly pressed. In this simple way letters are copied in merchant's counting houses, and offices of business. A little sugar is mixed with the ink, the writing-sheet is laid on the copying press, a blank sheet of porous and damped paper is put over it, and by the pressure of the machine a perfect fac-simile of the writing is struck off, sufficiently legible for all purposes.

This ingenious method saves a vast quantity of labour usually bestowed in copying letters, and besides prevents all possibility of mistakes.

Sometimes the ink of very old writings is so much faded by time as to be illegible. Dr. Blagden (Philosophical Transactions, vol. lxxvii.) in his experiments on this subject, found that in most of these the colour might be restored, or rather a new body of colour given, by pencilling them over with a solution of prussiate of potash, and then with a dilute acid, either sulphuric or muriatic: or else, *vice versa*, first with the acid, and then with the prussiate. The acid dissolves the oxide of iron of the faded ink, and the prussiate precipitates it again of a blue, which restores the legibility of the writing. If this be done neatly, and blotting paper laid over the letters as fast as they become visible, their form will be retained very distinctly. Pencilling over the letters with an infusion of galls also restores the blackness to a certain degree, but not so speedily nor so completely.

The blackness of common ink is almost instantly and irrevocably destroyed by the oxymuriatic acid, and hence any writing may be effaced by this method completely. To prevent this mischief, which might often be a serious one, several additions have been proposed to common ink, of which by far the best is lamp-black or charcoal, in impalpable powder, on which the acid has no effect. The lamp-black should be of the least oily kind, as it does not readily mix with the ink, and some pains must be taken to incorporate them. On this account, perhaps, common charcoal is preferable. About a quarter of the weight of the vitriol used will be amply sufficient. This will not fade by age.

Ink, *China or Indian.* The well known and much admired Indian or China ink is brought over in small oblong cakes, which readily become diffused in water by rubbing, and the blackness remains suspended in it for a considerable time, owing to the extreme subtlety of division of the substance that gives the colour, and the intimacy with which it is united to the mucilaginous matter that keeps it suspended.

Indian ink does, however, deposit the whole of its colour by standing, when it is diffused in a considerable quantity of water. Dr. Lewis, on examining this substance, found that the ink consisted of a black sediment, totally insoluble in water, which appeared to be of the nature of the finest lamp-black, and of another substance soluble in water, and which putrified by keeping, and when evaporated left a tenacious jelly exactly like glue or isinglass. It appears probable, therefore, that it consists of nothing more than these two ingredients, and probably may be imitated with perfect accuracy by using a very fine jelly, like isinglass or size, and the finest lamp-black, and incorporating them thoroughly. The finest lamp-black known is made from ivory shavings, and thence called ivory-black.

Ink, *Printers'.* This is a very singular composition, partaking much of the nature of an oil varnish, but differing from it in the quality of adhering firmly to moistened paper, and in being, to a considerable degree, soluble in soap-water.

It is, when used by the printers, of the consistence of rather thin jelly, so that it may be smeared over the types readily and thinly, when applied by leather cushions, and it dries very speedily on the paper without running through to the other side, or passing the limits of the letter.

The method of making printers' ink is thus described by Dr. Lewis. Ten or twelve gallons of nut-oil are set over the fire in a large iron pot, and brought to boil. It is then stirred with an iron ladle, and, whilst boiling, the inflammable vapour rising from it either takes fire of itself, or is kindled, and suffered to burn in this way for about half an hour, the pot being partially covered so as to regulate the body of the flame, and consequently the heat communicated to the oil. It is frequently stirred during this time, that the whole may be heated equally, otherwise a part would be charred and the rest left imperfect. The flame is then extinguished by entirely covering the pot. The oil by this process has much of its unctuous quality destroyed, and when cold is of the consistence of soft turpentine, and is then called varnish. After this it is made into ink by mixture with the requisite quantity of lamp-black, of which about two ounces and a half are sufficient for sixteen ounces of the prepared oil. The oil loses by the boiling about an eighth of its weight, and emits very offensive fumes. Several other additions are made to the oil during the boiling, such as crusts of bread, onions, and sometimes turpentine. These are kept secret by the preparers. The intention of them is more effectually to destroy part of the unctuous quality of the oil, to give it more body, to enable it to adhere better to the wetted paper, and to spread on the types neatly and uniformly.

Besides these additions others are made by the printers, of which the most important is generally understood to be a little fine indigo in powder, to improve the beauty of the colour.

Red printers' ink is made, by adding to the varnish about half its weight of vermilion. A little carmine also improves the colour. (Encycl. Arts & Metiers, vol. iii. p. 518.)

Inks, *coloured.* Few of these are used except red ink. The preparation of these is very simple, consisting either of decoctions of the different colouring or dyeing materials in water, and thickened with gum-arabic, or of coloured metallic oxides, or insoluble powders, merely diffused in gum-water. The proportion of gum-arabic to be used may be the same as for black writing ink. All that applies to the fixed or fugitive nature of the several articles used in dyeing may be applied, in general, to the use of the same substance as inks.

Ink, *red*, is usually made by boiling about two ounces of Brazil wood in a pint of water for a quarter of an hour, and adding to the decoction the requisite quantity of gum, and about half as much alum. The alum both heightens the colour and makes it less fugitive. Probably a little madder would make it more durable.

Ink, *blue*, may be made by diffusing Prussian blue or indigo through strong gum-water.

Ink, *yellow*, may be made by a solution of gamboge in gum-water.

Most of the common water-colour cakes, diffused in water, will make sufficiently good coloured inks for most purposes.

Inks of other colours may be made from a strong decoction of the ingredients used in dyeing, mixed with a little alum and gum-arabic. For example, a strong decoction of Brazil wood, with as much alum as it can dissolve, and a little gum, forms a good red ink. These processes consist in forming a lake, and retarding its precipitation by the gum. See Lake.

On many occasions it is of importance to employ an ink indestructible by any process, that will not equally destroy the material on which it is applied. Mr. Close has recommended for this purpose, 25 grains of copal in powder dissolved in 200 grains of oil of lavender, by the assistance of gentle heat, and then mixed with 2½ grains of lamp-black, and half a grain of indigo: or 120 grains of oil of lavender, 17 grains of copal, and 60 grains of vermilion. A little oil of lavender, or of turpentine, may be added, if the ink be found two thick. Mr Sheldrake suggests, that a mixture of genuine asphaltum, dissolved in oil of turpentine, amber varnish, and lamp-black, would be still superior.

When writing with common ink has been effaced by means of oxygenated muriatic acid, the vapour of sulphuret of ammonia, or immersion in water impregnated with this sulphuret, will render it again legible. Or if the paper that contained the writing be put into a weak solution of prussiate of potash, and when it is thoroughly wet, a sulphuric acid be added to the liquor, so as to render it slightly acidulous, the same purpose will be answered.

Mr. Haussman has given some compositions for marking pieces of cotton or linen, previous to their being bleached, which are capable of resisting every operation in the processes both of bleaching and dyeing, and consequently might be employed in marking linen for domestic purposes. One of these consists of asphaltum dissolved in about four parts of oil of turpentine, and with this is to be mixed lamp-black, or black lead in fine powder, so as to make an ink of a proper consistence for printing with types. Another, the blackish sulphate left after expelling oxygen gas from oxide of manganese with a moderate heat, being dissolved and filtered, the dark grey pasty oxide left on the filter is to be mixed with a very little solution of gum tragacanth, and the cloth marked with this is to be dipped in a solution of potash or soda, mild or caustic, in about ten parts of water.

Among the amusing experiments of the art of chemistry, the exhibition of sympathetic inks holds a distinguished place. With these the writing is invisible, until some reagent gives it opacity. We shall here mention a few out of the great number, that a slight acquaintance with chemistry may suggest to the student. 1. If a weak infusion of galls be used, the writing will be invisible till the paper be moistened with a weak solution of sulphate of iron. It then becomes black, because these ingredients form ink. 2. If paper be soaked in a weak infusion of galls, and dried, a pen dipped in the solution of sulphate of iron will write black on that paper, but colourless on any other paper. 3. The diluted solutions of gold, silver, or mercury, remain colourless upon the paper, till exposed to the sun's light, which gives a dark colour to the oxides, and renders them visible. 4.

Most of the acids or saline solutions, being diluted, and used to write with, become visible by heating before the fire, which concentrates them, and assists their action on the paper. 5. Diluted prussiate of potash affords blue letters, when wetted with the solution of sulphate of iron. 6. The solution of cobalt in aqua-regia, when diluted, affords an ink which becomes green when held to the fire, but disappears again when suffered to cool. This has been used in fanciful drawings of trees, the green leaves of which appear when warm, and vanish again by cold. This effect has not been explained. If the heat be continued too long after the letters appear, it renders them permanent. 7. If oxide of cobalt be dissolved in acetous acid, and a little nitre added, the solution will exhibit a pale rose colour when heated, which disappears on cooling. 8. A solution of equal parts of sulphate of copper and muriate of ammonia gives a yellow colour when heated, that disappears when cold.

Sympathetic inks have been proposed as the instruments of secret correspondence. But they are of little use in this respect, because the properties change by a few days remaining on the paper; most of them have more or less of a tinge when thoroughly dry; and none of them resist the test of heating the paper till it begins to be scorched.

INNS *and innkeepers*. If one who keeps a common inn refuse either to receive a traveller as a guest into his house, or to find him victuals or lodging, upon his tendering a reasonable price for them, he is not only liable to render the damages for the injury in an action on the case, at the suit of the party grieved, but also may be indicted and fined at the suit of the king. In return for such responsibitity, the law allows him to retain the horse of his guest until paid for his keep; but he cannot retain such horse for the bill of the owner, although he may retain his goods for such bill; neither can he detain one horse for the food of another. An innkeeper, however, is not bound to receive the horse, unless the master lodge there also. Neither is a landlord bound to furnish provisions, unless paid beforehand. If an innkeeper make out unreasonable bills, he may be indicted for extortion; and if either he or any of his servants knowingly sell bad wine, or bad provisions, they will be responsible in an action of deceit. Keeping an inn is not a trading to make a man a bankrupt; but where an innkeeper is a chapman also, and buys and sells, he may on that account be a bankrupt. Innkeepers are clearly chargeable for the goods of guests stolen or lost out of their inns, and this without any contract or agreement for that purpose. But if a person come to an innkeeper, and desire to be entertained by him, which the innkeeper refuses, because, in fact, his house is already full; whereupon the party says he will shift among the rest of his guests, and there he is robbed, the host shall not be charged. If a man come to a common inn to harbour, and desire that his horse may be put to grass, and the host put him to grass accordingly, and the horse is stolen, the host shall not be charged; because by law the host is not bound to answer for any thing out of his inn, but only for those things that are *infra hospitium*. Innkeepers may detain the person of the guest who eats till payment. By the custom of London and Exeter, if a man commit an horse to an hostler, and he eat out the price of his head, the hostler may take him as his own, upon the reasonable appraisement of four of his neighbours; yet he cannot justify the taking him to himself at the price it was appraised at.

INNATE *ideas*, those supposed to be stamped on the mind from the first moment of its existence, and which it constantly brings into the world with it: a doctrine which Mr. Locke has abundantly refuted. See IDEA.

INNOMINATA *ossa*, in anatomy, three bones, which compose the extreme part of the trunk of a human body.

INNUENDO, is a word used in declarations and law pleadings, to ascertain a person or thing which was named before; as to say he (innuendo the plaintiff) did so and so, when there was mention before of another person. Innuendo may serve for an explanation, where there is precedent matter, but never for a new charge; it may apply what is already expressed, but cannot add or enlarge the importance of it. The doctrine of innuendoes is strangely misunderstood, in the opinion of the writer of this article, and has been confounded by too much learning and technical distinction being applied to it. The meaning of the word is 'limiting, suggesting, or meaning.' All words have different meanings, according to the manner, time, and other circumstances, under which they are used. If the words are used in their plain sense, they need no explanation; if in any other sense, then all the circumstances by which that sense is to be made out to be the meaning of the party must be stated, and then the pleader may suggest the true meaning in the indictment under an innuendo; but before the innuendo is used, the circumstances must be stated to which it applies. This is the plain and simple clue to solve all the difficulties that have occurred upon the subject.

INOCARPUS, in botany, a genus of the Decandria Monogynia class and order. Natural order of Dumosæ. Sapotæ, Jussieu. Essential character: calyx bifid; corolla funnel-form; stamens in a double row; drupe one-seeded. There is but one species, *viz.* I. edulis, a native of the Society, Friendly, New Hebrides Isles, &c. in the South Seas; also in Amboyna.

INOCULATION, in medicine, the art of transplanting a distemper from one subject to another, by incision, particularly used for ingrafting the small-pox. See VACCINATION.

INOCULATION. See BUDDING.

INORDINATE *proportion*, is where there are three magnitudes in one rank, and three others proportional to them in another, and you compare them in a different order. Thus suppose the numbers in one rank to be 2, 3, 9; and those of the other rank, 8, 24, 36; which are compared in a different order, *viz.* 2 : 3 :: 24 : 36; and 3 : 9 :: 8 : 24. Then rejecting the mean terms of each rank, you conclude 2 : 9 :: 8 : 36.

INQUEST, in law, an inquisition by jurors, or jury, which is the most usual trial of all causes, both civil and criminal, within this realm.

INQUISITION, in law, a manner of proceeding by way of search and examination, and used in the king's behalf on temporal causes and process, in which sense it is confounded with office. This inquisition is upon an outlawry found, in case of treason and felony committed; upon a *felo de se*, &c. to entitle the king to a forfeiture of lands and goods; and there is no such nicety required in an inquisition as in pleading: because an inquisition is only to inform the court how process shall issue for the king, whose title accrues by the attainder, and not by the inquisition; and yet, in cases of the king and a common person, inquisitions have been held void for uncertainty. Some of the inquisitions are in themselves convictions, and cannot afterwards be traversed or denied, and therefore the inquest ought to hear all that can be alleged on both sides. Of this nature are all inquisitions of *felo de se;* of flight, in persons accused of felony; of deodands, and the like; and presentment of petty offences in the sheriff's term, or court leet, whereupon the presiding officer may set a fine. Other inquisitions may be afterwards traversed and examined; as particularly the coroner's inquisition of the death of a man; for in such cases the offender may be arraigned upon the inquisition, and dispute the truth of it.

INROLLMENT, in law, is the registering, recording, or entering in the rolls of the Chancery, King's Bench, Common Pleas, or Exchequer, or by the clerk of the peace in the records of the quarter sessions, of any lawful act; a statute or recognizance acknowledged, a deed of bargain and sale of lands, and the like. But the inrolling a deed does not make it a record, though it thereby becomes a deed recorded; for there is a difference between a matter of record and a thing recorded to be kept in memory; a record being the entry in parchment of judicial matters controverted in a court of record, and whereof the court takes notice, whereas an inrollment of a deed is a private act of the parties concerned, of which the court takes no cognizance at the time of doing it, although the court permits it. By statute 27 Henry VIII. c. 16, no lands shall pass, whereby any estate of inheritance or freehold shall take effect, or any use thereof be made, by reason only of any bargain and sale thereof, except the bargain and sale be made by writing indented, sealed, and within six months enrolled in one of the king's courts of record at Westminster; or else within the county where the lands lie, before the clerk of the peace, and one or more justices. But by fifth Elizabeth, c. 26, in the counties palatine, they may be enrolled at the respective courts there, or at the assizes. Every deed before it is enrolled is to be acknowledged to be the deed of the party, before a master of chancery, or a judge of the court wherein it is inrolled, which is the officer's warrant for inrolling it; and the inrollment of a deed, if it be acknowledged by the grantor, it will be a good proof of the deed itself upon trial. But a deed may be inrolled without the examination of the party himself; for it is sufficient if oath be made of the execution. If two are parties, and the deed be acknowledged by one, the other is bound by it. And if a man live abroad, and would have lands here in England, a nominal person may be joined with him in the deed, who may acknowledge it here, and it will be binding. There have been plans proposed for the inrolling all conveyances of lands, and registering them, in order to secure men's titles; but this has been objected to by the landed interest in parliament, chiefly from motives of delicacy.

INSCRIBED, in geometry. A figure is said to be inscribed in another, when all its angles touch the sides or planes of the other figure.

INSCRIPTION, a title or writing carved, engraved, or affixed to any thing, to give a more distinct knowledge of it, or to transmit some important truth to posterity. The inscriptions mentioned by Herodotus and Diodorus Siculus sufficiently shew that this was the first method of conveying instruction to mankind, and transmitting the knowledge of history and sciences to posterity; thus the ancients engraved upon pillars both the principles of sciences, and the history of the world. Pisistratus carved precepts of husbandry on pillars of stone; and the treaties of confederacy between the Romans and Jews were engraved on plates of brass. Hence, antiquarians have been very curious in examining the inscriptions on ancient ruins, coins, medals, &c.

INSECTS, in natural history. We have, under the article ENTOMOLOGY, given an account of the Linnæan system of this department of natural history. We shall, in this place, enumerate some of those circumstances which form the line of distinction between insects and other animals. Insects are not furnished with red blood, but instead of it their vessels contain a transparent lymph. This may serve to distinguish them from the superior animals, but it is common to them with many of the inferior; though Cuvier has lately demonstrated the existence of a kind of red blood in some of the vermes. They are destitute of internal bones; but, in place of them, are furnished with a hard external covering, to which the muscles are attached, which serves them both for skin and bones; they are likewise without a spine formed of vertebræ, which is found in all the superior classes of animals. They are furnished with articulated legs, six or more; this circumstance distinguishes them from all other animals destitute of a spine formed of vertebræ. A very great number of insects undergo a metamorphosis: this takes place in all the winged insects. They frequently change their skin in the progress of their growth. A very great number of insects are furnished with jaws placed transversely.

The wings with which a very great number of insects are furnished distinguish them from all other animals, which are not furnished with a spine composed of vertebræ. Insects are generally oviparous; scorpions and aphides, during the summer months, are viviparous. Insects have no nostrils, are destitute of voice: they are not furnished with a distinct heart, composed of ventricle and auricle. Incubation is not necessary for hatching their eggs. Insects, like all other organized bodies, which form the animal and vegetable kingdoms, are composed of fluids and solids. In the four superior classes of animals, *viz.* quadrupeds, birds, reptiles and fishes, the bones form the most solid part, and occupy the interior part both of the trunk and limbs; they are surrounded with muscles, ligaments, cellular membrane, and skin. The matter is reversed in the class of insects; the exterior part is most solid, serving at the same time both for skin and bones; it encloses the muscles and internal organs, gives firmness to the whole body, and, by means of its articulations, the limbs, and different parts of the body, perform their various motions. In many insects, such as the crab, lobster, &c., the external covering is very hard, and destitute of organization; it is composed of a calcareous earth, mixed with a small quantity of gelatine, formed by an exudation from the surface of the body. As its great hardness would check the growth of the animal, nature has provided a remedy; all of these crustaceous insects cast their shell annually. See CRUSTS. The skin of most of the other insects is softer and organized, being formed of a number of thin membranes, adhering closely to one another, and putting on the appearance of horn. It owes its greater softness to a larger proportion of gelatine. The muscles of insects consist of fibres formed of fasciculi; there are commonly but two muscles to produce motion in any of their limbs, the one an extensor, the other a flexor. These muscles are commonly attached to a tendon, composed of a horny substance, connected to the part which they are destined to put in motion. In most insects, the brain is situated a little above the œsophagus; it divides into two large branches, which surround the œsophagus, and unite again under it, from which junction a whitish nervous cord proceeds, corresponding to the spinal marrow of the superior animals, which extends the whole length of the body, forming in its course twelve or thirteen knots or ganglions, from each of which small nerves proceed to different parts of the body. Whether insects be endowed with any senses different from those of the superior animals cannot easily be ascertained. It appears pretty evident that they possess vision, hearing, smell, and touch; as to the sense of taste, we are left to conjecture, for we are acquainted with no facts, by which we can prove that insects do or do not enjoy the sense of taste. The eyes of insects are of two kinds; the one compound, composed of lenses, large, and only two in number; the other are small, smooth, and vary in number, from two to eight. The small lenses, which form the compound eyes, are very numerous; they amount, in some insects, to many hundreds. The far greater number of insects have only two eyes, but some have three, as the scolopendra; some four, as gyrinus; some six, as scorpions; some eight, as spiders. The eyes of insects are commonly immoveable; crabs, however, have the power of moving their eyes. That insects are endowed with the sense of hearing can no longer be disputed, since frog-hoppers, crickets, &c. furnish us with undeniable proofs of the fact. Nature has provided the males of these insects with the means of calling their females, by an instrument fitted to produce a sound which is heard by the latter. The male and female death-watch give notice of each other's presence, by repeatedly striking with their mandibles against old wood, &c. their favourite haunts. Their ears have been discovered to be placed at the root of their antennæ, and can be distinctly seen in some of the larger kinds, as the lobster. That insects enjoy the faculty of smelling is very evident; it is the most perfect of all their senses.—Beetles, of various sorts, the different species of dermestes, flies, &c. perceive at a considerable distance the smell of ordure and dead bodies, and resort in swarms to the situations in which they occur, either for the purpose of procuring food, or laying their eggs. Insects feed on a great variety of substances; there are few things either in the vegetable or animal kingdoms which are not consumed by some of them. The leaves, flowers, fruit, and even the ligneous parts of vegetables, afford nourishment to a very numerous class; animal bodies, both dead and alive, even man himself, is preyed on by many of them: several species of the louse, of the acarus, of the gnat, and the common flea, draw their nourishment from the surface of his body; the pulex ulcerans penetrates the cuticle, and even enters his flesh. A species of gadfly, œstrus hominis, deposits its eggs under his skin, where the larvæ feed. Other caterpillars insinuate themselves into different cavities of his body. All the inferior animals have their peculiar parasitical insects, which feed on them during their life. There are some insects which can feed only on one species. Many caterpillars, both of moths and butterflies, feed on the leaves of some particular vegetable, and would die, could they not obtain this. There are others which can make use of two or three kinds of vegetables, but which never attain full perfection, except when they are fed on one particular kind; for example, the common silk-worm, which eats readily all the species of mulberry, and even common lettuce, neither attains so great a size, nor produces so much silk, as when fed on the white mulberry.—There are a great many which feed indiscriminately on a variety of vegetables. Almost all herbivorous insects eat a great deal, and very frequently; and most of them perish, if deprived of food but for a short time. Carnivorous insects can live a long while without food, as the carabus, ditiscus, &c. As many insects cannot transport themselves easily in quest of food, to places at a distance from one another, nature has furnished the perfect insects of many species with an instinct, which leads them to deposit their eggs in situations where the larvæ, as soon as hatched, may find that kind of food which is best adapted to their nature. Most of the butterflies, though they flutter about, and collect the nectareous juice of a variety of flowers, as food for themselves, always deposit their eggs on or near to those vegetables destined by nature to become the food of their larvæ. The various species of ichneumon deposit their eggs in the bodies of those insects on which their larvæ feed. See Ichneumon. The sirex and sphex are likewise careful to deposit their eggs in situations where their larvæ, when hatched, may find subsistence. The sphex figulus deposits its eggs on the bodies of spiders which it has killed, and encloses it in a cell composed of clay. Some insects, at different periods of their existence, makes use of aliment of very different properties; the larvæ of some are carnivorous, while the perfect insect feeds on the nectareous juice of flowers: *e. g.* sirex, ichneumon, &c. The larvæ of most of the lepidopterous insects feed on the leaves and young shoots of vegetables, while the perfect insects either take no food at all, or subsist on the sweet juice which they extract from flowers: indeed, the construction of their mouths prevents them from taking any other than fluid food.

We shall now refer to the functions of insects: beginning with respiration, which is the act of inhaling and exhaling the air into and out of the lungs. Quadrupeds, birds, and most of the amphibia, breathe through the mouth and nostrils. The air, when received into the lungs, is mixed with the blood, and imparts to it something necessary, and carries off something noxious. Some authors have asserted, that insects have no lungs; but later experiments and observations show, that no species wants them, or, at least, something similar to them; and in many insects they are larger in proportion to their bodies than in other animals. In most of them they lie at or near to the surface of the body, and send out lateral pores or tracheæ.

The respiration of insects has attracted the attention of many naturalists, and it is found that insects do not breathe through the mouth or nostrils; that there are a number of vessels, for the reception of air, placed along on each side of the body, which are commonly called spiracula, which are subdivided into a number of smaller vessels, or bronchiæ; that the vessels, or tracheæ, which proceed from the pores on the sides, are not composed of a simple membrane, but are tubes formed of circular rugæ; that the spiracula are distinguishable, and are covered with a small scaly plate, with an opening in the middle like a button-hole, which is furnished with membranes, or threads, to prevent the admission of extraneous bodies.

Insects are the only animals without vertebræ, in which the sexes are distinguished. Copulation is performed in them by the introduction of the parts of generation of the male into those of the female. All insects are either male or female, except in a few of the genera of the order Hymenoptera, such as the bee, ant, &c. where individuals are to be found, which are neither male nor female; and on that account called neuters. Among the bees, the neuters form the far greater part of the community, and perform the office of labourers. Among the ants, the neuters are very numerous, and constitute the only active members of the society. It has been alleged, that these neuters are nothing but females, whose parts have not been developed for want of proper nourishment. Oliver, however, after strict examination, is disposed to think them really different, though he does not adduce facts sufficient to establish his opinion. The parts which distinguish the male from the female may be divided into two classes, *viz.* 1. Those which are not directly connected with generation. 2. Those which are absolutely necessary for the purposes of generation. The circumstances which have no direct communication with generation, which serve to point out the distinction between the sexes, are the difference of size observable in the male and female; the brightness of the colour in each; the form and number of articulations of the antennæ; the size and form of their wings; the presence or absence of a sting; the male is always smaller than the female; the female ant is nearly six times larger than the male; the female cochineal is from twelve to fifteen times the size of the male; the female termes is two hundred or three hundred times the size of the male; the colours of the male are commonly much more brilliant than those of the female; this is particularly the case in lepidopterous insects; in some insects, the colour of the male is totally different from that of the female; the antennæ of the male are commonly of a different form, and larger than those of the female; frequently the males are furnished with wings, while the females have none; the lampyris, coccus, and blatta, and several moths, afford an example of this; the female bee is furnished with a sting, while the male is destitute of one; the males of some insects are furnished with sharp prominent points, resembling horns, situated either on the head or breast, which are either not perceptible, or very faintly marked, in the female. The parts essential to generation afford the best distinguishing mark; in most insects they are situated near the extremity of the rectum; by pressing the abdomen near to the anus, they may frequently be made to protrude; but the parts of generation are not always situated near the anus: in the spiders, they are situated in the feelers; in the libellula, the male organ is situated in the breast, while that of the female is placed at the anus.

The eggs of insects are of two sorts: the first membranaceous, like the eggs of the tortoise, and the other reptiles; the other covered with a shell like those of the birds; their figure varies exceedingly; some are round, some elliptical, some lenticular, some cylindrical, some pyramidal, some flat, some square, but the round and oval are the most common. The eggs of insects seldom increase in size, from the time they have been deposited by the parent till they are hatched; those of the tenthredo, however, and of some others, are observed to increase in bulk. At first there is nothing to be perceived in the eggs of insects but a watery fluid; after some little time, an obscure point is observable in the centre, which, according to Swammerdam, is not the insect itself, but only its head, which first acquires consistence and colour: and the same author alleges, that insects do not increase in bulk in the egg, but that their parts only acquire shape and consistence. Under the shell of the egg, there is a thin and very delicate pellicle, in which the insect is enveloped, which may be compared to the chorion and amnios, which surround the fœtus in quadrupeds. The little insect remains in the egg till the fluids are dissipated, and till its limbs have acquired strength to break the egg, and make its escape; the different species of insects remain inclosed in the egg for very different periods; some continue inclosed only a few days, others remain for several months. The eggs of many insects remain without being hatched during the whole winter, and the young insects do not come forth from them till the season at which the leaves of the vegetables, on which they feed, begin to expand. When the insects are ready to break their prison, they commonly attempt to pierce the shell with their teeth, and form a circular hole, through which they put forth first one leg, and then another, till they extricate themselves entirely.

Insects are by far the most numerous class of animals: about eleven thousand species have been described by Gmelin, in the last edition of the "System of Nature:" a great many more have been described by other naturalists since the publication of that work; and a very considerable number are to be met with in the cabinets of the curious, which have not as yet been described by any author. In those parts of the world which we are best acquainted with, we may easily suppose that many species of insects exist, which have hitherto escaped notice. The minuteness of some insects makes them easily overlooked; the agility of others renders the catching of them difficult; the retired situations which many of them haunt favour their concealment. In the unexplored parts of America, Africa, and Asia, many thousand species must exist utterly unknown to naturalists: all these circumstances render it very probable, that not one half of the insects which exist in the world have hitherto been described. In order to exhibit the proportion they bear to plants, it may be proper to remark, that, as inhabitants of England, eight thousand species have been already described, and only three thousand plants.

Insects afford nourishment to a great number of the superior animals: many of the fishes, reptiles, and birds, draw the principal part of their sustenance from that source. The immense swarms of different species of crab, which abound in every sea, directly or indirectly form the principal part of the food of the cod, haddock, herring, and a great variety of fishes. The snake, lizard, frog, and many other reptiles, feed both on land and aquatic insects. Gallinaceous fowls, and many of the small birds, &c. feed on insects. Swallows, indeed, feed entirely on winged insects. They afford food, likewise, to many of the mammalia, *viz.* to many species of the bat, to the ant-eater, &c. and even to man himself. Many species of crab, *viz.* lobster, common crab, shrimp, prawn, land-crab, &c. are reckoned delicacies. The larvæ of some coleopterous insects and locusts form part of the food of man. Insects, likewise, by consuming decayed animal and vegetable matter, which, if left to undergo the putrefactive process on the surface of the ground, might taint the atmosphere with pestilential vapours, preserve the air pure for the respiration of man and other animals.

INSERTION, in anatomy, the close conjunction of the vessels, tendons, fibres, and membranes of the body, with some other parts.

INSOLATION, in chemistry, a term sometimes made use of to denote that exposure to the sun, which is made in order to promote the chemical action of one substance upon another: one of the most striking experiments of this kind is that of the exposure of vegetables, as fresh-gathered cabbage-leaves, in a glass jar of water, to the rays of the sun, by the action of which a large quantity of pure oxygen gas is obtained.

INSOLUBILITY, in chemistry. The insolubility of a substance in a fluid, which is the medium of chemical action, has an influence on that action somewhat similar to that of cohesion, and is nothing but a modification of it, in relation to the fluid in which it is exerted. If substances in their liquid state be made to act on each other, their action will meet with little foreign resistance, and will be, in a great measure, proportioned to their affinity and quantity; but if one of them be solid, and be farther insoluble in the fluid, which is the medium of action, the insoluble matter must present comparatively few points of contact; it must be always withdrawn from the sphere of action, and of course, if it be opposed to a combination, it can act with comparatively little energy. From the same cause, if it be a compound, and be acted on by any substance tending to combine with one of its principles, its insolubility must in some measure protect it, as abstracting it from the action of the decomposing substance.

INSOLVENT *debtors.* Insolvent acts are statutes passed for the purpose of releasing from prison, and sometimes from their debts, persons whose transactions have not been of such a nature as would subject them to the bankrupt laws. Their discharge is usually from all suits and imprisonment, upon delivering up all their estates and effects, real and personal, for the benefit of their creditors.

INSPIRATION, among divines, &c. implies the conveying of certain extraordinary and supernatural notices or motions into the mind; or it denotes any supernatural influence of God upon the mind of a rational creature, whereby he is formed to any degree of intellectual improvements, to which he could not, or would not, in fact, have attained in his present circumstances, in a natural way. Thus the prophets are said to have spoken by divine inspiration.

Some authors reduce the inspiration of the sacred writers to a particular care of Providence, which prevented any thing they had said from failing or coming to nought; maintaining, that they never were really inspired either with knowledge or expression. According to others, inspiration is no more than a direction of the Holy Spirit, which never permitted the sacred writers to be mistaken. It is a common opinion, that the inspiration of the Holy Spirit regards only the matter, not the style or words.

Theological writers have enumerated several kinds of inspiration; such as "an inspiration of superintendency," in which God does so influence and direct the mind of any person, as to keep him more secure from error in some various and complex discourse, than he would have been merely by the use of his natural faculties; "plenary superintendent inspiration," which excludes any mixture of error from the performance so superintended; "inspiration of elevation," where the faculties act in a regular, and, as it seems, in a common manner, yet are raised to an extraordinary degree, so that the composer shall, upon the whole, have more of the true sublime or pathetic, than natural genius could have given; and "inspiration of suggestion," when the use of the faculties is superseded, and God does, as it were, speak directly to the mind, making such discoveries to it, as it could not otherwise have obtained, and dictating the very words in which such discoveries are to be communicated, if they are designed as a message to others.

It is generally allowed, that the New Testament was written by a superintendent inspiration; for without this the discourses and doctrines of Christ could not have been faithfully recorded by the Evangelists and Apostles; nor could they have assumed the authority of speaking the words of Christ, and evinced this authority by the actual exercise of miraculous powers; and, besides, the sacred writings bear many obvious internal marks of their divine original, in the excellence of their doctrines, the spirituality and elevation of their design, the majesty and simplicity of their stile, the agreement of their various parts, and their efficacy on mankind; to which may be added, that there has been in the Christian church, from its earliest ages, a constant tradition, that the sacred books were written by the extraordinary assistance of the Spirit, which must at least amount to superintendent inspiration; but it has been controverted, whether this inspiration extended to every minute circumstance in their writings, so as to be in the most absolute sense plenary. Jerome, Grotius, Erasmus, Episcopius, and many others, maintain, that it was not: whilst others contend, that the emphatical manner in which our Lord speaks of the agency of the spirit upon them, and in which they themselves speak of their own writings, will justify our believing that their inspiration was plenary, unless there be very convincing evidence brought on the other side to prove that it was not: and if we allow, it is said, that there were some errors in the New Testament, as it came from the hands of the Apostles, there may be great danger of subverting the main purpose and design of it; since there will be endless room to debate the importance both of facts and doctrines. See Doddridge's Lectures.

INSTALMENT, the instating or establishing a person in some dignity. This word is chiefly used for the induction of a dean, prebendary, or other ecclesiastical dignitary, into the possession of his stall, or other proper seat, in the cathedral to which he belongs. It is also used for the ceremony whereby the knights of the garter are placed in their rank, in the chapel of St. George at Windsor, and on many other like occasions. It is sometimes termed installation.

INSTANT, such a part of duration wherein we perceive no succession; or, it is that which takes up the time only of one idea in our minds.

INSTINCT, an appellation given to the sagacity and natural inclinations of brutes, which supplies the place of reason in mankind.

INSTITUTES, in literary history, a book containing the elements of the Roman law, and constitutes the last part of the civil law. The Institutes are divided into four books, and contain an abridgment of the whole body of the civil law, being designed for the use of students.

INSTITUTION, to a benefice, is that whereby the ordinary commits the cure of souls to the parson presented, as by induction he obtains a temporal right to the profits of the living. Previous to the institution, the oath against simony, the oaths of allegiance and supremacy, are to be taken; and, if it be a vicarage, the oath of residence. They are also to subscribe the thirty-nine articles, and the articles concerning the king's supremacy, and the book of common prayer.

INSULATED, in electricity, a term applied to bodies that are supported by electrics, or non-conductors, so that their communication with the earth, by conducting substances, is interrupted.

INSURANCE, or ASSURANCE, in law and commerce, a contract or agreement, whereby one or more persons, called insurers, assurers, &c. oblige themselves to answer for the loss of a ship, house, goods, &c. in consideration of a premium paid by the proprietors of the things insured. See ASSURANCE.

INSURANCE, *marine.* Insurance is a contract of indemnity, whereby the party, in consideration of a stipulated sum, undertakes to indemnify the other against certain specific perils or risks to which he is exposed, or against the occurrence of such events. The party who takes on himself the risk, is called the insurer; the party protected by the insurance is called the insured; the sum paid to the insurer, as the price of this risk, is called the premium; and the written instrument, in which the contract is set forth, and reduced into form, is called a policy of insurance.

Marine insurance is made for the protection of persons having an interest in ships, or goods on board, from the loss or damage which may happen from the perils of the sea, during a certain voyage, or for a fixed period of time.

In this country all persons, whether British subjects or aliens, may in general be insured; the only exception is in the case of an alien enemy. He cannot maintain an action on a policy on goods, though they were shipped before the war commenced; nor can an agent of such insured maintain the action, though he be a creditor of the insured for more than the sum insured.

The statute 6 George I. c. 18, authorized the king to grant charters to two distinct companies or corporations, called the Royal Exchange Assurance, and London Assurance; for the insurance of ships, goods, and merchandises, at sea, or going to sea, and for lending money on bottomry. They are invested with all the powers usually granted to corporations, and the privilege of purchasing lands to the amount of one thousand pounds per annum each, to provide a sufficient capital to insure all demands on their policies. All other companies are restrained from insuring ships and goods at sea, or lending money on bottomry And all policies made by any other corporation, and any copartnerships, shall be void, and the sums underwritten forfeited, and all bottomry bonds deemed usurious: but the right of individual insurers continues as before the act. Contracts made in derogation of the rights of the insurance companies are illegal and void.

Ships, freight, goods, and merchandises, &c. are the proper subjects of marine insurance, and there are certain articles which, from motives of public policy, cannot be legally insured in this country, and others which can only be insured under particular restrictions.

Insurance being a contract of indemnity from loss or damage, arising upon an uncertain event, there cannot be an indemnity without a loss, nor a loss without an interest; a policy, therefore, without interest, is not an insurance, but a mere wager. Different persons, having each a qualified property in goods, may insure them to the full value. A reasonable expectation of profit, on a well founded expectation of a future interest in the thing insured, is an insurable interest.

Wager policy. This is usually conceived in the terms, interest or no interest, or, without further proof of interest than the policy, to preclude all inquiry into the interest of the insured, and as a consequence of the insured's having no interest in the pretended subject of the policy, it follows, that the insurer cannot be liable for any partial loss.

INSURANCE *Re.* A policy of insurance being once signed, the underwriters are bound by the terms of it, nor can they be released from their contract without the consent of the insured. But an underwriter may shift it, or part of it, from himself to other insurers, by causing a re-insurance to be made on the same risk, and the new insurers will be responsible to him in case of loss to the amount of the re-insurance. But the re-insurer is only responsible to the original insurer, and not to the original insured. Thus stands the law on this subject in most of the states of Europe; but in England, by the 19 George II. c. 37, re-insurances are prohibited, except in case of the insolvency or death of the original insurer. This has been held to extend not only to British, but also to foreign ships.

INSURANCE, *double,* is where the insured make two insurances on the same risk and the same interest. A double insurance, though it be made with a view to a double satisfaction in case of loss, and is therefore in the nature of a wager, is not void. The two policies are considered as making but one insurance, and are good to the extent of the value of the effects put in risk. All the underwriters in this case contribute in proportion to their several subscriptions; and therefore, if the insured should sue only on one of the policies, the underwriters on that policy may recover a rateable contribution from those on the other.

Of the voyage. No insurance can be legally made upon any voyage undertaken contrary to the laws of this kingdom, or to those of its dependencies, or to the law of nations, and it is immaterial whether the insurer was or was not informed that the voyage was illegal. An insurance, therefore, upon a voyage undertaken contrary to the navigation law, is void.

INSURANCES, *risks against which may be made.* Insurances may be made against all the risks or perils which are incident to sea voyages, subject, however, to certain exceptions, founded in public policy and the interests of humanity, which require, that in certain cases men shall not be permitted to protect themselves against some particular perils of insurance. But an insurer cannot make himself answerable for a loss proceeding from the fault of the insured. No insurance can be made, even against the perils of the sea, upon illegal commerce. In order to confine insurances against real and important losses arising from the perils of the sea, and to obviate disputes respecting losses from the perishable quality of the goods insured, and all trivial subjects of litigation, it appears to be the general law of all states, that the insurer shall not be liable for any average loss, unless it exceed one per cent. beside which, a clause has been introduced into policies, that the insurer shall not be liable for any partial loss under a given rate per cent. In England it is now constantly stipulated in all policies, that upon certain enumerated articles the insurer shall not be answerable for any partial loss whatever; that upon certain others, liable to partial injuries, but less difficult to be preserved at sea, he shall only be liable for partial losses above three per cent. But this does not extend to the losses, however small, called general average, and losses occasioned by the stranding of the ship, and the loss by stranding must be an immediate loss.

Commencement and continuance of the risk. In England the commencement of the risk of the ship varies in almost every case. In outward-bound voyages, it is generally made to commence from her beginning to load at her port of departure. Sometimes privateers on a cruise, ships engaged in the coasting trade, or in short voyages, are insured for a limited period of time; and in such case the risk commences and ends with the term, wherever the ship may then happen to be. If a ship is ensured from the port of London to any other port, and before she breaks ground an accident happens to her, the insurers are not answerable, for the risk does not commence till she sets sail on her departure from the port of London. But if the insurance be allowed, and from the port of London, the insurers are liable to any accident that may happen to her from the time of subscribing the policy. When a ship, expected to arrive at a certain place abroad, is insured at and from that place, or from her arrival there, the risk begins from the first moment of her arrival at the place specified, and the words first arrival are implied, and always understood, in policies so worded. The risk in such cases continues there as long as the ship is preparing for the voyage insured; but if all thought of the voyage be laid aside, and the ship be suffered to lay there for a length of time, with the owner's privity, the insurers are not liable. In English policies, it is usually made to continue only until the ship has moored at anchor twenty-four hours in good safety, and on such policies the insurer is liable for no loss after that time.

To charge the insurer, it is not enough that a loss has happened at sea, it must appear to have happened in the course of the voyage, and during the continuance of the risk insured. Upon goods, the risk does not commence until they are actually on board the ship, and therefore the insurer is not answerable for any loss or damage which may happen to them while they are on the passage to the ship, and, in general, the risk on goods continues no longer than while they are on board the ship mentioned in the policy, and that if they be removed from on board that ship and landed, or put on board another ship, without the consent of the insurers, the contract is at an end.

Policies, with reference to the reality of the interest of the insured, are distinguished into interest and wager policies; with reference to the amount of the interest, they are distinguished into open and valued. An interest policy is where the insured has a real, substantial, assignable interest in the thing insured, in which case only it is a contract of indemnity. A wager policy is a pretended insurance, where the insured has no interest in the thing insured. Insurances of this sort are usually expressed by the words interest or no interest, or without further proof of interest than the policy, or without benefit of salvage to the insurer, and these are wholly illegal. An open policy is where the amount of the insured is not fixed by the policy, but is left to be ascertained by the insured, in case a loss should happen. A valued policy is where a value has been set on the ship or goods insured, and the value is inserted in the policy in the nature of liquidated damages, to save the necessity of proving it in case of total loss.

Every fact and circumstance relating to the contract of insurance must be stated with the most scrupulous regard to truth. The voyage insured must, therefore, be truly and accurately described in the policy; namely, the time and place at which the risk is to begin, the place of the ship's departure, the place of her destination, and the time when the risk shall end; whether on goods or on the ship. If a blank be left for the place either of the ship's departure or destination, the policy will be void for the uncertainty.

A warranty is a stipulation or agreement on the part of the insured, in nature of a condition precedent, or thing absolutely and strictly to be performed, as the very basis of the contract; as that the thing insured is neutral property; that the ship is of such a force, that she sailed, or was well on such a day, &c.; or as that a ship shall sail on or before some given day; that she shall depart with convoy; that she shall be manned with such a complement of men, &c. These warranties are either expressed or implied.

An implied warranty is that which reasonably results from the nature of the contract, as that the ship shall be seaworthy when she sails on the voyage insured, that the voyage is lawful, and shall be performed according to law, and in the usual course, and without deviation.

There are five things essential to a sailing with convoy: 1. It must be with the regular convoy appointed by government. 2. It must be from the place of rendezvous appointed by government. 3. It must be a convoy for the voyage. 4. The ship insured must have sailing instructions. 5. She must depart and continue with the convoy till the end of the voyage, unless separated by necessity.

Neutral property, in the sense of which that expression must be understood in this warranty, is that which belongs to the subjects of a state in amity with the belligerent powers. The documents requisite for neutral ships are: 1. The passport. 2. The sea-letter, or sea-brief. 3. The proofs of property, which ought to show that the ship really belongs to the subjects of a neutral state. 4. The muster-roll. 5. The charter-party. 6. The bill of lading. 7. The invoices. 8. The log-book, or ship's journal. 9. The bill of health. But though the want of some of these papers may be taken as strong presumptive evidence, yet it is not conclusive evidence against the ship's neutrality.

Representations. A representation in an insurance is denoted to be a collateral statement, either by word of mouth, or in writing, of such facts or circumstances relative to the proposed adventure, and not inserted in the policy, as are necessary for the information of the insurer, to enable him to form a just estimate of the risk.

A misrepresentation in a material point avoids the contract; and the insured cannot recover on the policy for loss arising from a cause unconnected with the fact misrepresented. So if it be made without knowing whether it be true or false, or even if the person making it believe it to be true; but if he only give it as his belief, without knowing the contrary, it will not affect the contract. Concealment consists in a fraudulent suppression of any fact or circumstance material to the risk. This, like every other fraud, avoids the contract *ab initio*, upon principles of natural justice. But it is not merely on the ground of fraud that a concealment avoids the contract; even an innocent concealment of material facts will avoid the policy.

Sea-worthiness. In every insurance, whether of ship or goods, there is an implied warranty of the sea-worthiness of the ship, that is to say, that she shall be tight, staunch, and strong, properly manned, and provided with all necessary stores, and in every other respect fit for the voyage.

Deviation, is a voluntary departure, without reasonable cause, from the regular course of the voyage insured. From the moment this happens the contract becomes void. The course of the voyage does not mean the nearest possible way, but the usual and regular course. Accordingly, stopping at certain places on the voyage is no deviation, if it be customary so to do; but such usage can only be supported by long and regular practice.

Loss, is either total or partial. The term total loss means not only the total destruction of, but also such damage to the thing insured, as renders it of little or no value to the insured, although it may specifically remain. Thus, a loss is said to be total, if, in consequence of the misfortune that has happened, the voyage be lost or not worth pursuing, and the projected adventure frustrated; or if the value of what is saved be less than the freight, &c. A partial loss is any thing short of a total loss; such losses are sometimes styled average losses. Losses by perils of the sea are generally understood to be such accidents or misfortunes as proceed from sea damage; that is to say, such as arise from stress of weather, winds, waves, lightning, tempests, rocks, sands, &c.

If a ship be not heard of for a reasonable time, she shall be presumed to have foundered at sea, and the insured has a right to recover, as such, from the underwriter. A loss by fire, which is merely accidental, and not imputable to the master or mariners, is undoubtedly within the policy. If a ship be burnt by order of the state where she happens to be, to prevent infection, this also has been held a loss within the policy.

If a ship be attacked by an enemy, and the captain, unable to defend her, leave and set fire to her, to prevent her from falling into the enemy's hands, the insurer is said to be liable.

Capture is where a ship is taken by an enemy in war, or by way of reprisals, or by a pirate. Capture may be with an intent to possess the ship and cargo, or only to seize the goods on board as contraband; the former is a capture, the latter only an arrest or detention. Every capture, whether lawful or unlawful, is within the policy; provided the words of the policy be sufficiently comprehensive. Where the ship is re-captured before abandonment, it is a partial loss; and the insurer is bound to pay the salvage, and other necessary expenses the insured may have incurred to recover his property. In general, wherever a ship is taken by the enemy, the insured may abandon, and demand as for a total loss; but he is not bound to abandon; if he do, the insurer, in case of re-capture, will stand in his place, and is liable for all fair charges occasioned by the capture.

Loss by detention of princes, &c. There is an obvious difference between this and capture; the object of the one is prize, that of the other detention, with a design to restore the ship or goods detained, or pay the value to the owner: and though neither of these should be done, still it must be considered as the arrest of princes, the character of any action depending on the original design with which it was done. An arrest of princes may be at sea as well as in port, if it be done from public necessity, and not with a view to plunder.

Loss by barratry. Barratry is any species of fraud committed by the master or mariners, whereby the owners sustain an injury; as by running away with the ship, wilfully carrying her out of her course, sinking or deserting her, embezzling the cargo, smuggling, or any other offence, whereby the ship or cargo may be subjected to arrest, detention, loss, or forfeiture. No fault of the master or mariners amounts to barratry, unless it proceed from an intention to defraud the owners; therefore a deviation, if made through ignorance, unskilfulness, or any motive which is not fraudulent, although it will avoid the policy, does not amount to barratry.

Loss by average contributions. The

goods on board are, in proportion to their respective interests, liable to contribute towards any particular loss or expense incurred for the general safety of the ship or cargo, so that the particular loser may not be a greater sufferer than the other owners of the goods. Thus, where the goods of a particular merchant are thrown overboard to lighten the ship; where the masts, cables, anchors, or other furniture of the ship are cut away, or destroyed, for the safety of the whole; in these, and similar cases, the loss is the proper subject of a general contribution, and ought to be rateably borne by the owners of the ship, freight, and cargo, so that the loss may fall proportionably on all. As to the articles liable to contribute, the rule is, that the ship, freight, and every thing remaining of the cargo, is subject to this charge; therefore, money, plate, and jewels, are as much liable as more heavy and bulky goods. But the persons on board, their wearing apparel, and the jewels belonging to it, shall not contribute; neither are seamen's wages liable to contribute.

Loss by expense of salvage. At common law, the party has a lien on every thing saved, till payment of salvage; but the regulations now principally in force are ascertained by the statutes 12 Anne, c. 18, 26. Geo. II. c. 19, 33. Geo. III. c. 66. The insured need not in his action declare for salvage, but may recover under a declaration for the loss which occasioned it, and the damage which the goods have sustained. In case of neutral ships captured by the enemy, and retaken by British men-of-war, or privateers, the Court of Admiralty has a discretionary power of adjusting the salvage. Before an action will lie for a loss by payment of salvage, the amount must be ascertained by decision of the Court of Admiralty.

Abandonment. The insured may abandon in every case, where, in consequence of any of the perils insured against, the voyage is lost, or not worth pursuing; where the thing insured is so damaged as to be of little or no value to the owner, where the salvage is immoderate, where what is saved is of less value than the freight, or where further expense is necessary, and the insurer will not undertake to pay that expense, &c.

Shipwreck is generally a total loss. What may be saved of the ship or cargo is so uncertain, that the law cannot distinguish this from the loss of the whole. But a mere stranding of the ship is not of itself a total loss; it is only where the stranding is followed by shipwreck, or the ship is otherwise incapable of prosecuting her voyage.

Return of premium. The premium is to be returned in all cases where the contract is void for want of interest; which may be either total, as where the insured has nothing on board the ship; or partial, where he has some interest, but not to the amount in the policy; and it is a general rule, that, wherever insurance is made through mistake, misinformation, or other innocent cause, without interest, or for more than the real interest, there shall be a return of premium.

On a wager policy, the insured cannot recover back the premium, at least after the risk is run. This policy is void, as being without interest, but both parties being guilty of a breach of the statute 19 Geo. II. c. 37, the rule, that where both parties are equally criminal, the possessor has the advantage, applies, and the insured cannot recover back the premium.

Insurance *upon life,* is a contract, by which the underwriter, for a certain sum, proportioned to the age, health, and profession of the person whose life is the object of the insurance, engages that the person shall not die within the time limited in the policy; or, if he do, that he, the underwriter, will pay a sum of money to the person in whose favour the policy is granted: and in this, as well as in marine insurances, the party must have an actual interest.

Insurance *against fire,* is a contract by which the insurer undertakes, in consideration of a premium, to indemnify the insured against all losses which he may sustain in his house or goods by means of fire, within the time limited in the policy.

INTEGER, in arithmetic, a whole number, in contradistinction to a fraction.

INTEGRAL, or *integrant,* in philosophy, appellations given to parts of bodies which are of a similar nature with the whole: thus filings of iron have the same nature and properties as bars of iron.

INTEGRAL *calculus.* See Calculus.

INTEGUMENTS, in physiology, denote the common coverings which invest the body, as the cutis, &c. The common integuments are the skin, with the fat and cellular membrane adhering to it. The term integument is also extended to the particular membranes which invest certain parts of the body, as the coats or tunics of the eye.

INTELLIGENCE, in a military sense, may be variously applied, and of course has different significations. No general can be said to be in any degree qualified for the important situation which he holds, unless, like an able minister of state, he be constantly prepared with the requisite means to obtain the best intelligence respecting the movements and the designs of the enemy he is to oppose. On the other hand, it is not possible to conceive a greater crime than that of affording intelligence to an enemy, and thereby bringing about the overthrow and destruction of a whole army. A French military writer makes the following observations respecting the latter species of intelligence, which he classes under two specific heads. He justly remarks, that to hold correspondence, or to be in intelligence with an enemy, is not only to betray your king, but likewise your country. Armies and fortified places are almost always surprised and taken by means of a secret intelligence which the enemy keeps up with domestic traitors, acting in conjunction with commissioned spies and delegated hirelings.

A garrison town may be taken by surprise, under the influence of secret intelligence, in two different ways. The one is, when the assailant, to whom the place has been surrendered, is not bound to join his forces to those troops by whom he has been admitted; the other, when it is necessary that an assault should be made by openly storming, by throwing shells, and by petards, or by stratagem. The first species of intelligence may be held with a governor, who has influence enough to direct the will and actions of the garrison; with a garrison, which is indisposed towards the governor and the officers that command the troops; with the inhabitants, who have undertaken to defend a place where no garrison is stationed; and, lastly, with the prevailing faction, where there are two parties that govern in a free town. The other species of intelligence may be practised with a governor, who either wants power or is afraid to tamper with the fidelity of the garrison; with some particular officer, serjeants, or soldiers; with the body of inhabitants, who think differently from the armed force that overawes them; or with active and shrewd individuals, who have access to the ruling party, and can skilfully combine affected loyalty with secret disaffection.

There is not, however, in human nature, perhaps, a more insidious or a more dangerous ground to tread on, than that of secret intelligence; nor are the faculties of the mind ever so much put to the test, as when it is necessary to listen to the report of an individual, who, whilst he is betraying one side, may be equally disposed to dupe the other. A wise general will consequently hear every thing, and say nothing; and a wise man, let his secret wishes be what they may, will warily consider, whether the person, who insinuates to him even the possibility of a plot, does not at that instant endeavour to get into his confidence, for the sole purpose of acting contrary to his supposed views, and of betraying the man who has unfolded other schemes. It is certainly justifiable policy, either in the governor of a town, or in a general, to affect to give into the views of any man or party of men whom he has cause to suspect, and whose ultimate object he is determined to defeat. But he should be equally cautious how he listens to the communications of spies or informers. The veil of honesty is often assumed to cover a deep-laid scheme of villany; and apparent candour is the surest path to unguarded confidence. When villains voluntarily unfold themselves in such a manner as to convince an able and penetrating officer that their treachery can be depended upon, much blood may be spared by making a proper use of their intelligence. This axiom has prevailed in every civilized country; and should be well attended to by thinking men. For when a battle has been gained, it avails little to ask whether the enemy owed his success to force or treachery? No treachery, however, is admissible, or should be sanctioned by belligerent powers, which militates against those laws of nations which are founded upon the wise basis of humanity. Private assassination, the use of poison, or the disregard of paroles of honour, must be generally reprobated; and whatever general obtains his ends by any of these dark means, his name should be stamped with infamy, and he himself be exposed to all the melancholy casualties of retaliation. See James's Military Dictionary.

INTENSITY, in physics, is the degree or rate of power or energy of any quality, as of heat and cold. The intensity of qualities, as gravity, light, heat, &c. vary in the reciprocal ratio of the squares of the distances from the centre of the radiating quality.

INTERCALARY, in chronology, an appellation given to the odd day inserted in leap-year; which was so called from *calo*, *calare*, to proclaim it, being proclaimed by the priests with a loud voice. See Bissextile.

INTERCEPTED *axis*, in conic sections, the same with abscisse. See Abscisse.

INTERDICT, an ecclesiastical censure, by which the Church of Rome forbids the performance of divine service in a kingdom, province, town, &c. This censure has been frequently executed in France, Italy, and Germany; and in the year 1170, Pope Alexander III. put all England under an interdict, forbidding the clergy to perform any part of divine service, except baptizing of infants, taking confessions, and giving absolution to dying penitents. But this censure being liable to the ill consequences of promoting libertinism and a neglect of religion, the succeeding popes have very seldom made use of it.

INTEREST, an allowance or compensation for the loan or use of a sum of money for a certain time, according to a fixed rate or proportion. The rate of interest varies in different countries, and at different times, according to the scarcity or plenty of money, and the security of lending; in most commercial states, it has been thought necessary to establish by law a fixed rate of interest for the use of money: this restriction, however, must nearly correspond with the current rate of interest, that is, the rate at which money can be readily borrowed on good security; for if it be attempted to reduce by law the common rate of interest below the lowest ordinary market rate, the restriction will be generally evaded, as under all such attempts it has hitherto invariably been.

By 37th Henry VIII. cap. 9, all interest above 10 per cent. was declared unlawful: before that time higher rates had usually been taken. In the reign of Edward VI. religious zeal prohibited all interest for money; but the prohibition, like all others of the same kind, is said to have produced no effect, and probably rather increased than diminished the evil of usury. The statute of Henry VIII. was revived by the 13th Elizabeth, cap. 8, and 10 per cent. continued to be the legal rate of interest till the 21st of James I. when it was restricted to 8 per cent. In 1651, the rate of interest in several other countries being lower than in England, the parliament reduced the legal rate to 6 per cent. which, soon after the restoration, was confirmed by 12th Charles II. c. 13. The last act of parliament for regulating the interest of money was 12th Anne, st. 2. c. 16, by which it was fixed at five per cent. per annum. These different statutory regulations seem to have been made with great propriety, as they followed the market rate of interest; and since the time of Queen Anne, 5 per cent. appears to have been rather above than below the market rate. Before the American war, government borrowed at little more than 3 per cent.; and about the year 1792, good bills were readily discounted at 4 per cent.

The legal rate of interest in France was not always regulated by the market rate. In 1601, Henry IV. issued an edict for reducing the interest of money in that kingdom to 6¼ per cent.; but the current rate afterwards rose above this limit. In 1720, interest was reduced from the twentieth to the fiftieth penny, or from 5 to 2 per cent. In 1724, it was raised to the thirtieth penny, or to $3\frac{1}{3}$ per cent. In 1725, it was again raised to the twentieth penny, or to 5 per cent. In 1766, it was reduced to the twenty-fifth penny, or to 4 per cent; but a few years after, it was raised again to the old rate of 5 per cent. The supposed purpose of many of these violent reductions of interest was, to prepare the way for reducing that of the public debts; a measure which, when it is not justified by a previous fall in the current rate of interest, is nothing better than defrauding the public creditors.

In Holland, previously to the revolution, the government frequently borrowed at 2 per cent. and private persons of good credit at 3 per cent. This lowness of interest induced many of the Dutch to invest their property in the French and English funds. In the United States of America, the lawful rate of interest is 6 per cent. in most of the states; in a few it is 7 per cent.; and in one it is only 5 per cent. In Greece, the mean rate of interest is 20 per cent. and in the other parts of Turkey nearly the same; in Persia, 25 per cent.; and in the Mogul empire, 30 per cent. In Bengal, and the other British possessions in India, the interest is generally from 8 to 12 per cent. on government security, but individuals are frequently obliged to pay a much higher rate. In these countries there is no fixed rate of interest, and the usual high rate arises chiefly from the insecurity of lending.

Interest is generally payable yearly, half-yearly, or quarterly, and is distinguished into *simple interest and compound interest;* the former being merely the compensation paid for the use of a capital at a certain fixed rate for a year, and a proportionately greater or less sum for a greater or less time; while in the latter the interest which becomes due in the first year, or other interval, is added to the principal, and thus forms a new capital, on which the interest of the second year is to be computed; and thus the capital, and consequently the amount of interest, are continually increasing. Simple interest only is lawful in loans between individuals, and in discounting notes or bills of exchange; but in the granting or purchasing of annuities, either for terms of years, or for lives, or of leases, or reversions, it is usual to allow the purchaser compound interest for his money, unless there is a particular agreement to the contrary.

INTEREST, *simple.* If 5*l.* is the interest of 100*l.* for a year, $\frac{5}{100}$, or .05, is the interest of 1*l.* for the same term: for, as $100 : 5 :: 1 : \frac{5}{100}$. Let then the interest of 1*l.* for one year $= r$; the principal $= p$; the time $= t$; the amount in the said time, *viz.* principal and interest $= a$. Then r being the interest of 1*l.* for one year, the interest of 1*l.* for two years will be $2r$; for three years, $3r$; and for any number of years, tr. Now, as one pound is to its interest, so is any given principal to its interest, or

As $1 : tr :: p : ptr =$ interest of p.

Then the principal being added to its interest, their sum will be $= a$, the amount required; which gives the following theorems for answering all questions relating to simple interest, *viz.*

If principal, time, and rate, are given, to find the amount.

Theo. 1. $ptr+p=a$.

If the amount, time, and rate, are given, to find the principal?

Theo. 2. $\frac{a}{tr+1}=p$.

If the principal, amount, and time, are given, to find the rate?

Theo. 3. $\frac{a-p}{pt}=r$.

If the principal, amount, and rate, are given, to find the time?

Theo. 4. $\frac{a-p}{pr}=t$.

Ex. 1. What sum will one penny amount to in 1808 years, if put out to interest at 5 per cent. per annum?

Multiply .004166 by 1808 and by .05, the product is .376666, which, added to the principal, gives .380833 = 7*s.* 7½*d.*

Ex. 2. What sum will amount to 100*l.* in seven years, at 4 per cent. per annum?

Multiply 7 by .04, and add 1, which makes 1.28; divide 100*l.* by this sum, and the quotient is 78.125 = 78*l.* 2*s.* 6*d.*

Ex. 3. At what rate per cent. per annum, will 100*l.* amount to 145*l.* 10*s.* in 7 years, at simple interest?

Subtract 100*l.* from 145*l.* 10*s.* the remainder is 45*l.* 10*s.* which, divided by the product of the principal and time, or 700, gives .065 = 6½ per cent.

Ex. 4. In what time will 125*l.* amount to 212*l.* 10*s.* at simple interest of 5 per cent. per annum?

Subtract 125*l.* from 212*l.* 10*s.* the remainder is 87*l.* 10*s.* which, divided by the product of the principal and rate, or 6.25, gives the answer, 14 years.

Tables of simple interest are easily computed, and many such have been published, but those only are of much utility, which show readily the interest of any sum for any number of days. Such a table is unavoidably very extensive, and forms of itself a thick volume; it cannot therefore be inserted in a work of this nature, but that which follows will answer all useful purposes to those who are acquainted with decimal arithmetic. Such as prefer a table expressed in pounds, shillings, and pence, are referred to the interest tables published by Mr. John Thompson of Edinburgh, Mr. Joseph King of Liverpool, and particularly to the improved interest tables of Mr. William Reed, which show at one reference the interest at 5 per cent. of all sums, at the dates that usually occur in business.

The interest of any sum, for one day, is found by dividing the annual interest by 365; thus, at 5 per cent. the interest of 1*l.* for one day is - - - - 00013699

which, multiplied by 2, gives

the interest for 2 days - - 00027397

by 3 - - 3 - - - 00041096

by 4 - - 4 - - - 00054795

and by proceeding in this manner, the following table is easily formed.

INTEREST.

TABLE,

Showing the Simple Interest of One Pound for any Number of Days, at 5 per cent. per Annum.

Days.	Amount.	Days.	Amount.	Days.	Amount.	Days.	Amount.
1	.0001369	27	.0036986	53	.0072602	78	.0106849
2	.0002739	28	.0038356	54	.0073972	79	.0108219
3	.0004109	29	.0039726	55	.0075342	80	.0109589
4	.0005479	30	.0041095	56	.0076712	81	.0110958
5	.0006849	31	.0042465	57	.0078082	82	.0112328
6	.0008219	32	.0043835	58	.0079452	83	.0113698
7	.0009589	33	0045205	59	.0080821	84	.0115068
8	.0010958	34	.0046575	60	.0082191	85	.0116438
9	.0012328	35	.0047945	61	.0083561	86	.0117808
10	.0013698	36	.0049315	62	.0084931	87	.0119178
11	.0015068	37	.0050684	63	.0086301	88	.0120547
12	.0016438	38	.0052054	64	.0087671	89	.0121917
13	.0017808	39	.0053424	65	.0089041	90	.0123287
14	.0019178	40	.0054794	66	.0090411	91	.0124657
15	.0020547	41	.0056164	67	.0091780	92	.0126027
16	.0021917	42	.0057534	68	.0093150	93	.0127397
17	.0023287	43	.0058904	69	.0094520	94	.0128767
18	.0024657	44	.0060274	70	.0095890	95	.0130137
19	.0026027	45	.0061643	71	.0097260	96	.0131506
20	.0027397	46	.0063013	72	.0098630	97	.0132876
21	.0028767	47	.0064383	73	0100000	98	.0134246
22	.0030137	48	.0065753	74	.0101369	99	.0135616
23	.0031506	49	.0067123	75	.0102739	100	.0136986
24	.0032876	50	.0068493	76	.0104109	200	.0273972
25	.0034246	51	.0069863	77	.0105479	300	.0410958
26	.0035616	52	.0071232				

Ex. 1. What is the interest of 250*l.* for 63 days?

$.0086301 \times 250 = 2l.\ 3s.\ 1\frac{3}{4}d.$

The interest for any number of days, not specified in the table, may be easily found, by adding two of the numbers contained in it.

Ex. 2. What is the interest of 115*l.* for 237 days?

The interest of 1*l.* for 200 days is .0273972, and for 37 days .0050684, which added together make 0324656; therefore,

$.0324656 \times 115 = 3l.\ 14s.\ 8d.$ = the interest required.

By the act of 12 Anne, no person is to take for the loan of money, above 5*l.* for the interest of 100*l.* for a year; and all notes, bonds, or other contracts made for money at a greater rate of interest, are to be void, and the offender to forfeit treble the value.

INTEREST, *compound*, is allowing interest upon interest, or adding the interest as it becomes due to its principal, and considering the whole as a new principal, bearing interest at the same rate as before. Let r now represent the amount of one pound in one year, that is, principal and interest; let n = the number of years; p = the principal; a = the amount. Then

$1 : r :: r : r^2$ the amount of 1*l.* in 2 years,
$1 : r :: r^2 : r^3$ the amount of 1*l.* in 3 years,
$1 : r :: r^3 : r^4$ the amount of 1*l.* in 4 years,
&c.

Whence it appears, that r raised to the power whose exponent is the given number of years, or r^n, will be the amount of 1*l.* in those years; and as

$$1l. : r^n :: p : a$$

from which the following theorems are easily deduced, *viz.* if the principal, time, and rate of interest, are given, to find the amount.

Theo. 1. $p \times r^n = a$

If the amount, time, and rate, are given, to find the principal?

Theo. 2. $\frac{a}{r^n} = p.$

If the principal, amount, and time, are given, to find the rate?

Theo. 3. $\sqrt[n]{\frac{a}{p}} = r$

If the principal, amount, and rate, are given, to find the time?

Theo. 4. $\frac{a}{p}=r^n$, therefore, $\frac{a}{p}$ being divided by r till nothing remains, the number of divisions will be n.

It seldom happens, however, that it is necessary to work questions relative to compound interest by these rules, as very extensive and accurate tables have been published by Mr. John Smart and others, which save much labour in such calculations, and are therefore generally resorted to in practice. The principles on which such tables are formed will appear from what has been already said: thus, the numbers in a table shewing the amount of 1*l.* in any given number of years, are merely the powers of 1*l.* increased by its interest for a year; that is, r, r^2, r^3, r^4, &c. and the numbers contained in a table of the present values of 1*l.* to be received at the end of a given number of years, are 1*l.* discounted for those years, or 1*l.* divided by the powers of r, that is, $\frac{1}{r}, \frac{1}{r^2}, \frac{1}{r^3}, \frac{1}{r^4}$, &c.

Tables of this kind being usually confined to six or eight places of decimals, necessarily give the amount beyond the first three or four years somewhat less than the true amount, but the difference is so small as to be of no importance in the purposes to which they are usually applied.

TABLE I.

Showing the Sum to which 1*l.* Principal will increase, at 5 per cent. Compound Interest, in any Number of Years not exceeding a Hundred.

Years.	Amount.	Years.	Amount.	Years.	Amount.	Years.	Amount.
1	1.05	26	3.555672	51	12.040769	76	40.774320
2	1.1025	27	3.733456	52	12.642808	77	42.813036
3	1.57625	28	3.920129	53	13.274948	78	44.953688
4	1.215506	29	4.116135	54	13.938696	79	47.201372
5	1.276281	30	4.321942	55	14.635630	80	49.561441
6	1.340095	31	4.538039	56	15.367412	81	52.039513
7	1.407100	32	4.764941	57	16.135783	82	54.641488
8	1.477455	33	5.003188	58	16.942572	83	57.373563
9	1.551328	34	5.253347	59	17.789700	84	60.242241
10	1.628894	35	5.516015	60	18.679185	85	63.254353
11	1.710339	36	5.791816	61	19.613145	86	66.417071
12	1 795856	37	6.081406	62	20.593802	87	69.737924
13	1.885649	38	6.385477	63	21.623492	88	73.224820
14	1.979931	39	6.704751	64	22.704667	89	76.886061
15	2.078928	40	7.039988	65	23.839900	90	80.730365
16	2.182874	41	7.391988	66	25.031895	91	84.766883
17	2.292018	42	7.761587	67	26.283490	92	89.005227
18	2.406619	43	8.149666	68	27.597664	93	93.455488
19	2.526950	44	8.557150	69	28.977548	94	98.128263
20	2.653297	45	8.985007	70	30.426425	95	103.034676
21	2.785962	46	9.434258	71	31.947746	96	108.186410
22	2.925260	47	9.905971	72	33.545134	97	113.595730
23	3.071523	48	10.401269	73	35.222390	98	119.275517
24	3.225099	49	10.921333	74	36.983510	99	125 239293
25	3.386354	50	11.467399	75	38.832685	100	131.501257

Ex. 1. What sum will 500*l.* increase to in 21 years, if improved at 5 per cent. compound interest?

500 × 2.785962 = 1392*l.* 19*s.* 7¼*d.*

Ex. 2. What sum, if improved at 5 per cent. compound interest, will accumulate to a million in 50 years?

$\frac{1000000}{11.467399}$ = 87203*l.* 14*s.* 8*d.*

The increase of an annuity, if forborne for a given time, may be found by this table, in the same manner as the amount of a given sum; for as each payment of the annuity will become due at an equal distance from the time in which it would have been due, the amount of the first payment must give that of each of the succeeding ones.

Ex. 3. A person being entitled to an annuity of 50 guineas per annum, is willing that the same shall not commence till after the expiration of 6 years, on being then allowed an equivalent annuity. What must this annuity be?

52.5 × 1.340095 = 70*l.* 7*s.* 1*d.*

TABLE II.

Showing the present Value of 1*l.* to be received at the end of any Number of Years not exceeding a Hundred, discounting at the rate of 5 per cent. Compound Interest.

Years.	Value.	Years.	Value.	Years.	Value.	Years.	Value.
1	.952381	26	.281241	51	.083051	76	.024525
2	.907029	27	.267848	52	.079096	77	.023357
3	.863868	28	.255094	53	.075330	78	.022245
4	.822702	29	.242946	54	.071743	79	.021186
5	.783526	30	.231377	55	.068326	80	.020177
6	.746215	31	.220359	56	.065073	81	.019216
7	.710681	32	.209866	57	.061974	32	.018301
8	.676839	33	.199873	58	·059023	83	.017430
9	.644609	34	.190355	59	.056212	84	.016600
10	.613913	35	.181290	60	.053536	85	.015809
11	.584679	36	.172657	61	.050986	86	.015056
12	.556837	37	.164436	62	.048558	87	.014339
13	.530321	38	.156605	63	.046246	88	.013657
14	.505068	39	.149148	64	.044044	89	.013006
15	.481017	40	.142046	65	.041946	90	.012387
16	.458112	41	.135282	66	.039949	91	.011797
17	.436297	42	.128840	67	.038047	92	.011235
18	.415521	43	.122704	68	.036236	93	.010700
19	.395734	44	.116861	69	.034509	94	.010191
20	.376889	45	.111297	70	.032866	95	.009705
21	.358942	46	.105997	71	.031301	96	.009243
22	.341850	47	.100949	72	.029811	97	.008803
23	.325571	48	.096142	73	.028391	98	.008384
24	.310068	49	.091564	74	.027039	99	.007985
25	.295303	50	.087204	75	.025752	100	.007604

Ex. 1. A person is entitled to receive 1000*l.* at the end of seven years from the present time; what sum paid him immediately would be equivalent thereto?

1000 × .710681 = 710*l.* 13*s.* 7¼*d.*

Ex. 2. What is the present worth of 222*l.* 10*s.* payable 15 years hence?

222.5 × .481017 = 107*l.* 0*s.* 6¼*d.*

Ex. 3. What is the present value of 1392*l.* 19*s.* 7*d.* to be received at the expiration of 21 years?

1392.98 × .358942 = 500*l.*

Tables showing the present value or amount of annual payments of compound interest are given under the articles Annuities and Leases.

It is not legal to lend money at compound interest, but in granting or purchasing annuities, either for lives or terms of years, it is always usual to compute their value at compound interest; this is particularly the case with respect to sums of money which are not receivable till some future period. See Reversions.

Interest, in law, is usually taken for a term, or chattel real, and more particularly for a future term.

Interest *of money*, is the premium paid for the use of a sum, and is by law, in this country, limited strictly to five per cent. per annum. See Usury.

Where an estate is devised for payment of debts, chancery will not allow interest for book debts. In case of a vested legacy, due immediately, and charged on land, or money in the funds, which yield an immediate profit, interest shall be payable thereon from testator's death; but if charged only on the personal estate, which cannot be immediately got in, it shall carry interest only from the end of the year after the death of the testator. Where lands are charged with payment of a sum in gross, they are also chargeable in equity with payment of interest for such sum.

INTERJECTION, in grammar, an indeclinable part of speech, signifying some passion or emotion of the mind. As the greatest part of the expressions used on these occasions are taken from nature alone, the real interjections, in most languages, are monosyllables; and as all nations agree in these natural passions, so do they agree in the signs and indications of them, as of love, mirth, &c. See Grammar.

INTERLOCUTORY *judgments*, in law, are such as are given in the middle of a cause, upon some plea, proceeding, or default, which is only intermediate, and does not finally determine or complete the suit.

INTERLUDE, an entertainment exhibited on the theatre between the acts of a play, to amuse the spectators while the actors take breath and shift their dress, or to give time for changing the scenes and decorations.

INTERMEDIATES, in chemistry, a term made use of when speaking of chemical affinity. Oil, for example, has no affinity to water, unless it be previously combined with an alkali, it then becomes soap, and the alkali is said to be the intermedium which causes the union.

INTERNAL, in general, signifies whatever is within a thing.

Euclid (lib. i. prop. 32) proves, that the sum of the three angles of every triangle is equal to two right angles; whence he deduces several useful corollaries.—He likewise deduces from the same proposition, this theorem, *viz.* that the sum of the angles of every rectilinear figure is equal to twice as many right angles as the figure hath sides, excepting or subtracting four.

INTERPOLATION, among critics, denotes a spurious passage, inserted into the writings of some ancient author.—One great rule with regard to the expunging interpolations is, that the restitution be perfectly agreeable to the rest of the work.

Interpolation, in algebra, is used for finding an intermediate term of a series, its place in the series being given.

INTERROGATION, or *point of* Interrogation, in grammar, a character of this form (?) serving to denote a question.

Interrogation, in rhetoric, is a figure, whereby the orator proposes something by way of question; which, it must be owned, greatly enlivens the discourse.

INTERSECTION, in the mathematics, signifies the cutting of one line or plane by another. Thus, we say, that the mutual intersection of two planes is a right line. The centre of a circle, or conic section, &c. is the intersection of two diameters; and the central point of a quadrangle is the intersection of two diagonals.

INTERVAL, in music, the difference between two sounds, in respect of acute and grave; or that imaginary space terminated by two sounds, differing in acuteness or gravity.

When two or more sounds are compared in this relation, they are either equal or unequal in the degree of time; such as are equal are called unisons, with regard to each other, as having one tune; the other, being at a distance from each other, constitute what we call an interval in music; which is properly the distance in time between two sounds. Intervals are distinguished into simple and compound. A simple interval is without parts or divisions. Such are the octave, and all that are within it; as the second, third, fourth, fifth, sixth, and seventh, with their varieties. A compound interval consists of several lesser intervals; such are all those greater than the octave, as the ninth, tenth, eleventh, twelfth, &c. with their varieties.

INTESTINA, in natural history, the first of the five orders of the class Vermes, in the Linnæan system. This order is described as of a formation the most simple, being naked animals without limbs. They live, some of them within other animals, some in waters, and a few in the earth. They are distinguished from the Mollusca, by the want of moveable appendages, or tentacula. There are two divisions.

A, found within other animals, without eyes, of which there are fifteen genera; *viz.*

Ascaris	Ligula
Caryophyllæus	Linguatela
Cucullanus	Scolex
Echynorhynchus	Strongylus
Fasciola	Tænia
Filaria	Tricocephalus
Furia	Uncinariæ
Hæruca	

B, not inhabiting the bodies of other animals, these are some with and some without a lateral pore, and others perforated with a lateral pore. Of these there are five species, *viz.*

Gordius	Planaria
Hirudo	Sipunculus
Lumbricus.	

We refer the reader to the articles under these words in the alphabetical order; but having omitted CARYOPHYLLÆUS, we insert it here: Body round; mouth dilated and fringed. One species, *viz.* C. piscium, which inhabits the intestines of various fresh water fish, as the carp, tench, bream, &c.; the body is clay colour, about an inch long, rounded at the hind part, and broader before.

INTESTINES, in anatomy, long cylindrical, hollow, and membranaceous bodies; or rather one such continued body, or tube, reaching from the stomach to the anus. See ANATOMY.

INTORSION, in botany, a term used to denote the bending of any of the parts of a plant towards one side. This admits of certain distinctions. 1. Twining stems which bend towards the left, as in hops, honey-suckle, &c.; but in the kidney-bean, convolvulus, &c. they bend to the right. 2. Twining tendrils, which bend to the right and back again; of this kind are the tendrils of most of the pea-bloom or leguminous tribe of plants. 3. Twisted flowers in the periwinkle; the petals bend to the left; the pointal in the viscous campion is twisted to the left, as the seed-bud is in the screw-tree. In oats, the beard which terminates the husk is twisted like a rope. This species of contortion being effected by the moisture or dryness of the atmosphere is denominated by Linnæus, "intorsio hygrometrica." Another species of intorsion is the appearance of the petals in the violet, basil, &c. in which the upper lip of the corolla looks to the ground, and the under lip upwards.

INTRADOS, in architecture the interior and lower side, or curve, of the arch of a bridge; in contradistinction from the extrados, or exterior curve, or line, on the upper side of the arch.

INTRINSIC, a term applied to the inner, real, and genuine values, properties, &c. of any thing, in opposition to their extrinsic or apparent values, &c.

INTUITION, among logicians, the act whereby the mind perceives the agreement or disagreement of two ideas, immediately by themselves, without the intervention of any other; in which case the mind perceives the truth as the eye doth the light, only by being directed towards it. Thus the mind perceives that white is not black, that three are more than two, and equal to one and two. This part of knowledge, says Mr. Locke, is irresistible, and, like the sunshine, forces itself immediately to be perceived, as soon as ever the mind turns its view that way. It is on this intuition that all the certainty and evidence of our other knowledge depends; this certainty every one finds to be so great, that he cannot imagine, and therefore cannot require, a greater.

INVECTED, in heraldry, denotes a thing fluted, or furrowed. Invected is just the reverse of ingrailed, in which the points are turned outward to the field, whereas in invected, they are turned inward to the ordinary, and the small semicircles outward to the field.

INVECTIVE, in rhetoric, differs from reproof, as the latter proceeds from a friend, and is intended for the good of the person reproved; whereas the invective is the work of an enemy, and entirely designed to vex and give uneasiness to the person against whom it is directed.

INVENTION, denotes the act of finding any thing new, or even the thing thus found. Invention is, according to lord Bacon, of two very different kinds, the one of arts and sciences, the other of arguments and discourse: the former he sets down as absolutely deficient. That the other part of knowledge is wanting, says he, seems clear; for logic professes not, nor pretends to invent, either mechanical or liberal arts; nor to deduce the operations of the one, or the axioms of the other, but only leaves us this instruction, "To believe every artist in his own art." His lordship further maintains, that men are hitherto more obliged to brutes than reason for inventions. Whence those who have written concerning the first inventors of things, and origin of sciences, rather celebrate chance than art, and bring in beasts, birds, fishes, and serpents, rather than men, as the first teachers of arts. No wonder, therefore, as the manner of antiquity was to consecrate the inventors of useful things, that the Egyptians, to whom many arts owe their rise, had their temples filled with the images of brutes, and but a few human idols amongst them.

Invention is, therefore, used for a subtlety of mind, or somewhat peculiar in a man's genius, which leads him to the discovery of things new; whence we say a man of invention. Invention, according to Du Bos, is that part which constitutes the principal merit of works, and distinguishes the great genius from the simple artist.

INVENTION, in rhetoric, being one of the second divisions of invention, according to Bacon, signifies the finding out and choosing of arguments which the orator is to use for proving his point, in moving his hearers' passions.

This invention, in the opinion of that philosopher, cannot properly be called invention, which is the discovery of things not yet known, and not the recollecting things that are known: the only use and office of this rhetorical invention being, out of the stock of knowledge already laid up, to select such articles as make for the purpose. The same author divides the method of procuring a stock of matter for discourse into two; the first of which is either by marking out and indicating the parts wherein a thing is to be searched after, which he calls the topical way; and the second is by laying up arguments for use that were composed before hand, and which he calls the promptuary way.

INVENTION, in poetry, is applied to whatever the poet adds to the history of the subject he has chosen, as well as to the new turn he gives it.

INVENTION, in painting, is the choice which the painter makes of the objects that are to enter the composition of his piece.

IN VENTRE SA MERE, is where a woman is with child at the time of her husband's death; which child, if he had been born, would be heir to the land of the husband. A devise to an infant in ventre sa mere is good, by way of future executory devise. And where a daughter comes into land by descent, the son, born after, shall put her out, and have the land.

INVERSE, is applied to a manner of working the rule of three, or proportion, which seems to go backward, or contrary to the order of the common or direct rule. See PROPORTION.

INVERSE *proportion*, or INVERSE *ratio*, in philosophy, is that in which more requires less, or less requires more. Thus, in the case of light and heat flowing from a luminous body, the light and heat are less at a greater distance, and greater at a less distance; so that in this instance more gives less, or a greater distance receives less light and heat; and less gives more, that is, a person coming nearer the illuminated body receives more light and heat than he would at a greater distance. This is expressed in different books, in different ways, sometimes by the term inversely, sometimes by the term reciprocally; as in the case referred to, we say the light and heat are inversely, or reciprocally, as the square of the distance, or in the inverse, or reciprocal, duplicate ratio of the distance.

INVERSION, or, as it is in Euclid, *invertendo*, or by inversion, is inverting the terms of a proportion by changing the antecedents into consequents, and the consequents into antecedents: thus if

$$a : b :: c : d$$
$$4 : 9 :: 12 : 27$$

Then by inversion it will be

$$b : a :: d : c$$
$$9 : 4 :: 27 : 12$$

INVERSION, in music, is a changed position either of a subject or of a chord. The inversion of a subject is produced by giving it a higher or lower situation among the several parts of a score, sometimes making it the bass, at other times the tenor, counter-tenor, or the treble. The inversion of a chord is that changed position of its compotent parts, with respect to its fundamental bass, by which, though the harmony remain the same, the intervals are varied, and the compound assumes another name.

INVERSION, in grammar, is where the words of a phrase are ranged in a manner not so natural as they might be. It is a considerable beauty, either in verse or prose, when we have it from an able hand; it gives vigour and variety to a sentence, and keeps the mind in an agreeable suspense and expectation of a marvellous turn and conclusion.

INVESTIGATION, properly denotes the searching or finding any thing out by the tracks or prints of the feet; whence mathematicians, schoolmen, and grammarians, come to use the term in their respective researches.

INVESTITURE, in law, is the giving possession of lands by actual seisin. The ancient feudal investiture was, where the vassal or descent of lands was admitted in the lord's court, and there received his seisin, in the nature of a renewal of his ancestor's grant, in the presence of the rest of the tenants; but in after-times, entering on any part of the lands, or other notorious possession, was admitted to be equivalent to the formal grant of seisin or investiture.

INULA, in botany, *common inula*, or *elecampane*, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ.

Corymbiferæ, Jussieu. Essential character: receptacle naked; down simple; anthers ending in two bristles at the base. There are thirty-four species; these are generally herbaceous plants; leaves simple, alternate; flowers yellow, axillary, or terminating frequently in corymbs. I. helenium, common inula, or elecampane, has a perennial, fusiform, branching, aromatic root; according to some botanists it is biennial. It is from three to five feet high, and one of the largest of our herbaceous plants; lower leaves on foot stalks, lanceolate, a foot long, and four inches broad in the middle; flowering heads very large, single, terminating the stem and branches; flowrets all yellow, those of the ray narrow, linear, from an inch to an inch and an half in length, with three sharp teeth at the end; pappus, egret or down white, twice as long as the seed, appearing to be capillary; but when viewed with a glass, finely toothed on one side, shorter than the florets, sessile. Native of Japan, Denmark, Germany, Flanders, &c. The official name is enula campana, whence our English name elecampane is derived.

INUNDATÆ, in botany, the name of the fifteenth order in Linnæus's "Fragments of a Natural Method," consisting of plants which grow in the water. Among these may be mentioned, the ceratophyllum, horned pond-weed, and elatine, water-wort. The plants of this order are, as the name imports, aquatic, low, herbaceous, and mostly perennial; the roots are fibrous; the stem is usually wanting, and in its stead is an assemblage of leaves, which, unfolding one another mutually, form a sheath, from the middle of which is produced the foot-stalk of the flower; the leaves are sometimes alternate, sometimes placed in whorls round the stem; the flowers are hermaphrodite in some, as the pond-weed; and on others, the male and female are in the same root; the flowers, in some cases, proceed singly from the wings of the leaves, as in the ceratophyllum, elatine, and hippuris; those of the lower leaves of the myriophillum, water-milfoil, are female; those of the upper, male. The zannichellia, triple-headed pond-weed, has two flowers in the same wing; one male and the other female. The flowers in potamogeton, pond-weed, and ruppia, are disposed in specks in the wings of the leaves; the flower-cup is either wanting, or consists of three, four, or five divisions or leaves; the petals are generally wanting, but the elatine and pond-weed have four; the stamina are in number from one to sixteen and upwards; the seed-buds are from one to four; the style is frequently wanting, as the seed-vessel is universally, except in the elatine, which has a dry capsule, with four external openings, and the same number of cells; there are generally four seeds; but in the ceratophyllum the fruit is a nut or stone, egg-shaped, and containing a single cell.

INVOICE, an account, in writing, of the particulars of merchandise, with their value, custom, charges, &c. transmitted by one merchant to another in a distant country. One copy of every invoice is to be inserted verbatim in the invoice-book, for the merchant's private use; and another copy must, immediately upon shipping off the goods, be dispatched by post, or otherwise, to the correspondent. This copy is commonly drawn out upon a sheet of large post paper, to the end of which is subjoined a letter of advice.

It must here be observed, that when a merchant ships off goods for his own account, the invoice sent to the factor contains only the quantity of goods, but nothing of the cost and charges; and the letter subjoined consists of instructions, signifying in what manner the employer inclines to have his goods disposed of, and returns made.

INVOICE *book*, this book is paged, and contains copies of the invoices of goods sent to sea; for as a merchant is obliged to send his correspondent an invoice of all the goods he consigns to him, so it is reasonable that he should keep a copy of it for himself. For the further uses of invoice-books, see BOOK *of invoices*.

INVOLUCRUM. See BOTANY.

INVOLUTE, *figure* or *curve*, in the higher geometry, is that which is traced out by the outer extremity of a string, as it is folded or wrapped upon another figure, or as it is unwound from off it. The involute of a cycloid is also a cycloid equal to the former, a part that was discovered by Huygens, and by means of this he fell upon the plan of making a pendulum vibrate in the curve of the cycloid, and in equal times, whatever be the length of the curve.

INVOLUTION in algebra, the raising a quantity from its root to any power assigned. See ALGEBRA.

JOINERY, the art of working in wood, or of fitting various pieces of timber together. It differs from the art of the carpenter, inasmuch as the joiner is employed chiefly in the inside work of a house, but the carpenter does the rough work, which, in general, requires more strength and less skill.

JOINT, in general, denotes the juncture of two or more things. The joints of the human body are called by anatomists articulations. The term joint is also applied to the separation between the stones or bricks of a building, usually filled with mortar, plaster, or cement; also by carpenters, to the several manners of assembling or fitting pieces of wood together; as a dovetail joint, &c.

Joint, *universal*, an invention adapted to all kinds of motions and flexures. This was probably the origin of the gimbols used in suspending the mariner's compass. By means of the universal joint, the pull of a bell may be carried to any part of a room, and made to act as well in one place as in another.

Joint Stock Companies. About the time of the famous Mississippi scheme in France, and the South Sea scheme in England, there arose a sort of epidemic fever of speculation, and every one was anxious to join in some partnership, for carrying on speculations in foreign commerce or domestic trade, by companies of persons uniting several individual stocks of small amount into one common fund. At the best it has been observed, that trade, so carried on by large companies, is not very beneficial to the individuals who engage in it, or if it were so, would be greatly prejudicial to the public in general, and to other individuals trading on their own capitals. At the period above mentioned, about 1718 and 1724, many serious consequences ensued from this spirit of speculation, many frauds were committed by adventurers taking advantage of it, and the whole nation was in a manner convulsed by the injuries which the people at large suffered from it, many families having been reduced to utter ruin by it. To prevent these evils occurring in future, the following enactments were passed:—stat. 16 George I. c. 18, s. 18, 19, 20, 21: by which, after reciting, that whereas it is notorious, that several undertakings or projects of different kinds have, at some time or times, since the four-and-twentieth day of June, one thousand seven hundred and eighteen, been publickly contrived and practised, or attempted to be practised within the city of London, and other parts of this kingdom, as also in Ireland, and other his majesty's dominions, which manifestly tend to the common grievances, prejudice, and inconvenience of great numbers of your Majesty's subjects, in their trade or commerce, and other their affairs; and the persons who contrive or attempt such dangerous and mischievous undertakings or projects, under false pretences of public good, do presume, according to their own devices and schemes, to open books, for public subscriptions, and draw in many unwary persons to subscribe therein, towards raising great sums of money, whereupon the subscribers, or claimants under them, do pay small proportions thereof, and such proportions, in the whole, do amount to very large sums; which dangerous and mischievous undertakings, or projects, do relate to several fisheries, and other affairs, wherein the trade, commerce, and welfare of your Majesty's subjects, or great numbers of them, are concerned or interested: and whereas, in many cases, the said undertakers or subscribers have, since the said four-and-twentieth day of June, one thousand seven hundred and eighteen, presumed to act as if they were corporate bodies, and have pretended to make their shares in stocks transferrable or assignable, without any legal authority, either by act of Parliament, or by any charter from the crown, for so doing &c. it is enacted, by authority of this present Parliament, that from and after the four-and-twentieth day of June, one thousand seven hundred and twenty, all and every the undertakings and attempts described as aforesaid, and all other public undertakings and attempts, tending to the common grievance, prejudice, and inconvenience of his Majesty's subjects, or great numbers of them, in their trade, commerce, or other lawful affairs, and all public subscriptions, receipts, payments, assignments, transfers, pretended assignments and transfers, and all other matters and things whatsoever, for furthering, countenancing, or proceeding, in any such undertaking or attempt, and more particularly, the acting, or presuming to act, as a corporate body or bodies; the raising, or pretending to raise, transferable stock or stocks; the transferring, or pretending to transfer, or assign, any share or shares in such stock or stocks, without legal authority, either by act of Parliament, or by any charter from the crown, to warrant such acting as a body corporate, or to raise such transferrable stock or stocks, or to transfer shares therein, and all acting, or pretending to act, under any charter, formerly granted from the crown, for particular or special purposes therein expressed, by persons who do or shall use, or endeavour to use the same charters, for raising a capital stock, or for making transfers or assignments, or pretended transfers or assignments of such stock, not intended or designed by such charter to be raised or transferred, and all acting, or pretending to act, under any obsolete charter, become or voidable by non-user or abuser, or for want of making lawful elections, which were necessary to continue the corporation thereby intended, shall (as to all or any such acts, matters and things, as shall be acted, done, attempted, or endeavoured, or proceeded upon, after the said four-and-twentieth day of June, one thousand seven hundred and twenty) for ever, be deemed to be illegal and void, and shall not be practised, or, in anywise, put in execution. And further, the parties offending, by committing any of the acts above enumerated, and, more particularly, the presuming or pretending to act as a corporate body, or to raise a transferrable stock or stocks, or to make transfers or assignments of any share or shares therein, without such legal authority as aforesaid, &c. shall be deemed to be a public nuisance and nuisances: and all offenders therein, being thereof lawfully convicted, shall be liable to such fines and penalties as persons convicted for public nuisances are; and, moreover, shall incur any further pains, penalties, and forfeitures provided by the statute of provisions and præmunire, made in the sixteenth year of the reign King Richard the second.

If any merchant or trader, at any time after the said four-and-twentieth day of June, one thousand seven hundred and twenty, shall suffer any particular damage in his, her, or their trade, commerce, or other lawful affairs, by occasion or means of any undertaking or attempt, matter or thing, by this act declared to be unlawful, as aforesaid, and will sue to be relieved therein, then, and in every such case, such merchant or trader shall and may have his and their remedy for the same, by an action or actions to be grounded upon this statute, against the persons, societies or partnerships, or any of them, who, contrary to this act, shall be engaged or interested in any such unlawful undertaking or attempt: and in every such action, the plaintiff shall or may recover treble damages, with full costs of suit.

By s. 21, if any broker, or person acting as a broker, shall bargain, sell, buy, or purchase, or contract or agree for the bargaining, &c. of any share or interest in any of the undertakings by the act declared illegal, he shall be rendered incapable of acting as a broker, and forfeit *500l.*, one moiety to the King, and the other to the informer.

S. 25, this act is not to prohibit the carrying on of any home or foreign trade in partnership, in such manner as has been usually and may be legally done, except in insurances, &c.

These enactments have for many years since the passing of them, in 1721, not been enforced, except in the instance of one Cafwood, Michaelmas, 8 George 1., Strange Rep. 472, and Lord Raymond, 1361, who was fined *5l.* and imprisoned during his majesty's pleasure, for being the projector of an unlawful undertaking to trade to the North Sea. In the interval between that time and the present, (1808) many institutions have been formed and carried on in direct violation of the act, such as fire and life insurance companies, which are all beneficial to the community, as they necessarily would be, if carried on with regularity and good faith. The success of these institutions has given rise to many speculations in more recent times, which were not of such obvious utility; and a Mr. Dodd, having projected a distillery, by a joint-stock company, became an object of jealousy to some private distillers, who applied to the court of King's Bench for leave to file a criminal information against him; upon which the court pronounced him within the words of the act, which prohibit the raising of joint stock shares; but refused to interfere, on account of the length of the time during which the statute had lain dormant.

The words of this statute are so clear, that, to the writer of this article, it appears strange that they could ever be misunderstood. They prohibit all combinations in trade, except partnerships and lawful corporations established by act of parliament, or royal charter; and when the nature of mercantile contracts is considered, the law could not safely do otherwise; for it would leave the unwary open to the grossest frauds, and the most ruinous self-delusion. A corporation is not the mere fanciful essence which it is ignorantly deemed to be: it is a combination, formed upon a strict view of legal principle, and the commerce of mankind; upon the only plan on which large bodies of men can be enabled to contract with individuals. In trusting to a corporation, there must be a permanent fund, out of which to answer all obligations, because no individual is answerable personally. Corporations must be confined only, therefore, to those cases in which dealings are simple, and in which a permanent fund can be kept together. Partnerships depend altogether upon individual responsibility, and can therefore not safely be composed of many persons; for in suing and being sued, all the partners must be named. This inconvenience has been attempted to be remedied by making acts of Parliament, to enable certain fire companies, the Albion, Globe, &c. to sue and be sued by their chief clerk, without making them corporations: yet, as they stipulate not to be answerable beyond their individual shares, it will be found difficult, if not impossible, to levy execution upon them, and the party must still sue out one or two thousand writs of fieri facias, for a debt of 20*l.* Such is the consequence of interfering with the established common law. The result will be found to be, that, in all such cases, the public deal with a body of people upon honour and good faith only, and each individual embarks all his fortune in such concerns, and, being once engaged in them, continues still liable. Whether it would be feasible to give further facility to the erecting of trading corporations, considering the advantages of some such institutions, is therefore a question of great difficulty, both in political economy and legislation.

JOINT *tenants,* are those that come to, and hold lands or tenements by one title *pro indiviso,* or without partition. These are distinguished from sole or several tenants, from parceners, and from tenants in common; and they must jointly implead, and jointly be impleaded by others, which properly is common between them and coparceners; but joint tenants have a sole quality of survivorship, which coparceners have not; for if there be two or three joint tenants, and one hath issue and dies, then he or those joint tenants that survive shall have the whole by survivorship. The creation of an estate in joint tenancy depends on the wording of the deed or devise, by which tenant claims title, and cannot arise by act of law. If any estate be given to a plurality of persons, without adding any restrictive, exclusive, or explanatory words, as if an estate be granted to A and B, and their heirs, this makes them immediately joint tenants in fee of the lands. If there be two joint tenants, and one release the other, this passes a fee without the word heirs, because it refers to the whole fee, which they jointly took, and are possessed of by force of the first conveyance; but the tenants in common cannot release each other, for a release supposes the party to have the thing in demand: but tenants in common have several distinct freeholds, which they cannot transfer otherwise than as persons who are sole seized. Although joint tenants are seized *per mie et per tout,* yet to divers purposes each of them hath but a right to a moiety; as, to enfeoff, give or demise, or to forfeit or lose by default in a præcipe; and therefore, where there are two or more joint tenants, and they all join in a feoffment, each of them in judgment gives but his part.

At common law, joint tenants in common were not compellable to make partition; except by the custom of some cities and boroughs. But now joint-tenants may make partition; the one party may compel the other to make partition, which must be by deed: that is to say, all the parties must by deed actually convey and assure to each other the several estates, which they are to take and enjoy severally and separately. Joint tenants being seized *per mie et per tout,* and deriving by one and the same title, must jointly implead, and be jointly impleaded with others. If one joint-tenant refuse to join in an action, he may be summoned and severed; but if the person severed die, the writ abates in real actions, but not in personal and mixed actions.

JOINTURE, a jointure, strictly speaking, signifies a joint estate, limited to both husband and wife; but in common acceptation, it extends also to a sole estate, limited to the wife only, and may be thus defined, *viz.* a competent livelihood for the wife of freehold of lands and tenements, to take effect, in profit or possession, presently after the death of the husband; for the life of the wife at least. By the statute of 27 Henry VIII. c. 10. if a jointure be made to the wife, it is a bar of her dower, so as she shall not have both jointure and dower. And to the making of a perfect jointure within that statute, six things are necessary to be observed. 1. Her jointure is to take effect presently after her husband's decease. 2. It must be for the term of her own life, or greater estate. 3. It should be made to herself. 4. It must be made in satisfaction of her whole dower, and not of part of her dower. 5. It must be either expressed or averred to be in satisfaction of her dower.

6. It should be made during the coverture.

The estate should be made to herself; but as the intention of the statute was to secure the wife a competent provision, and also to exclude her from claiming dower, and likewise her settlement, it seems that a provision or settlement on the wife, though by way of trust, if in other respects it answer the intention of the statute, will be enforced in a court of equity. It should be made during the coverture; this the very words of the act of parliament require; and therefore, if a jointure be made to a woman during her coverture, in satisfaction of dower, she may wave it after her husband's death; but if she enter and agree thereto, she is concluded; for though a woman is not bound by any act when she is not at her own disposal, yet, if she agree to it when she is at liberty, it is her own act, and she cannot avoid it.

JOISTS, in architecture, those pieces of timber framed into the girders and summers, on which the boards of the floor are laid. See ARCHITECTURE and BUILDING.

IONIC *order*, the third of the five orders of architecture, being a kind of mean between the robust and delicate orders. See ARCHITECTURE.

IONIC dialect, in grammar, a manner of speaking peculiar to the people of Ionia. At first it was the same with the ancient Attic; but passing into Asia, it did not arrive at that delicacy and perfection to which the Athenians attained. The Ionians generally changed the *ω* into *η*, as *σοφια* into *σοφιη*; they put the *η* and *ι* for *ε*, and *αιη* for *η*, as *αγγηϊον* for *αγγειον*: *αναγκαιη* for *αναγκη*: they also change *α* and *ει* into *ηι*, *αυ* into *ωυ*, *ει* into *εα* and *εε*, *ευ* into *ω* and *ηϋ*, and *εο* into *ευ*.

JONCQUETA, in botany, so named in memory of Dennis Joncquet, a genus of the Decandria Tetragynia class and order. Essential character: calyx five leaved; petals five, spreading; filaments growing to a glandule; styles none; capsule subglobular, one-celled, five-valved, five-seeded. There is but one species, *viz.* J. guianensis, a large tree, forty to fifty feet high, and about three in diameter, with a russet bark, and a white uncompact wood; it has a great number of branching boughs at the top, those in the middle erect, the rest horizontal, spreading in all directions. Native of Guiana.

JONES (INIGO), an eminent architect, was the son of a clothworker in London, and was born in that city about 1572. Scarcely any thing is known of the manner in which he passed his early years, but it is probable that he enjoyed few advantages of education, and was destined to a mechanical employment. He displayed, however, a talent for the fine arts, which attracted the notice of some lords about the court, among whom were the Earls of Arundel and Pembroke. The latter of these noblemen has generally the credit of becoming his patron, and sending him into Italy for the purpose of perfecting himself in landscape painting, to which his genius seemed first to point. He took up his residence chiefly at Venice, where the works of Palladio gave him a turn to the study of architecture, which branch of art he made his profession. He acquired a reputation in that city, which procured him an invitation from Christian IV. King of Denmark, to come and occupy the post of his first architect. He was some years in the service of that sovereign, whom he accompanied, in 1606, on a visit to his brother in law, King James, and, expressing a desire of remaining in his native country, he was appointed architect to the queen. He served Prince Henry in the same capacity, and obtained a grant in reversion of the place of Surveyor General of the works. After the death of the Prince, Jones again visited Italy, where he pursued further improvement during some years. When the Surveyor's place fell, he returned to occupy the office, and finding the Board of Works much in debt, he relinquished his own dues, and prevailed upon the Comptroller and Paymaster to do the same, till all arrears were cleared.

The King, in 1620, set him a task better suited to a man of learning than an artist; which was to exercise his ingenuity in conjecturing the founders and the purpose of that remarkable remain of antiquity, Stonehenge. Jones, whose ideas were all Roman, convinced himself that it ought to be ascribed to that people, and wrote a treatise to prove his point; but of all the guesses relative to that structure, this has least obtained the concurrence of sound antiquarians. At that time he was building the banquetting-house at Whitehall, which was meant only as a pavilion to a splendid palace intended to be erected, and of which there exists a magnificent design from his ideas. The banquetting-house subsists, a model of the pure and elegant taste of the architect. He was in that reign appointed a commissioner for repairing the Cathedral of St. Paul's, which office, as well as his other posts, were continued to him under Charles I. The entertainments, called masques, introduced by James's queen, Anne of Denmark, and in vogue during the gay part of the succeeding reign, gave Jones frequent employment in the invention of the scenery and decorations. The poetical composer of most of these pieces was Ben Jonson, between whom and Jones a violent quarrel took place, productive of much virulent abuse, in detestable verse, on the part of the testy bard. It appears that the architect, too, was a dabbler in poetry, which, perhaps, might be the occasion of the difference between them.

The repairs of St. Paul's did not commence till 1633. Of our architect's performance in this business, Mr. Walpole thus speaks: "In the restoration of that cathedral, he made two capital faults. He first renewed the sides with very bad Gothic, and then added a Roman portico, magnificent and beautiful indeed, but which had no affinity with the ancient parts that remained, and made his own Gothic appear ten times heavier. He committed the same error at Winchester, thrusting a screen, in the Roman or Grecian taste, into the middle of that cathedral. Jones, indeed, was by no means successful when he attempted Gothic." He had much employment, both from the court and among the nobility, and realized a handsome fortune, which was diminished by sufferings during the troubles which succeeded. He was obnoxious, both as a favourite of his royal master, and as a Roman Catholic. The first attack made upon him was in 1640, when he was called before the House of Lords, on a complaint of the parishioners of St. Gregory's, for demolishing part of their church, in order to make room for his additions to St. Paul's. In 1646 he was obliged to pay 545*l.* by way of composition as a malignant.

The king's death greatly affected him; and he died, worn down by grief and misfortune, in July, 1651. He is said to have been a skilful geometrician, and to have been well acquainted with various branches of knowledge. He was certainly the greatest English architect previous to Sir Christopher Wren. His designs with the pen were highly valued by Vandyke. A collection of them was engraved and published by Mr. Kent, in two volumes folio, 1727, and some lesser designs in 1744. Others were published in 1743, 4to. by Mr. Ware. A copy of Palladio's Architecture, with manuscript notes by Jones, is in the library of Worcester College, Oxford. Mr. Walpole has given a catalogue of the principal buildings erected and decorated by this architect.

Jones (William), in biography, a very eminent mathematician in the seventeenth and former part of the eighteenth century, was born in the parish of Llanfihangel trer Bard, at the foot of Bodavon mountain, in the isle of Anglesea, North Wales, in the year 1680. His parents were yeomen, or small farmers, on that island, and he there received the best education which they were able to afford; reading, writing, and accounts, in English, and the Latin grammar. Having, however, an extraordinary turn for mathematical studies, by the industrious exertion of vigorous intellectual powers, he supplied the defects of adequate instruction, and laid the foundation of his future fame and fortune. He began his career in life by teaching mathematics on board a man of war; and in this situation he attracted the notice, and obtained the friendship, of Lord Anson. In his twenty-second year, Mr. Jones published "A New Compendium of the whole Art of Navigation," &c. 8vo. which is a neat little piece, and was received with great approbation. He was present at the capture of Vigo, in the same year, and having joined his comrades in quest of pillage, he eagerly fixed upon a bookseller's shop as the object of his depredation; but finding in it no literary treasures, which were the sole plunder that he coveted, he contented himself with a pair of scissars, which he frequently exhibited to his friends as a trophy of his military success, relating the anecdote by which he gained it. After the return of the fleet to England, he immediately established himself as a teacher of mathematics in London, where, in the year 1706, he published his "Synopsis Palmariorum Matheseos;" or, "A New Introduction to the Mathematics," &c. containing a perspicuous and useful compendium of all the mathematical sciences, and affording a decisive proof of his early and consummate proficiency in his favourite studies. The private character of Mr. Jones was respectable; his manners were agreeable and inviting; and those qualities not only contributed to enlarge the circle of his friends, whom his established reputation for science had attracted, but also to secure their attachment to him.

Among others who honoured him with their esteem, was the great and virtuous Lord Hardwicke, whom he attended as a companion on the circuit, when he was Chief Justice; and this nobleman, when he afterwards held the Great Seal, availed himself of the opportunity to testify his regard for the merit and character of his friend, by conferring upon him the office of secretary for the peace. He was also introduced to the friendship of Lord Parker (afterwards President of the Royal Society) which terminated only with his death; and, amongst other distinguished characters in the annals of science and literature, the names of Sir Isaac Newton, Halley, Mead, and Samuel Johnson, may be enumerated as the intimate friends of Mr. Jones. By Sir Isaac Newton he was treated with particular regard and confidence; and having afterwards found, among some papers of Collins which fell into his hands, a tract of Newton's, entitled "Analysis per quantitatum Series, Fluxiones, ac differentias: cum Enumeratione Linearum tertii Ordines," with the consent and assistance of that great man, he ushered it into the world, accompanied by other pieces on analytical subjects, in 1711, quarto.

By being thus the means of preserving some of Newton's papers, which might have otherwise been lost, he secured to his friend the honour of having applied the method of infinite series to all sorts of curves, some time before Mercator had published his "Quadrature of the Hyperbola," by a similar method. And its appearance at a time when the dispute ran high between Leibnitz and the friends of Newton, concerning the invention of fluxions, contributed to the decision of the question in favour of our illustrious countryman.

Mr. Jones was elected a member, and afterwards a Vice-President, of the Royal Society. After the retirement of Lord Macclesfield to Sherborne Castle, Mr. Jones resided with his lordship as a member of his family, and instructed him in the Sciences. While he was in this situation, he had the misfortune to lose the greatest part of his property, the accumulation of industry and economy, by the failure of a banker; but the friendship of Lord Macclesfield diminished the weight of the loss, by procuring for him a sinecure place of considerable emolument. From the same nobleman he had the offer of a more lucrative situation; but he declined the acceptance of it, as it required a more close official attendance than was agreeable to his temper, or compatible with his attachment to scientific pursuits.

While he was in this situation, also, he entered into a matrimonial connexion, from which sprang three children, the last of whom was the late Sir William Jones. Mr. Jones survived the birth of this son only three years, being attacked with a disorder, which the sagacity of Dr. Mead, who attended him with the anxiety of an affectionate friend, immediately discovered to be a polypus of the heart, and wholly incurable. He died in July, 1749, when about sixty-nine years of age, leaving behind him a great reputation and moderate property.

"The history of men of letters," says Lord Teignmouth, from whom we have chiefly extracted the preceding particulars, "is too often a melancholy detail of human misery, exhibiting the unavailing struggles of genius and learning against penury, and life consumed in fruitless expectation of patronage and reward. We contemplate with satisfaction the reverse of this picture in the history of Mr. Jones, as we trace him in his progress from obscurity to distinction, and in his participation of the friendship and beneficence of the first characters of the times. Nor is it less grateful to remark, that the attachment of his professed friends did not expire with his life; after a proper interval, they visited his widow, and vied in their offers of service to her: amongst others, to whom she was particularly obliged, I mention with respect Mr. Baker, author of a treatise on the improved microscope, who afforded her important assistance, in arranging the collection of shells, fossils, and other curiosities, left by her deceased husband, and in disposing of them to the best advantage."

Mr. Jones's papers in the Philos. Trans. are, "A Compendious Disposition of Equations for exhibiting the Relations of Goniometrical Lines," in the forty-fourth volume; "A Tract on Logarithms," in the sixty-first; "An Account of the Person killed by Lightning in Tottenham-court Chapel, and its Effects on the Building," in the sixty-second; and "Properties of the Conic Sections, deduced by a Compendious Method," in the sixty-third volume. These pieces, and indeed all his works, are distinguished by remarkable neatness, brevity, accuracy, and perspicuity. If, however, Mr. Nichols is not deceived in his information, the world has been deprived of his last and most laborious work, which he lived to complete, but not to see it printed. It was a work of the same nature with his "Synopsis," but far more copious and diffusive, and intended to serve as a general introduction to the sciences, or, which is the same thing, to the mathematical and philosophical works of Newton. A work of this kind was a desideratum in literature, and it required a geometrician of the first class to sustain the weight of so important an undertaking; for which, as D'Alembert justly observes, "the combined force of the greatest mathematicians would not have been more than sufficient."

Mr. Jones was fully aware of the arduous nature of such a task; but the importunity of his numerous acquaintance, and particularly of his friend Lord Macclesfield, induced him to commence, and to persist till he had completed his design, the result of all his knowledge and experience, and, what he had reason to hope, would prove a lasting monument of his talents and industry. Scarcely had he sent the first sheet to the press, when his illness, which proved fatal, obliged him to stop the impression; but before his death he entrusted his MS. fairly transcribed, to the care of Lord Macclesfield, who promised to publish it, as well for the honour of the author, as the benefit of his family. The Earl survived his friend many years; but the MS. was forgotten or neglected, and after Lord Macclesfield's death was not to be found. Whether it was accidentally destroyed, or whether, as has been suggested, it was lent to some geometrician, who basely concealed it, or possibly burnt the original, to prevent the advantages which he derived from it from detection, cannot now be ascertained. Such is the relation given in the "Anecdotes of Bowyer," on which Lord Teignmouth remarks, that there is no evidence in the memoranda left by Sir William Jones to confirm or disprove these assertions. Mr. Jones is said to have possessed the best mathematical library in England, containing almost every book of that kind which was to be met with. By a bequest in his will, it became the property of Lord Macclesfield, and forms at present a distinguished part of the Macclesfield collection at Sherborne Castle, in Oxfordshire. He had also collected a great quantity of MS. papers and letters of former mathematicians, which have often proved useful to the writers of their lives, &c. After his death, these were dispersed, and fell into the hands of different persons, and, among others, into those of Mr. Robertson, librarian and clerk to the Royal Society, from whose executors Dr. Hutton purchased a considerable number of them.

JONK, or Jonque, in naval affairs, is a kind of small ship, very common in the East Indies: these vessels are about the bigness of our fly-boats, and differ in the form of their building, according to the different methods of naval architecture used by the nations to which they belong. Their sails are frequently made of mats, and their anchors are made of wood.

JOURNAL, a day-book, register, or account of what passes daily.

Journal, or Day-Book, among merchants, is that wherein the transactions recorded in the waste-book are prepared to be carried to the ledger, by having their proper debtors and creditors ascertained and pointed out. For a more distinct account of which, see Book-keeping.

Journal, at sea, is a register, kept by the pilot and others, wherein notice is taken of every thing that happens to the ship from day to day, with regard to the winds, the rhumbs, the rake, soundings, &c. and in order to enable him to adjust the reckoning, and determine the place where the ship is.

In sea journals, the day, or twenty-four hours, terminate at noon, because the errors of the dead reckoning are at that period generally corrected by a solar observation. The first twelve hours, from noon to midnight, are marked with P. M. signifying after mid-day; and the second twelve hours, from midnight to noon, are marked with A. M. signifying after midnight; so that the ship account is twelve hours earlier than the short account of time. There are various ways of keeping journals, according to the different notions of mariners concerning the articles that are to be entered. Some keep such a kind of journal as is only an abstract of each day's transactions, specifying the weather, what ships or lands were seen, accidents on board, the latitude, longitude, the meridional distance, course, and run. These particulars are to be drawn from the ship's log-book, or from that kept by the pilot himself. Others keep only one account, including the log-book, and all the work of each day, with the deductions drawn from it. Notwithstanding the form of keeping journals is very different in merchant ships, yet one method appears to be invariably pursued in the navy, which, however, admits of much improvement, for no form can be properly called perfect, that leaves as great a space for one day's work, which may not be interesting, and can therefore be told in a few lines, as for another, which may probably abound with important incidents, and consequently require much room. According to circumstances, the matter must be greater or less, and the appropriated space should admit of all.

JOURNEYMAN, properly one who works by the day only; but it is now used for any one who works under a master, either by the day, the year, or the piece.

JOY, one of the most powerful mental emotions, accompanied with an extraordinary degree of animation and pleasure. The effect of joy, if not too violent, invigorates the whole animal frame. But sudden and excessive joy is often as injurious as the operation of either grief or terror, and there are a thousand instances on record, in which the precipitate communication of unexpected good news has proved fatal.

IPECACUANHA. See Materia Medica.

IPOMOEA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Campanaceæ. Convolvuli, Jussieu. Essential character: corolla funnel-form; stigma headed globose: capsule three-celled. There are twenty-seven species, of which I. quamoclit, winged-leaved ipomoea, is an annual plant, rising with oblong, broad seed leaves, which remain a considerable time before they fall off; stems slender, twining, rising by support to the height of eight feet, sending out several side branches, which twine about each other. The flowers come out singly from the side of the stalks, on slender peduncles, an inch long. The tube of the corolla is about the same length, narrow at bottom, and gradually widening to the top, where it spreads open, flat, with five angles. It is of a beautiful scarlet colour, making a fine appearance. It is a native of both Indies.

IRESINE, in botany, a genus of the Dioecia Pentandria class and order. Natural order of Holoraceæ. Amaranthi, Jussieu. Essential character: calyx two leaved; corolla five-petalled: male, nectary seven; female, stigmas two, sessile; capsule with tomentose seeds. There is only one species, viz. I. celosia, a perennial weak plant requiring support, rising twelve feet in height, having large knots at each joint, with oval lanceolate smooth leaves; stems very diffused, branching out on every side; flowers terminating in slender loose panicles, covered with a silky down, of a pale yellow colour. Native of Jamaica, and other islands in the West Indies.

IRIDIUM. Mr. Tennant, on examining the black powder left after dissolving platina, which, from its appearance, had been supposed to consist chiefly of plumbago, found it contained two distinct metals, never before noticed, which he has named iridium and osmium. The former of these was observed soon after by Descostils, and by Vauquelin.

To analyse the black powder, Mr. Tennant put it into a silver crucible, with a large proportion of pure dry soda, and kept it in a red heat for some time. The alkali being then dissolved in water, it had acquired a deep orange or brownish yellow colour, but much of the powder remained undissolved. This digested in muriatic acid gave a dark blue solution, which afterwards became of a dusky olive green, and finally, by continuing the heat, of a deep red. The residuum being treated as before with alkali, and so on alternately, the whole appeared capable of solution. As some silex continued to be taken up by the alkali, till the whole of the metal was dissolved, it seems to have been chemically combined with it. The alkaline solution contains oxide of osmium, with a small proportion of iridium, which separates spontaneously in dark-coloured thin flakes, by keeping it some weeks.

The acid solution contains likewise both the metals, but chiefly iridium. By slow evaporation it affords an imperfectly crystallized mass; which being dried on blotting-paper, and dissolved in water, gives by evaporation distinct octaedral crystals. These crystals, dissolved in water, produce a deep red solution, inclining to orange. Infusion of galls occasions no precipitate, but instantly renders the solution almost colourless. Muriate of tin, carbonate of soda, and prussiate of potash, produce nearly the same effect. Ammonia precipitates the oxide, but, possibly from being in excess, retains a part in solution, acquiring a purple colour. The fixed alkalies precipitate the greater part of the oxide, but retain a part in solution, this becoming yellow. All the metals that Mr. Tennant tried, except gold and platina, produced a dark or black precipitate from the muriatic solution, and left it colourless.

The iridium may be obtained pure, by exposing the octaedral crystals to heat, which expels the oyxgen and muriatic acid. It was white, and could not be melted by any heat Mr. Tennant could employ. It did not combine with sulphur, or with arsenic. Lead unites with it easily, but is separated by cupellation, leaving the iridium on the cupel as a coarse black powder. Copper forms with it a very malleable alloy, which, after cupellation, with the addition of lead, leaves a small proportion of the iridium, but much less than in the preceding instance. Silver forms with it a perfectly malleable compound, the surface of which is tarnished merely by cupellation: yet the iridium appears to be diffused through it in fine powder only. Gold remains malleable, and little altered in colour, though alloyed with a considerable proportion; nor is it separable either by cupellation or quartation. If the gold or silver be dissolved, the iridium is left as a black powder.

The French chemists observed, that this new metal gave a red colour to the triple salt of platina and sal ammoniac, was not altered by muriate of tin, and was precipitated of a dark brown by caustic alkali. Vauquelin added, that it was precipitated by galls, and by prussiate of potash: but Mr. Tennant ascribes this to some impurity.

Mr. Tennant gave it the name of iridium, from the striking variety of colours it affords while dissolving in muriatic acid.

Dr. Wollaston has observed, that among the grains of crude platina, there are some scarcely distinguishable from the rest but by their insolubility in nitro-muriatic acid. They are harder, however, when tried by the file; not in the least malleable; and of the specific gravity of 19.5. These appeared to him to be an ore, consisting entirely of the two new metals.

IRIS, in anatomy, the anterior coloured part of the uvea of the eye, so called because of its variety of colours, iris being the Latin word for rainbow. The iris is a circular variously coloured part, which surrounds the pupil; it is in some persons blue, in others black, brown, grey, &c. each of which has its peculiar beauty, and is suited to the complexion of the person who has it. See ANATOMY, OPTICS.

IRIS, in botany, a genus of the Triandria Monogynia class and order. Natural order of Ensatæ. Irides, Jussieu. Essential character: corolla six-petalled, unequal, petals alternate, jointed and spreading, stigmas petal-form, cowled, two-lipped. There are fifty species. The iris is an inhabitant of every quarter of the world; America, however, produces very few. Several are found natives of the colder regions of Asia, more still of Europe, and most of the Cape of Good Hope. These plants are herbaceous flowering perennials, both of the fibrous, tuberous, and bulbous rooted kind, producing thick annual stalks, from three inches to three feet in height, terminated by large hexapetalous flowers, having three of the petals reflexed back and three erect: these are very ornamental plants, appearing in flower in May, June, and July.

IRON is a metal of a bluish white colour, of considerable hardness and elasticity; very malleable, exceedingly tenacious and ductile, and of a moderate specific gravity among metallic substances. It is much disposed to rust by the access of air, or the action of water, in the common temperature of the atmosphere.—The appearance of prismatic colours on its polished surface takes place long before ignition; and at so low a temperature, that the slightest coating of grease is sufficient to prevent their appearance, by defending it from the contact of air. It may be ignited, or at least rendered sufficiently hot to set fire to brimstone, by a quick succession of blows with a hammer. When struck with a flint, or other hard stone, it emits decrepitating ignited particles, such as can be obtained from no other metal by the same means. These particles are seldom larger than the two hundredth part of an inch in diameter; and, when examined by a magnifier, are found to be hollow, brittle, and of a greyish colour, resembling the scales of burned iron. This metal is easily oxided by fire. A piece of iron wire, immersed in a jar of oxygen gas, being ignited at one end, will be entirely consumed by the successive combustion of its parts. It requires a very intense heat to fuse it; on which account, it can only be brought into the shape of tools and utensils by hammering. This high degree of infusibility would deprive it of the most valuable property of metals, namely, the uniting of smaller masses into one, if it did not possess another singular and advantageous property, which is found in no other metal, except platina; namely, that of welding. In a white heat, iron appears as if covered with a kind of varnish; and in this state, if two pieces be applied together, they will adhere, and may be perfectly united by forging. Iron is thought to be the only substance in nature, which has the property of becoming magnetical. It is highly probable, from the great abundance of this metal, that all substances which exhibit magnetism do contain iron; but it must be confessed, that there remain many experiments to be made among the earths and powders which exhibit magnetical properties, before this negative proposition, which confines magnetism to iron, can be admitted as proved.

When iron is exposed to the action of pure water, it acquires weight by gradual oxydation, and hydrogen gas escapes: this is a very slow operation. But if the steam water be made to pass through a red hot gun-barrel, or through an ignited copper or glass tube, containing iron wire, the iron becomes converted into an oxide, while hydrogen gas passes out at the other end of the barrel. The action of air, assisted by heat, converts iron into a black oxide, containing twenty-five of oxygen. By the action of stronger heat this becomes a reddish brown oxide, containing forty-eight of oxygen. The yellow rust, formed when iron is long exposed to damp air, is not a simple oxide, as it contains a portion of carbonic acid. According to M. Chenevix, there are four stages of oxydation of iron: the first, or minimum, white; the second, green; the third, black; the fourth, or maximum, red. Thenard admits only three, the white, green, and red.

The concentrated sulphuric acid scarcely acts on iron, unless it is boiling. If the sulphuric acid be diluted with two or three parts of water, it dissolves iron readily, without the assistance of any other heat than what is produced by the act of combination. During this solution, hydrogen gas escapes in large quantities.

Sulphate of iron is not made in the direct way, because it can be obtained at less charge from the decomposition of martial pyrites. It exists in two states, one containing oxide of iron, with .27 of oxygen, which is of a pale green, not altered by gallic acid, and giving a white precipitate with prussiate of potash. The other, in which the iron is combined with .48 of oxygen, is red, not crystallizable, and gives a black precipitate with gallic acid, and a blue with prussiate of potash. In the common sulphate these two are mixed in various proportions.

Distillation separates the acid from sulphate of iron, and leaves the brown oxide of iron, called colcothar.

Vegetable astringent matters, such as nut galls, the husks of nuts, logwood tea, &c. which contain the gallic acid, precipitate a fine black fecula from sulphate of iron, which remain suspended for a considerable time in the fluid, by the addition of gum arabic. This fluid is well known by the name of ink. See Ink.

The beautiful pigment well known in the arts by the name of Prussian blue, is likewise a precipitate afforded by sulphate of iron.

If two parts of alum, and one of sulphate of iron, be dissolved in eight or ten parts of boiling water, and a solution of prussiate of potash be added as long as any effervescence and precipitation are produced, the precipitate, thoroughly washed by effusion of boiling water, will have a green colour. This is owing to the yellow oxide of iron thrown down with the prussiate, which must be dissolved by adding muriatic acid. The deep blue powder, insoluble in this acid, is then to be washed and dried for use. According to Professor Proust, the iron in Prussian blue contains .48 of oxygen, and is obtained only from a super-oxygenated sulphate; the precipitate from a pure alkaline prussiate and sulphate of iron with a minimum of oxygen being white, and containing only .27 of oxygen. This may explain a fact, observed by a French colourman, who, having mixed some Prussian blue and white lead with nut oil, and set it by for some time covered with water, found the surface only blue, and all the rest white. On pouring it out on his stone, and beginning to grind it afresh, with intention to add more Prussian blue, he found the colour gradually returning of itself. Here it might be supposed that the oxide of the prussiate had parted with oxygen to the oil, or the oxide of lead, or both, thus becoming white, except that on the surface, which was supplied with oxygen from the superincumbent water; and that it recovered its colour by attracting oxygen from the air. But on this supposition it would seem, that light must contain oxygen, since the colour of this paint, spread on wood or paper, returned by exposure to light in vacuo, as well as in the open air. The colour of Prussian blue is affected by the contact of iron. Mr. Gill, finding a knife with which he was mixing some Chinese blue acquire a green tinge, spread a little of it, and afterwards a little Prussian blue, sufficiently diluted, on the blade of a knife, and with a camel hair pencil took off enough to form a tint on paper, and thus continued till he had taken off, in the first instance, thirty-six, and in the second eighty-six, without adding any fresh colour. These tints differed in regular gradation from greenish blue to green, olive-green, yellowish green, yellow, and so on to a buff.

Concentrated nitric acid acts very strongly upon iron filings, much nitrous gas being disengaged at the same time. The solution is of a reddish brown, and deposits the oxide of iron after a certain time, more especially if the vessel be left exposed to the air. A diluted nitric acid affords a more permanent solution of iron, of a greenish colour, or sometimes of a yellow colour. Neither of the solutions afford crystals; but both deposit the oxide of iron by boiling, at the same time that the fluid assumes a gelatinous appearance.

Diluted muriatic acid rapidly dissolves

iron, at the same time that a large quantity of hydrogen is disengaged, and the mixture becomes hot. In this, as well as in the sulphuric solution of iron, the same quantity of alkali is said to be required to saturate the acid as before the solution; whence it is inferred, that the acid is not decomposed, but that the oxidation is effected by the oxygen of the water; whence also it appears to follow, that the hydrogen must be afforded from the decomposed water, and not from the metal.

Carbonic acid, dissolved in water, combines with a considerable quantity of iron, in proportion to its mass. Vinegar scarcely dissolves it, unless by the assistance of the air.

Phosphoric acid unites with iron, but very slowly. The union is best effected by adding an alkaline phosphate to a solution of one of the salts of iron, when it will fall down in a white precipitate. A saturated phosphate of iron has been found native in France, semi-transparent, of a red brown colour, and foliated texture. A deep blue phosphate of iron, lamellated, and fragile, of the specific gravity of 2.6, brought from the Isle of France, and analysed by Laugier, Fourcroy, and Vauquelin, gave iron 41.25, phosphoric acid 19.25, water 31.25, alumina, 5, and ferruginous silex 1.25, in 100 parts. A similar phosphate has been found in Brazil. This acid is found combined with iron in the bog ores, and, being at first taken for a peculiar metal, was called siderite by Bergman.

Liquid fluoric acid attacks iron with violence; the solution is not crystallizable, but thickens to a jelly, which may be rendered solid by continuing the heat. The acid may be expelled by heating it strongly, leaving a fine red oxide.

Borate of iron may be obtained by precipitating a solution of the sulphate with neutral borate of soda.

Arsenic acid likewise unites with iron. This arseniate is found native in Cornwall, in pretty large cubic crystals, tolerably transparent, of a dark green colour, with a brownish tinge; sometimes yellowish, or of a brown yellow, like resin. The Count de Bournon found likewise a cupreous arseniate of iron, in minute rhomboidal crystals, of a faint sky blue colour and uncommon brilliancy. Specific gravity 3.4. The green and red sulphates of iron may be decomposed by arseniate of ammonia, and afford arseniate of iron in the two different states.

Chromate of iron is said to have been found abundantly in the department of Var in France, and to form a beautiful green for enamelling or colouring pastes. Its analysis by Vauquelin and Tassaert gave chromic acid 43, oxide of iron 34.7, alumina 20.3, silex 2, in 100 parts.

In the dry way, this metal does not combine with earths, unless it be previously oxided; in which case it assists their fusion, and imparts a green colour to the glass. It appears to combine with alkalies by fusion. Nitre detonates strongly with it, and becomes alkalized.

Sulphur combines very readily with iron in the dry, and even in the humid way, though neither of these substances is scarcely at all soluble in water. A mixture of iron filings and flowers of sulphur being moistened, or made into a paste, with water, becomes hot, swells, adheres together, breaks, and emits watery vapours of an hepatic smell. If the mixture be considerable in quantity, as for example, one hundred pounds, it takes fire in twenty or thirty hours, as soon as the aqueous vapours cease.

By fusion with iron, sulphur produces a compound of the same nature as the pyrites, and exhibiting the same radiated structure when broken. If a bar of iron be heated to whiteness, and then touched with a roll of sulphur, the two substances combine, and drop down together in a fluid state. It is necessary that this experiment should be made in a place where there is a current of air to carry off the fumes; and the melted matter, which may be received in a vessel of water, is of the same nature as that produced by fusion in the common way, excepting that a greater quantity of sulphur is fused by the contact of the bar of iron. According to Proust, the native sulphuret, or pyrites, contains 47.36 per cent. of sulphur, the artificial sulphuret but 37.5. Mr. Hatchett however has found, that the magnetical pyrites contains the same proportion as the artificial sulphuret.

Phosphorus may be combined with iron, by adding it cut into small pieces to fine iron wire, heated moderately red in a crucible; or by fusing six parts of iron clippings, with six of glacial phosphoric acid, and one of charcoal powder. This phosphuret is magnetic; and Mr. Hatchett remarks that iron, which in its soft or pure state cannot retain magnetism, is enabled to do so, when hardened by carbon, sulphur, or phosphorus, unless the dose be so great as to destroy the magnetic property, as in most of the natural pyrites and plumbago.

The combination of carbon with iron is of all the most important, under the names of cast iron and steel. We shall just observe here, that, according to Mr. Mushet, of the Calder iron-works, who has investigated the subject very extensively in the large way, soft cast steel, capable of welding, contains 1 one-hundred and twentieth of carbon, common cast steel 1 one-hundreth, cast steel of a harder kind 1 ninety-sixth, steel too hard for drawing one-fiftieth, white cast iron one-twenty-fifth, melted cast iron one-twentieth, black cast iron one-fifteenth. He conceives, however, that in steel the carbon is more intimately united with the iron. When iron is saturated with carbon, it becomes what is commonly called plumbago.

Iron unites with gold, silver, and platina. When heated to a white heat, and plunged in mercury, it becomes covered with a coating of that metal. Long trituration of mercurial amalgams likewise causes a coating to adhere to the ends of iron pestles; small steel springs, kept plunged beneath the surface of mercury in certain barometers, become brittle in process of time; and the direct combination of iron and mercury in the form of an amalgam may be obtained, according to Vogel, by triturating the filings with twice their weight of alum, then adding an equal weight or more of mercury, and continuing the friction, with a very small quantity of water, till the union is completed. Mr. A. Aikin unites an amalgam of zinc and mercury with iron filings, and then adds muriate of iron, when a decomposition takes place, the muriatic acid combining with the zinc, and the amalgam of iron and mercury assuming the metallic lustre by kneading, assisted with heat. Iron and tin very readily unite together, as is seen in the art of tinning iron vessels, and in the fabrication of those useful plates of iron, coated with tin, which are generally distinguished by the simple name of tin alone. The chief art of applying these coatings of tin consists in defending the metals from oxidation by the excess of air. After the iron plates are scraped, or rendered very clean by scouring with an acid, they are wetted with a solution of sal ammoniac, and plunged into a vessel containing melted tin, the surface of which is covered with pitch or tallow, to preserve it from oxydation. The tin adheres to, and intimately combines with, the iron to a certain depth, which renders the tinned plates less disposed to harden by hammering than before; as well as much less disposed to alter by the united action of air and moisture. The process for tinning iron vessels does not essentially differ from that which has already been described for copper vessels. Iron does not unite easily with bismuth, at least in the direct way. This alloy is brittle, and attractable by the magnet, even with three fourths of bismuth. As nickel cannot be purified from iron without the greatest difficulty, it may be presumed that these substances would readily unite, if the extreme infusibility of both did not present an obstacle to the chemical operator. Arsenic forms a brittle substance in its combination with iron. Cobalt forms a hard mixture with iron, which is not easily broken. The inflammability and volatility of zinc present an obstacle to its combination with iron. It is not improbable, however, but that clean iron filings would unite with zinc, if that metal were kept in contact with them for a certain time, in a heat not sufficient to cause it to rise; for it has been found, that zinc may be used in the operation of coating iron in the same manner as tin. Antimony unites with iron, and forms a hard brittle combination, which yields in a slight degree to the hammer. The sulphuret of antimony is decomposed by virtue of the greater affinity of the iron to the sulphur. For this purpose, five ounces of the points of nails from the farriers may be made red hot in a crucible, one pound of pulverized ore of antimony must then be thrown into the crucible, and the heat quickly raised to fuse the whole. When the fusion is perfect, an ounce of nitre in powder may be thrown in, to facilitate the separation of the scoriæ. After the mass is cooled, the antimony is found separate at the bottom of the crucible, while the iron remains in combination with the sulphur and alkali. If the proportion of the iron be considerably greater than five ounces to the pound of ore, the antimony will be alloyed with iron. Manganese is almost always united with iron in the native state. Tungsten forms a brittle, whitish-brown, hard alloy, of a compact texture, when fused with white crude iron. The habitudes of iron with molybdena are not known.

Iron is the most diffused, and the most abundant, of metallic substances. Few mineral bodies or stones are without an admixture of this metal. Sands, clays, and the waters of rivers, springs, rain, or snow, are scarcely ever perfectly free from it. The parts of animal and vegetable substances likewise afford iron in the residues they leave after incineration. It has been found native, in large masses, in

Siberia, and in the internal parts of South America. This metal, however, in its native state is scarce: most iron is found in the state of oxide, in ochres, bog ores, and other friable earthy substances, of a red, brown, yellow, or black colour. The hematites, or blood stones, are likewise ores with oxide of iron: these are either of a red colour, or blue, yellow, or brown. An iron ore is likewise found, of a blue colour, and powdery appearance. This useful metal is so abundant, that whole mountains are composed of iron stone; whereas other metals usually run in small veins. Besides these ores of iron, which are either nearly pure, or else mixed with earths, as in spars, jaspers, boles, basaltes, &c. iron is mineralized with sulphur, as in the pyrites, or with arsenic. The coally iron ores contain bitumen. The magnet, or load stone, is an iron ore, the constitution of which has not yet been accurately examined. Iron is also found in combination with the sulphuric acid, either dissolved in water, or in the form of sulphate.

To analyse the ores of iron in the humid way, they must be reduced to a very subtle powder, and repeatedly boiled in muriatic acid. If the sulphureous ores should prove slow of solution, a small quantity of nitric acid must be added to accelerate the operation. The iron being thus extracted, the insoluble part of the matrix only will remain. Prussiate of potash being added to the decanted solution, will precipitate the iron in the form of Prussian blue. This precipitate, when washed and dried, will be equal in weight to six times the quantity of metallic iron it contains; and from this iron four parts in the hundred must be deducted, to allow for the iron which is contained in the prussiate of potash itself. But as this alkali, and every other preparation containing the prussic acid, does not constantly afford the same quantity of iron, the most exact way, in the use of such preparations, consists in previously dissolving a known quantity of iron in sulphuric acid, and precipitating the whole by the addition of the prussiate of potash. This result will afford a rule for the use of the same alkali in other solutions. For as the weight of the precipitate obtained in the trial experiment is to the quantity of iron which was dissolved and precipitated, so is the weight of the precipitate obtained from any other solution to the quantity of iron sought.

If the iron be united to any considerable proportion of zinc or manganese, the Prussian blue must be calcined to redness, and treated with strong nitric acid, which will take up the oxide of zinc. The manganese may then be dissolved by nitric acid with the addition of sugar; and the remaining iron being dissolved by muriatic acid, and precipitated by subcarbonate of soda, will afford 225 grains of precipitate for every 100 grains of metallic iron.

To examine the ores of iron in the dry way, the only requisite is fusion, in contact with charcoal. For this purpose eight parts of pulverized glass, one of calcined borax, and half a part of charcoal, are to be well mixed together. Two or three parts of this flux being mixed with one of the pounded ore, and placed in a crucible, lined with a mixture of a little clay, and pounded charcoal, with a cover luted on, is to be urged with the strong heat of a smith's forge for half an hour. The weight of the ore, in this experiment, should not exceed sixty grains. Other processes for determining the contents, or metallic product, of iron ores, are instituted, by performing the same operations in the small, as are intended to be used in the large way.

In the large iron works, it is usual to roast or calcine the ores of iron, previously to their fusion; as well for the purpose of expelling sulphureous or arsenical parts, as to render them more easily broken into fragments of a convenient size for melting. The mineral is melted or run down in large furnaces, from sixteen to thirty feet high; and variously shaped, either conical or elliptical, according to the opinion of the iron-master. Near the bottom of the furnace is an aperture for the insertion of the pipe of large bellows, worked by water or steam, or of other machines for producing a current of air; and there are also holes at proper parts of the edifice, to be occasionally opened, to permit the scoriæ and the metal to flow out, as the process may require. Charcoal, or coke, with lighted brushwood, is first thrown in; and when the whole inside of the furnace has acquired a strong ignition, the ore is thrown in by small quantities at a time, with more of the fuel, and commonly a portion of limestone, as a flux: the ore gradually subsides into the hottest part of the furnace, where it becomes fused; the earthy part being converted into a kind of glass, while the metallic part is reduced by the coal, and falls through the vitreous matter to the lowest place. The quantity of fuel, the additions, and the heat, must be regulated, in order to obtain iron of any desired quality; and this quality must likewise, in the first product, be necessarily different, according to the nature of the parts which compose the ore.

The iron which is obtained from the smelting furnaces is not pure, and may be distinguished into three states: white crude iron, which is brilliant in its fracture, and exhibits a crystallized texture, more brittle than the other kinds, not at all malleable, and so hard as perfectly to withstand the file: grey crude iron, which exhibits a granulated and dull texture when broken; this substance is not so hard and brittle as the former, and is used in the fabrication of artillery, and other articles which require to be bored, turned, or repaired: and black cast iron, which is still rougher in its fracture; its parts adhere together less perfectly than those of the grey crude iron; this is usually fused again with the white crude iron.

Whenever crude iron, especially the grey sort, is used again in contact with air, it emits sparkles, loses weight, and becomes less brittle. In order to convert it into malleable iron it is placed on a hearth, in the midst of charcoal, urged by the wind of two pair of bellows. As soon as it becomes fused, a workman continually stirs it with a long iron instrument. During the course of several hours it becomes gradually less fusible, and assumes the consistence of paste. In this state it is carried to a large hammer, the repeated blows of which drive out all the parts that still partake of the nature of crude iron so much as to retain the fluid state. By repeated heating and hammering, more of the fusible iron is forced out; and the remainder, being malleable, is formed into a bar or other form for sale. Crude iron loses upwards of one fourth of its weight in the process of refining; sometimes, indeed, one half.

Purified, or bar iron, is soft, ductile, flexible, malleable, and possesses all the qualities which have been enumerated under this article as belonging exclusively to iron. When a bar of iron is broken, its texture appears fibrous; a property which depends upon the mechanical action of the hammer while the metal is cold. Ignition destroys this fibrous texture, and renders the iron more uniform throughout; but hammering restores it.

If the purest malleable iron be bedded in pounded charcoal, in a covered crucible, and kept for a certain number of hours in a strong red heat, (which time must be longer or shorter, according to the greater or less thickness of the bars of iron) it is found that by this operation, which is called cementation, the iron has gained a small addition of weight, amounting to about the hundred and fiftieth, or the two hundredth part, and is remarkably changed in its properties. It is much more brittle and fusible than before. Its surface is commonly blistered when it comes out of the crucible; and it requires to be forged to bring its parts together into a firm and continuous state. This cemented iron is called steel. It may be welded like bar iron, if it have not been fused or over-cemented: but its most useful and advantageous property is that of becoming extremely hard when ignited and plunged into cold water. The hardness produced is greater in proportion as the steel is hotter, and the water colder. The colours which appear on the surface of steel slowly heated are yellowish-white, yellow, gold colour, purple, violet, deep blue; after which the ignition takes place. These signs direct the artist in tempering or reducing the hardness of steel to any determinate standard. If steel be too hard, it will not be proper for tools which are intended to have a fine edge, because it will be so brittle that the edge will soon become notched; if it be too soft, it is evident that the edge will bend or turn. Some artists ignite their tools, and plunge them into cold water; after which they brighten the surface of the steel upon a stone: the tool being then laid upon charcoal, or upon the surface of melted lead, or placed in the flame of a candle, gradually acquires the desired colour; at which instant they plunge it into water. If a hard temper be desired, the piece is dipped again, and stirred about in the cold water as soon as the yellow tinge appears. If the purple appear before the dipping, the temper will be fit for gravers, and tools used in working upon metals; if dipped while blue, it will be proper for springs, and for instruments used in the cutting of soft substances, such as cork, leather, and the like; but if the last pale colour be waited for, the hardness of the steel will scarcely exceed that of iron. When soft steel is heated to any one of these colours, and then plunged into water, it does not acquire nearly so great a degree of hardness as if previously made quite hard, and then reduced by tempering. The degree of ignition required to harden steel is different in the different kinds. The best kinds require only a low red heat. The harder the steel, the more coarse and granulated its fracture will be; and as this is not completely remedied by the subsequent tempering, it is advisable to employ the least heat capable of affording the requisite hardness. It is a circumstance worthy of remark, that steel has a less specific gravity when hardened than when soft; but there are no circumstances upon which a probable connection between these two properties, namely, the increased hardness and the diminished specific gravity, can be made out.

If the cementation be continued too long, the steel becomes porous, brittle, of a darker fracture, more fusible, and incapable of being forged or welded. On the contrary, steel cemented with earthy infusible powders is gradually reduced to the state of forged iron again. Simple ignition produces the same effect; but is attended with oxidation of the surface. The texture of steel is rendered more uniform by fusing it before it is made into bars; this is called cast steel, and is rather more difficultly wrought than common steel, because it is more fusible, and is dispersed under the hammer if heated to a white heat.

The conversion of iron into steel, either by fusion, *viz.* the direct change of crude iron into steel, or by cementation of bar-iron, presents many objects of interesting inquiry. From various experiments of Bergman, it appeared that good crude iron, kept for a certain time in a state of fusion, with such additions as appeared calculated to produce little other effect than that of defending the metal from oxidation, became converted into steel with loss of weight. These facts are conformable to the general theory of Vandermonde, Monge, and Berthollet: for, according to their researches, it should follow, that part of the carbon in the crude iron was dissipated, and the remainder proved to be such in proportion as constitutes steel. The same chemist cemented crude iron with plumbago, or carbonate of iron, and found that the metal had lost no weight. Morveau repeated the experiment with grey crude iron. The loss of weight was little, if any. The metal exhibited the black spot by the application of nitric acid, as steel usually does, but it did not harden by ignition and plunging in water. Hence it is concluded, that it was scarcely altered: for crude iron also exhibits the black spot, and cannot by common management acquire the hardness of steel.

From the experiments of the three excellent chemists last mentioned, it appears that the grey crude iron consists principally of iron, with as much carbon as it can dissolve in the strong heat of the smelting furnace. They have shown also, that it deposits part of this addition, when cooled in contact with an iron bar immersed in the bath. This separation must be general in the ordinary or gradual way of cooling, whence the grey colour must arise from the blue white colour of the iron mixed with the black of the carbon. And this grey colour is also in a degree perceived, when soft close-grained steel is broken. These circumstances lead to an inference, that hard steel may in a certain respect differ from that which is softer by the intimate combination of a larger proportion of carburet. This accounts for the whiter and more metallic aspect of hardened steel, than of such as is soft. For the former contains less of disengaged carburet. Hence also we may account for the greater hardness of steel, which has been made quite hard, and then let down by tempering to a certain colour, than of steel merely heated to that colour, and pluuged in water. For, in the first method of hardening, a sufficient degree of heat is given to produce combination between part of the disengaged carburet and the iron, which in the latter does not take place. If the carburet be merely sufficient to saturate all the iron at a moderate degree of ignition, the hardness will be considerable; but the steel will be easily degraded to the state of iron by frequent ignition. Such steel, in its hard state, will be very uniform in its texture, not excessively hard in its temper, but disposed to take a very fine firm edge, which will not easily be broken or injured by violence. These are accurately the properties of the English cast steel, which is of so uniform a nature, as to be distinguished by its conchoidal or glassy fracture. When the dose of carbon in steel is greater, it will bear a greater heat without degradation, insomuch that it may be welded like iron. Its hardness will also be capable of a higher degree; and if this degree, produced by a stronger ignition, be not given, the edge of the tool will never become fine and smooth; and even at this higher degree, with all the advantage of subsequent tempering, it will be less smooth than that of the cast steel, and more disposed to break. Steel of this kind is better adapted for the construction of hammers, vices, hatchets, leather-cutters' knives, and other instruments, wherein the edge is either stout, or sudden blows unnecessary, or the construction demands frequent heating and welding.

By pursuing this train of reflection, it will follow, that, since crude iron differs from steel only in the superabundance of carbon, it ought to be capable of extreme hardness, if ignited to that degree which is requisite to combine the greater part of this carbon with the iron, and then suddenly cooled. This is accordingly found to be the case. If the grey crude iron, commonly distinguished by our founders by the name of soft metal, be heated to a white heat, and then plunged into water, it becomes very hard, much whiter, denser, and more metallic in its appearance, and will bear a pretty good edge, fit for gravers, for the use of turners in iron or steel. In these tools the angle of the planes which form the edge is about 45°. The hardness of this kind of iron is not considerably diminished but by ignition continued for a length of time, which is a fact also conformable to what happens in steel. For the cast steel will be softened nearly as much by annealing to the straw colour, as the harder steels are by annealing to a purple or full blue.

Some of our artists have taken advantage of this property of soft crude iron in the fabrication of axles and collars for wheel-work; for this material is easily filed and turned in its soft state, and may afterward be hardened so as to endure a much longer time of wear.

The founders who cast wheels and other articles of mechanism are occasionally embarrassed by this property. For, as the metal is poured into their moulds of moistened sand, the evaporation of the water carries off a great portion of the heat, and cools the iron so speedily, as to render it extremely hard, white, and close, in its texture. This is most remarkable in such portions of the metal, as have the greatest distance to run from the git or aperture of reception. For these come in contact successively with a larger portion of the sand, and are therefore more suddenly cooled. We have seen the teeth of cog-wheels altogether in this state, while the rim and other parts of the wheel remained soft. The obvious remedy for this defect is, to increase the number of gits, and to have the sand as dry as possible or convenient. In other articles this property has been applied to advantage, particularly in the steel rollers for large laminating mills, which Messrs. Vandermonde, Monge, and Berthollet, have supposed to be an over-cemented steel. They are made by casting the grey crude iron in moistened sand, the contact of which gives the hard steel temper to the outside surface, for the depth of more than half an inch. There is no doubt, but that the iron-masters pay considerable attention to the quality of the iron, and perhaps to the degree of heat and moisture of the sand in this operation, in order that the hardness may be such as to yield to the turning tool; and it is likewise understood, that a considerable number crack longitudinally in the cooling, a loss which in all probability arises from the difference of contraction between the hard and soft parts.

A variety of facts concerning the hardening and softening of steel are collected by Guyton Morveau, the most interesting of which shall be here subjoined. According to Reaumur, that part of the steel which was hottest at the time of immersion in the water will be the hardest; whence it has been thought a fair conclusion, that the hardness of steel is the greater, the stronger the ignition, and the more speedy the cooling. Nevertheless, the celebrated Rinman deduces a very different consequence; namely, that the steel which is naturally the hardest is that which requires the least heat, and that the best temper for each kind of steel is that produced by the lowest degree of heat suitable to that peculiar kind. Hence, various methods have been proposed to ascertain the degree of heat most advantageous to any particular sample of steel. They are all reducible to that of igniting one end of a bar to a white heat, and plunging it into water. The hardness of the several parts may then be ascertained by examination.

It appears that the considerations on which the first-mentioned general rule is founded are rather of a complicated nature. If it be true, as conjectured above, that the hardness of steel depends principally on the intimate combination of its carbon, it will follow, that the utmost hardness any steel is capable of will be produced by a degree of heat sufficient to effect this purpose, and that any superior degree will only degrade the quality of the steel; and, consequently, that the general rule will apply only to heats inferior to this maximum. It may also happen, when the mass of water is not considerable, though the fact has been doubted when the quantity is large, that the heating of the water, and the production of hydrogen, may so far modify the rate of cooling, as even to render it less sudden than might have happened with an inferior degree of ignition. Lavoisier has remarked, that the conversion of iron into the hard brittle oxide, when water is decomposed, may perhaps be of the same nature as the hardening of steel. There is another fact, which is of great consequence, and may perhaps afford the principal ground for Rinman's apparent exception to the general rule concerning the hardening of steel. Hardness is that property of bodies by which they resist indendation, and rather break, than bend or suffer contusion. It is the opposite to softness. Tenacity, which is very frequently confounded with hardness, is not the property by which they resist indentation, but separation of their parts. It is the opposite to friability or brittleness. Now that steel, in common language, is said to be the hardest, which unites most eminently the properties of hardness and tenacity. But the effect of heat and sudden cooling is directly opposite in these two respects. Soft steel is the most tenacious, but the least hard. The operation of hardening diminishes its tenacity, and increases its hardness progressively to the maximum of heat the steel is formed to bear. There will be no difficulty then in conceiving, that the best state of steel, relative to any particular use, will be at some precise degree between the softest and hardest qualities. Thus, for springs, much tenacity and moderate hardness are required. For chissels and similar tools, which operate by a blow, a greater hardness may be admitted. Razors, knives, and such tools as effect the intended purpose by a gradual stroke, will be still more valuable the harder they are: but even in these the tenacity must not be too much diminished, otherwise the edge will be liable to break. They must all be capable of having the edge turned or bended on one side in the operation of whetting. Files are perhaps of all tools such as require the greatest hardness; but in these, it is far from being the utmost the steel is capable of receiving. It is found, that the tenacity of steel is considerably increased by continued hammering to a certain point. But the whole effect of this hammering is taken off by strong ignition. Good steel by hardening at a white heat may be rendered so brittle, that it will break full as easily as a stick of the same dimensions, and its texture is then found to be coarse and large grained. As the subsequent annealing does not restore the effect of the hammering, nor bring the grain of the steel to the state it would have possessed if a lower heat had been used at first, it is evident, that the most useful hardness is produced by that degree of heat, which is just sufficient to effect the purpose. And, accordingly, tools made of cast steel, and intended to sustain a good edge for cutting iron and other metals, are not afterwards annealed, but the ignition is carefully regulated at first. Annealing ought only to be used where considerable softness is required.

Iron may be hardened to a certain degree by ignition and plunging in water, but this effect is confined to the surface; except, as it very often happens, the iron contains veins of steel. These are no shall impediments to the filing and working this material. It sometimes likewise may happen, that the iron may have undergone a process of the nature of case-hardening from the fuel. We have been informed by a workman, that ignited iron, suddenly plunged into the soft leather of a shoe, becomes very hard on its surface, which must arise from an instantaneous effect of this kind.

The increase of dimensions acquired by steel in hardening is such, that in general such pieces of work as are finished soft will not fit their places when hardened. Rinman found, that bars of steel, six inches long, six lines wide, and half an inch thick, were lengthened at least one line after hardening by a whitish red heat, which is about one seventieth of the linear dimensions; and supposing the dilatation to be proportional, Guyton Morveau computes the bulks to be as 48 to 49. But the cubes of 72 lines and 73 lines are in proportion more nearly as 47 to 50. Various kinds of steel at different hardness must no doubt greatly differ in this respect. The specific gravities, as given by Brisson, p. 366, art. Gravity, (*specific*), afford a much less ratio. Rinman found, by his experiments on two different kinds of fine cemented steel, the specific gravity of which was 7.991, that one after hardening gave only 7.553, and the other 7.708. These numbers agree sufficiently near with the experiment of the six inch bar. Yet he once found Styrian steel augmented in density, by hardening, in the ratio of 7.822 to 7.782. Morveau found, with pieces of steel 28 lines long, that the increase of length by hardening was about the 350th part.

The fineness of grain in hard steel, as exhibited in its fracture, is various, according to the quality of the metal, and the temper it has received. The harder the steel the coarser the grain. But in like circumstances, fine steel has the closest grain, and is ever the most uniform in its appearance. Workmen avail themselves much of this indication. In general, a neat curved line fracture, and even grey texture, denote good steel; and the appearance of threads, cracks, or brilliant specks, denotes the contrary. But the management of the forging and other circumstances of manufacturing will modify these indications; and the steel that is good for some purposes may be less suited to others.

The fluid into which ignited steel is plunged is of great consequence. All the facts seem reducible to these general conclusions. The hardness will be greater, 1. The hotter the steel is made, provided it be not decomposed: 2. The more considerably its temperature is lowered in the cooling: 3. The shorter the time of cooling: and 4. The more favourable the fire or the cooling material may be to the steel-making process. But the most useful combination of hardness and tenacity will be at a medium temperature in each kind of steel.

With regard to the first particular, little need be said, but that the decomposition of steel in heating will be prevented, and its surface somewhat improved, if it be bedded in charcoal, or the cementing compound, during the application of the heat. The second and third, namely, the quantity and suddenness of cooling, require an attention to the doctrine of Caloric, as explained under that article. The cooling will be more sudden and effectual, the greater the quantity of heat absorbed in the same time. There are three circumstances which favour this effect, namely, a very low temperature of the body to which the hot steel is applied; that it should be a good conductor of heat; or that it shall assume either the fluid or elastic state, which always demand a supply of heat for their maintenance. Thus it is found, that steel is more effectually hardened in cold than in warm water, and, at like temperatures, more effectually in mercury than in water. It may also be remarked, that these two fluids cool the steel by different energies. The water is partly converted into vapour, which carries off the heat, and leaves the fluid much less altered in temperature than mercury, which acts by its conducting property. This last fluid, not having evaporated in the process, is found to have acquired a much more elevated temperature by the immersion. Oil is found to harden the surface of steel much more than its internal part, so that it resists the file, but is much less easily broken by the hammer. This effect arises from its imperfect conducting quality, and the elevated temperature it demands to be converted into the vaporous state; to which we may also add, that a stratum of coal is formed round the steel from the burned oil, which still more effectually prevents the transmission of the heat. A remarkable instance of this nature presented itself to our observation, in hardening a small piece of steel two inches long, and a quarter of an inch diameter. At the time of ignition, the water nearest at hand had been used with soap. The steel made very little noise when plunged into the water, and remained hot for a considerable time; but when taken out, was found to be scarcely at all hardened. It was covered with coally matter; which being cleared off, and the process repeated with clean water, it became perfectly hard. The heat, in both cases, was a low red heat, proper for cast steel which is not intended to be afterwards annealed. We had very little doubt, but that alcohol and the essential oil of turpentine, which are good conductors of heat, and very volatile, would render steel very hard, if their inflammability, and the little necessity there is for using them, were not an impediment to their application. Various artists avail themselves of different substances for the immersion of ignited steel. Some use urine, others water charged with common salt, nitre, or sal ammoniac. Tallow and oil are used for such works as are not required to be brittle, though very hard, the reason of which has just been mentioned; but tallow differs from oil in the heat which becomes latent for its fusion; and, accordingly, solid tallow is an excellent material for hardening drills and other small articles. It has been found by Reaumur, that saline liquids produce rather more hardness than common water; and, in particular, that aquafortis possesses this property in an eminent degree, probably from its conducting power; the makers of files cover them with the grounds of beer and common salt, which assist their hardening, and keep the surface from scorifying. The mucilage of the beer supplies a coally matter; and the fused salt seems not only to form a varnish in the fire and defend the steel, but may also produce coal, by its sudden solution in the water at the time of immersion. Very small articles heated in a candle are found to be hardened perfectly by suddenly whirling them in the cold air; and thin bars or plates of steel, such as the magnetic needle of a compass, acquire a good degree of hardness by being ignited, then laid on a plate of cold lead, and suddenly covered with another plate. These would be unequally hardened, and bend, if plunged in water.

The *bluing* of steel appears to effect its elasticity in a manner not easily explained. This operation consists in exposing steel, the surface of which has been first brightened, to the regulated heat of a plate of metal, or a charcoal fire, or the flame of a lamp, till the surface has acquired a blue colour. Now, if this blue coal be removed by grinding, the elasticity is completely destroyed, and may be restored by bluing the steel again. Rubbing with sand or emery-paper, glazing, or burnishing, equally impairs the elasticity, in proportion as it destroys the blue coat. Saw-makers first harden their plates in the usual way, in which state they are brittle and warped; they then soften them by blazing, which consists in smearing the plate with oil or grease, and heating it till thick vapours are emitted, and burn off with a blaze; and after this they may be hammered flat; lastly, they blue them on a hot iron, which renders them stiff and elastic, without altering their flatness.

The Damascus sword blades have long been celebrated for their excellence, but it is not known how they are made. Mr. Stoddart took six small bars of good malleable iron, and the same number of sheer steel; laid them alternately on each other; welded them together; forged them into a stout flat plate, which was twisted spirally into a cylinder, hammered flat, and again welded; hammered this flat, doubled it throughout its length, inserted in the fold a slip of good steel to form the edge, and by another welding heat consolidated the whole into one mass. This being forged to a proper shape, cracked in different places on being cooled in water after heating; but Mr. Stoddart conceives, that, by using more pieces, repeating the twisting, and not quenching in water, the process would succeed.

Every species of iron is convertible into steel by cementation; but good steel is not to be made except from iron of the best quality, which possesses a certain stiffness and hardness as well as malleability. Swedish iron, as we have before remarked, is the best for this purpose. M. Duhamel tried a great number of the irons of France, Sweden, and Spain. He found the second to be the best; but he likewise obtained excellent steel, superior to those of Styria and Carinthia, which are the best German steels, by using certain iron made in France. But this iron was selected without fault; and, in some instances, the loup or piece at the smelting furnace was fused and forged a second time; a process, which, though attended with loss of weight and additional expense, he recommends as absolutely necessary for making steel iron from ores of indifferent quality. The white sparthose iron ores afforded him the best iron for the purpose of cementation; and these also are the ores which afford the best steel by fusion in Styria, Carinthia, and Tyrol. He informs us that the English use no other cement than mere charcoal, which he also finds perfectly adequate to the purpose; and, moreover, that the quality of the steel is not affected by the different kinds of charcoal made use of. He remarks, nevertheless, that it may be advisable to add from one-fourth to one-third of wood ashes, especially where the iron is not of so good a quality as to afford steel possessing tenacity of body, as well as hardness. These ashes, which he used with success, prevent the steel-making process from being effected as rapidly as it would otherwise be, and give the steel pliability, without diminishing its hardness. It is remarked, that, in the case of this management, the blisters on the surface of the steel are smaller and more numerous. He likewise tried sea-salt. Fifty pounds of salt are sufficient for a furnace of steel of twelve thousand weight. The salt is pulverized, and sprinkled on the bars of iron when put into the furnace. He found that this ingredient likewise contributes to give body to the steel. In the arrangement of the bars in the furnace, the cement is laid one inch thick at the bottom, and half an inch thick between each layer of iron. Our author affirms, that the process would succeed equally well, if the thickness were a little more than a quarter of an inch. The thickness of the bars of iron is indifferent, but there ought not to be a great difference in this respect between bars cemented at the same time. The common thickness is little more than half an inch. It is not advisable that they should be very broad in proportion to the thickness, as this figure is found to produce flaws and cracks in the direction of the length of the bar. The bars may be square, or their breadth may conveniently be somewhat more than twice their thickness. The fire for cementation must be of considerable intensity, and kept up until the conversion has perfectly taken place, which is ascertained by proof bars, so disposed as to be taken out from time to time. The cementation is finished on the sixth day; that is to say, it commonly lasts five times four-and-twenty hours. And, accordingly, the workmen take one of the proofs out on the fifth day, which is forged, hardened, and examined by the fracture. If it break short, and shew no indications of iron, the fire of the furnace is suffered to go out. But if it contain iron, the fire is kept up for twelve or twenty-four hours, accordingly as the quantity of fibrous iron may have proved greater or less in the first proof. A second proof bar, taken out at the proper time, serves to direct them in the same manner with regard to their operations. By this management the cementation is continued somewhat beyond the time requisite for the entire conversion. For there is less inconvenience attending a slight degree of excess in the cementation, than would result from a portion of iron remaining in the steel. The charcoal after cementation is as black, and apparently in the same state, as it was before. M. Duhamel moistened it, and applied it to the same use a second time: it answered the purpose, but so much more slowly, that he objects to the use of it in manufactories. From this, as well as other circumstances attending the steel-making process, it seems advantageous, at least with regard to expedition, that the coals should contain volatile matter. And hence, the superior advantages of animal coal, such as the coal of leather, or the hoofs and horns of animals, imperfectly burned, which are used in case-hardening, though they may be less applicable to the longer process of steel-making, for various reasons.

M. Duhamel advises to have two tilting hammers; one of the weight of one hundred and fifty pounds, and the other half that weight; the first for the purpose of forging large works, and the latter small bars for cutlers. He recommends another small hammer of about twelve pounds, for forging bars still smaller, to make gravers, small files, and the like. The steel must not be heated beyond the degree of cherry-red for forging. The tilting hammers should give at least three hundred strokes in a minute.

The cast steel of England is made as follows: a crucible about ten inches high, and seven in diameter, is filled with ends and fragments of the crude steel of the manufactories, and the filings or fragments of steel works. They add a flux, the component parts of which are usually concealed. It is probable, however, that the success does not much depend upon this flux, which, from the quality of the cast steel itself, may be presumed to be of the nature of a steel cement. This crucible is placed in a wind furnace like that of the founders, but smaller, because intended to contain one pot only. It is likewise surmounted by a cover and chimney, to increase the draught of air. The furnace is entirely filled with coke or charred pit-coal. Five hours are required for the perfect fusion of the steel. It is then poured into long square or octagonal moulds, each composed of two pieces of cast iron fitted together. The ingots, when taken out of the moulds, have the appearance of cast iron. It is then forged in the same manner as other steel, but with less heat and more precaution, because more liable to break.

This cast steel is almost twice as dear as other good steel. M. Duhamel says that it is not proper for all kinds of work, particularly those which require much tenacity, as well as hardness, to resist violent blows and strains; but it is good for razors, knives, and all toys and small work which require an exquisite polish. It does not seem, however, that the tenacity of this steel is inferior to that of the best of the other kinds, and its uniformity of texture is for many works an invaluable advantage. It is daily more and more used in England, and must necessarily be excluded from many works of considerable size, on account of the facility with which it is degraded in the fire, and the difficulty of welding it, which cannot be done in the common way. We have been informed, that the faces of anvils and broad hammers for the use of silversmiths and other artists have been made of cast steel, and welded to iron by a particular management, which consisted in substituting between the iron and the steel another kind of steel, in the form of filings, or a thin plate. The steel plate intended for the face was made as hot as could be done with safety, and the iron being at the same time brought to the welding heat, was applied to the steel, and quickly united by hammering.

When we consider the operations by which crude iron is brought into the malleable state, then converted into steel, and afterwards into a fusible metal, which is not malleable, we may perceive that steel-making is a kind of inversion of the process of refining iron, as practised in the first instance. When the oxide of iron is mixed in the smelting furnace with combustible matter and glass, it will either be completely or partially revived, according to the management of the process. Much of the coal will however be so enveloped with the vitreous matter as to remain unburned: and the reduced iron, with which it may be in contact, will be in the same situation as forged iron in the cementing pot; that is to say, it will be in contact with coal at a very elevated temperature, and defended from the air. From the great infusibility of iron, it may reasonably be concluded, that the reduced metal does not flow into the bottom of the furnace, until the charcoal has converted it into a fusible matter similar to steel, by the same action which takes place in cementation, whatever that action may be. Hence it must follow, that the various specimens of crude or cast iron will differ in their qualities, as well on account of the degree of cementation they have undergone, as the degree of reduction which has taken place among the metallic parts, which are carried down, and form the whole mass. Since the coal, in the process of cementation, communicates or adds weight to the iron; and since crude iron, as well as steel, exhibits sparkles, and is more easily burned than other iron; it may therefore be concluded, that, in the process of refining, that part of the inflammable substance which had united with the metal is burned, and leaves the iron much less fusible than before. Stirring the mass multiplies the contacts of the air with the burned substances; these surfaces of contact will therefore successively afford thin coats of infusible metal. In this manner it is found, that, if a large piece of crude iron be exposed to heat in a wind furnace, the external part will be deprived of its fusibility during the time required to produce a strong heat in the whole mass; and the internal part will be melted, and run out, leaving the shell behind. Iron, which is of the consistence of paste, may therefore be considered, like any other paste, as a mixture of a fluid with a solid. It will be easily understood, that the forging will bring the parts of difficult fusion together, and extrude the less refined and fluid parts; it will also be evident, that this operation is not likely to drive out the whole of the fusible matter. When the iron has arrived at that state, wherein the quantity of fibre or tough iron is sufficient to answer the mechanical purposes to which it is intended to be applied, the artist will consider it as sufficiently refined; and the residue of fusible iron contained in the bar answers, in all probability, the valuable purpose of connecting these infusible masses together. Thus we find that forged iron appears as if covered with a varnish, when urged to a white heat; we find that this varnish is more abundant in steel; and that iron and steel may be respectively welded together by application in this state; an effect which it would be very difficult to account for, in this most infusible of metals, if it were not for such an admixture. But cast steel, steel over cemented, and crude iron, appear to be in the state of all other metals platina excepted. They cannot be welded, because welding implies a partial fusion; or an effect similsr to the gluing or uniting of solids by the application of a fluid, which afterwards becomes consistent. And as platina possesses this valuable property, it seems reasonable to infer, that it must also consist of two metallic substances of different degrees of fusibility; a supposition that appears to be confirmed by the discoveries of Dr. Wollaston and Mr. Tennant.

Crude iron, and steel of a uniform texture, consist therefore of a fusible combination of iron with the combustible substance of the coal, or something which is imparted from it, the crude iron differing from the steel simply in being overdosed with carbon, and less pure, on account of the admixture of metallic oxide, which can scarcely, perhaps, be avoided in the large process. It appears, therefore, that crude iron must pass through the state of steel, before it can become forged iron; and, consequently, that the fabrication of steel from this last is a circuitous process, which can only be repaid by the absence of those unreduced parts which may exist in the crude iron. At some forges, however, where the ore, the flux, the fuel, and the management, are adapted to each other, the produce affords steel, when duly refined. At other manufactories, the crude iron is either refined, or converted into steel, by running it into thin plates, which are stratified with charcoal, and burned in a close furnace. In this way the metal is refined by degrees, without undergoing fusion; and if the heat be raised to that of cementation, the iron will not only be reduced, but converted into steel. In the forges of Carinthia, the grey crude iron is also converted either into soft iron, or steel, according to the management of a somewhat similar process. The iron is fused in a large melting pot; and a small and laying it by for a week or two, till a complete coat of rust is formed. A little oil is then applied, and the surface, being rubbed dry, is polished by means of a hard brush and a little bees-wax.

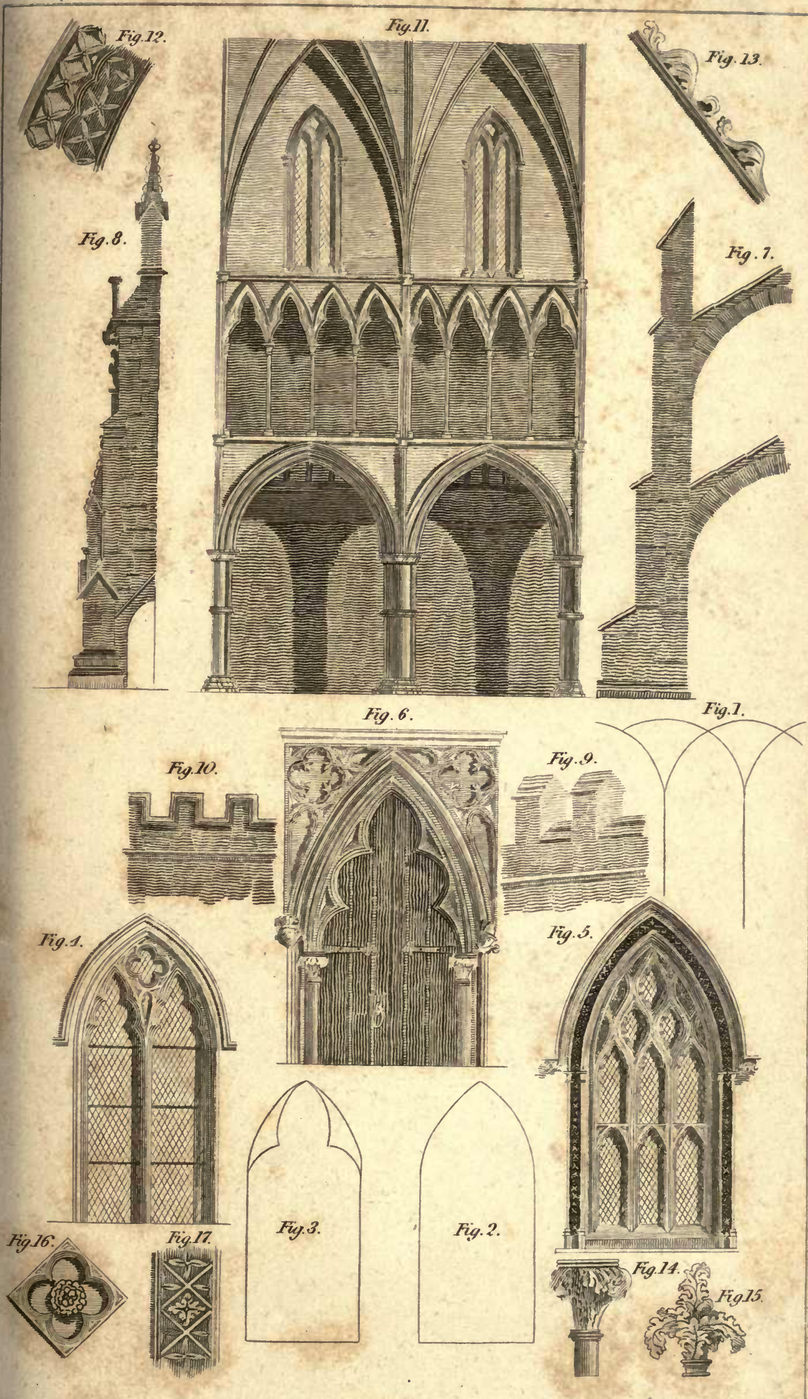
The yellow spots, called iron moulds, which are frequently occasioned by washing ink spots with soap, may in general be removed by lemon juice, or the oxalic or tartarous acids; or by muriatic acid diluted with five or six parts of water, but this must be washed off in a minute or two. Ink spots may readily be removed by the same means. If the iron mould have remained so long, that the iron is very highly oxided, so as to be insoluble in the acid, a solution of an alkaline sulphuret may be applied, and, after this has been well washed off, the acid will remove the stain.

END OF VOL. VI.

Fig.1. Falco *Chrysaetos: Golden Eagle_ Fig. 2.* F. Litho falco: *Stone Falcon_ Fig. 3.* F. Ossifragus: *Osprey_ Fig. 4.* Fulica *aterrima Greater Coot_ Fig. 5.* Glareola *Austriaca: Austrian Pratincole_ Fig. 6.* Hæmatopus *Ostralagus: Pied Oyster catcher.*

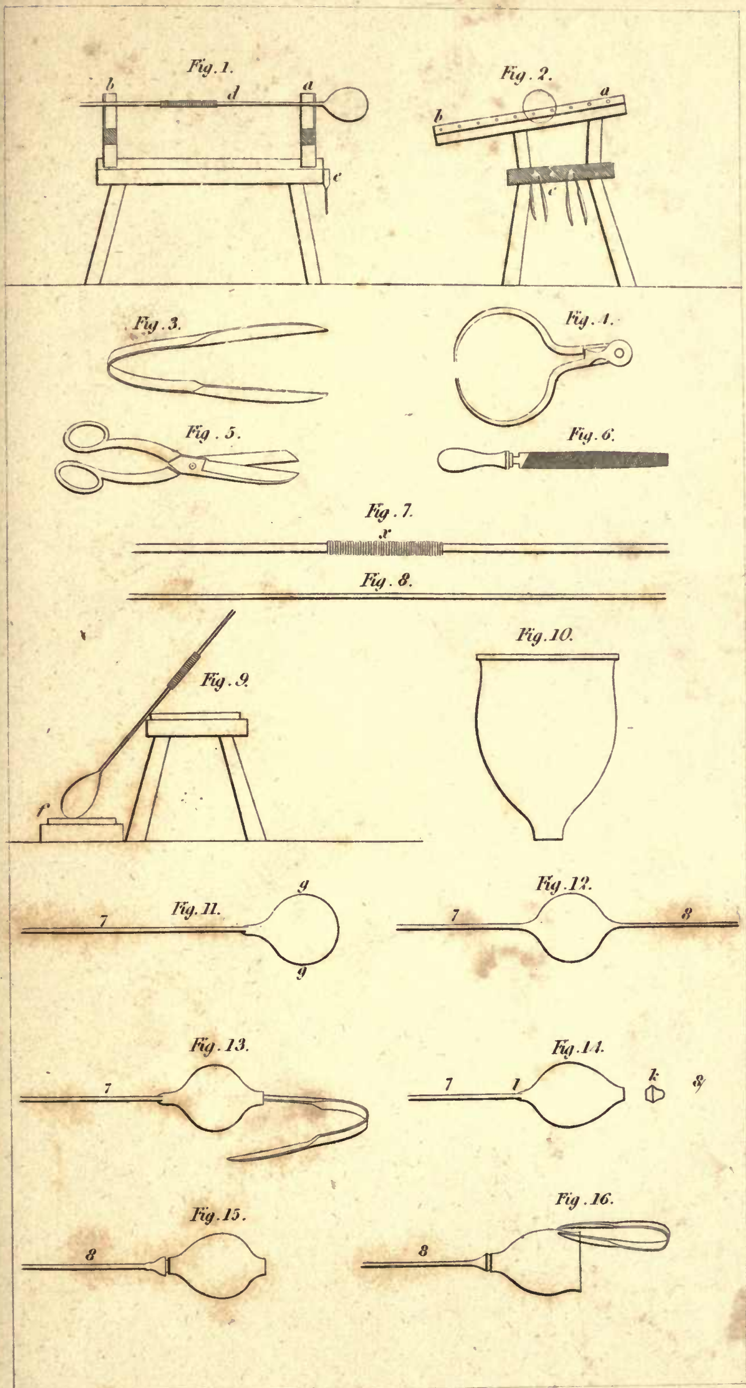
Fig.1. Diodon *hystrix: Porcupine diodon_ Fig. 2.* Exocoetus *exiliens: Oceanic flying fish*
Fig. 3. Echineis *remora: Mediterranean remora_ Fig. 4.* Gobins *lanceolatus: Lance tailed goby_ Fig. 5.* Gymnotus *electricus: Electrical gymnote.*

GOTHIC ARCHITECTURE.



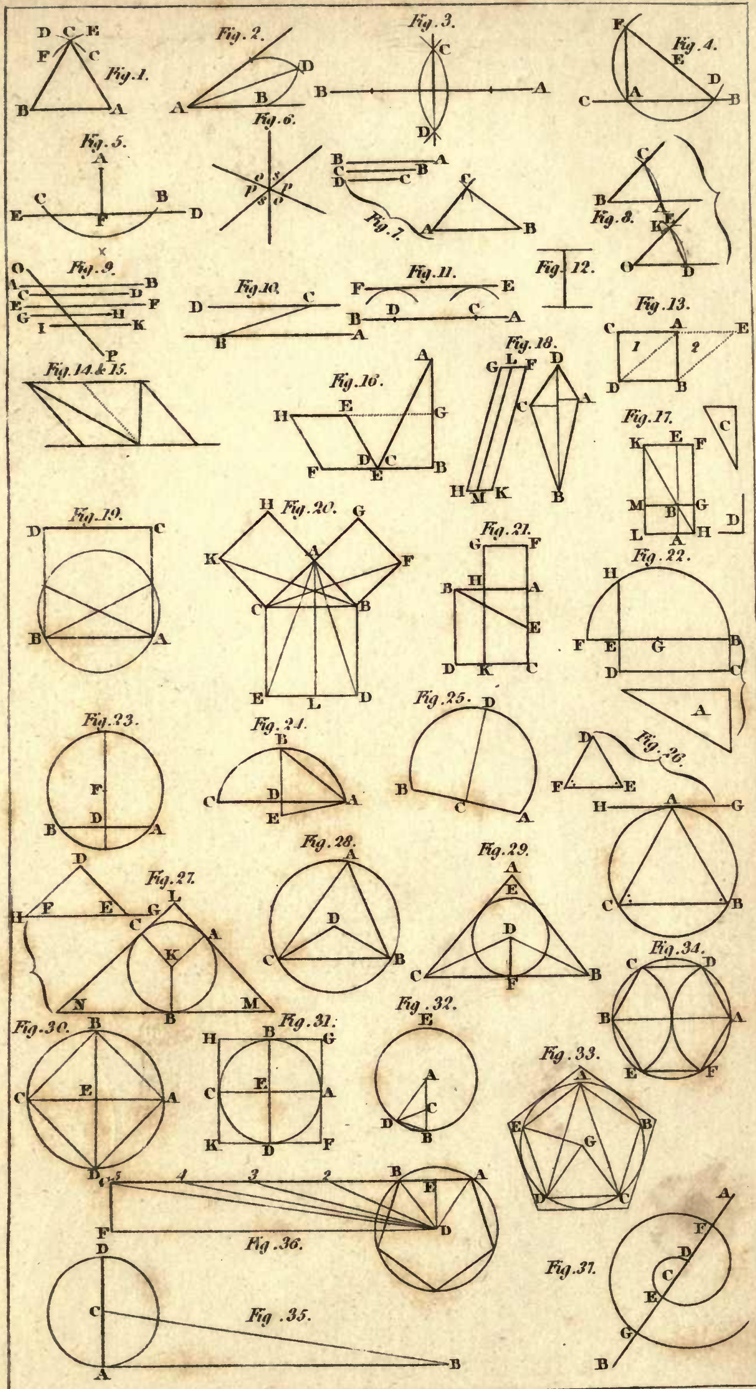
Kneass, Young & Co. Sc.

IMPLEMENTS used in GLASS BLOWING.



Kneass, Young & Co. Sc.

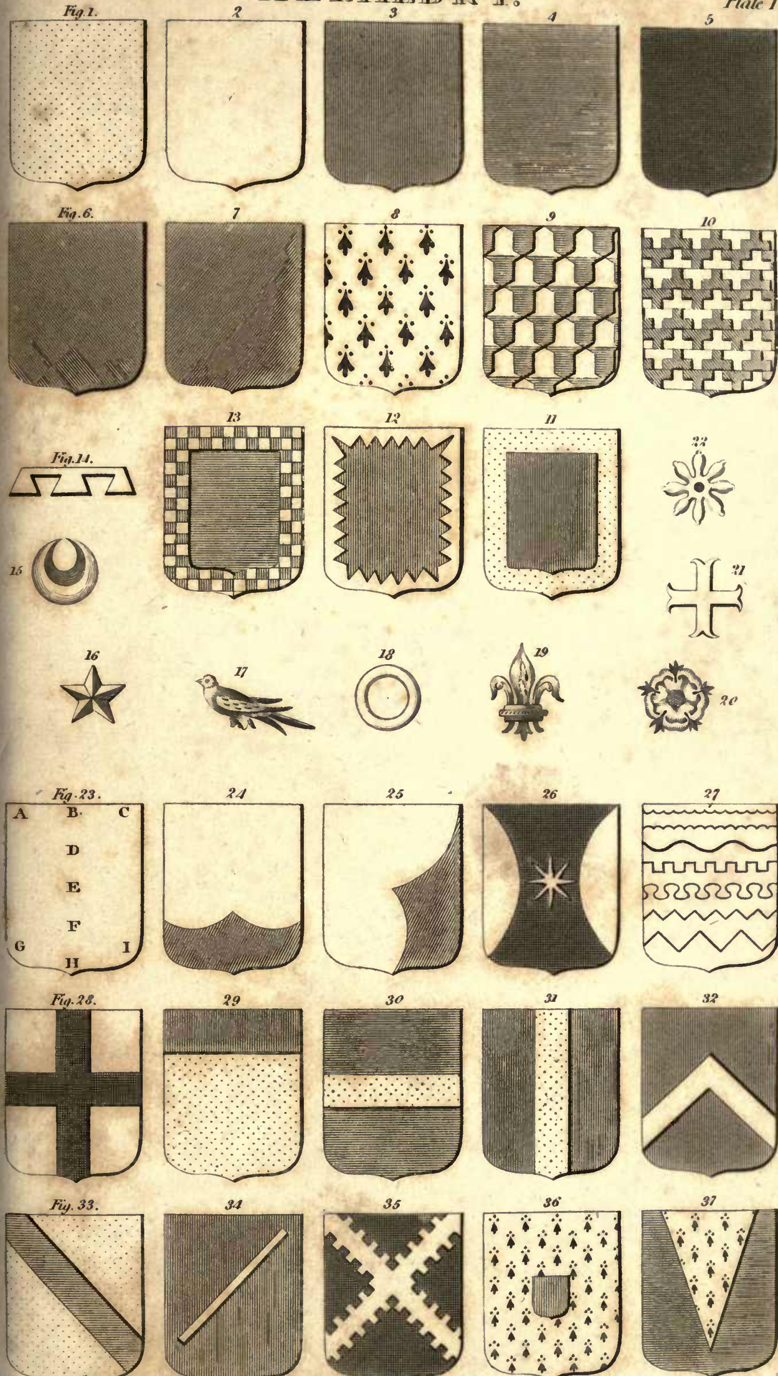
GEOMETRY.



Kneass, Young & Co. Sc

HERALDRY.

Plate 1.

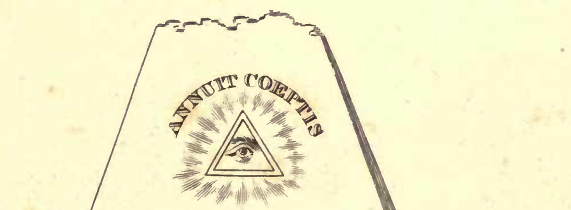


HERALDRY.

Plate II.

Arms of the U. States.

Reverse of the Great Seal.



NOVUS ORDO SECLORUM.

Designed by W. Barton Esq.^r

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Fig. 1

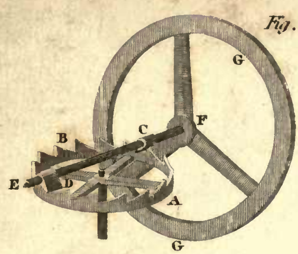


Fig. 2.

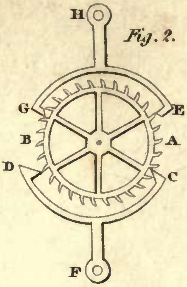


Fig. 3.

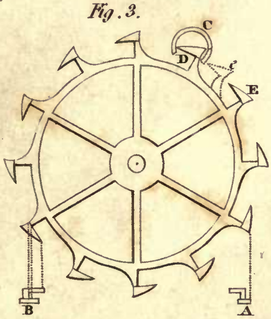


Fig. 4.

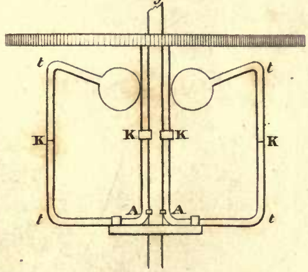


Fig. 5.

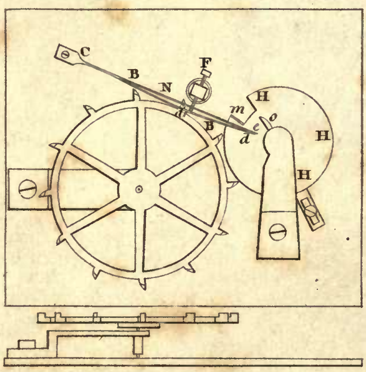


Fig. 7.

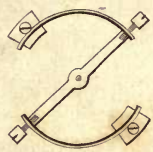


Fig. 6.

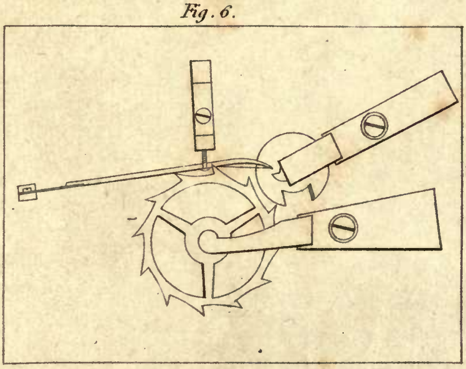
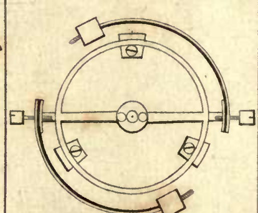


Fig. 8.



Kneass Sc.

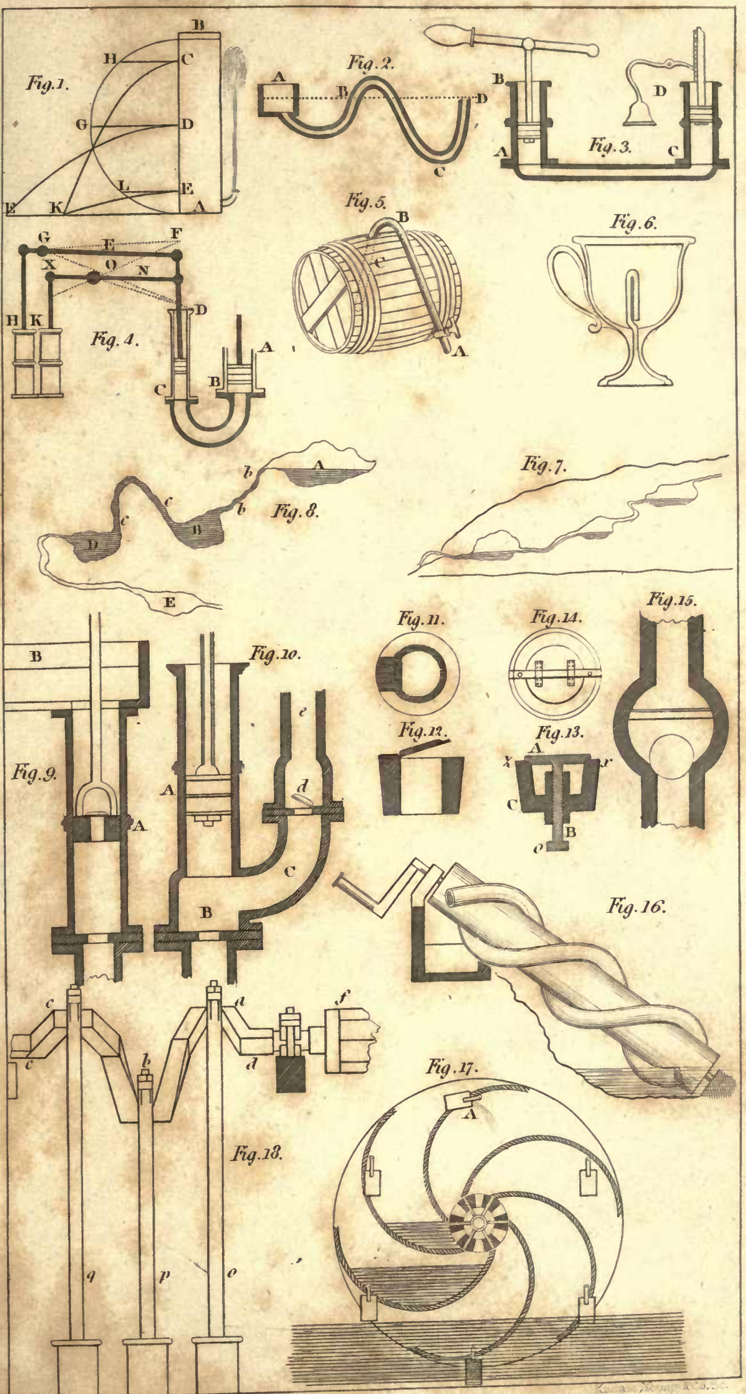


Fig. 1.
B
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K
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Fig. 2.
A
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Fig. 3.
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Fig. 4.
G
E
F
X
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N
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B
C
Fig. 5.
B
C
A
Fig. 6.
Fig. 7.
Fig. 8.
A
b
c
b
c
B
D
E
Fig. 9.
B
A
Fig. 10.
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A
d
C
B
Fig. 11.
Fig. 14.
Fig. 15.
Fig. 12.
Fig. 13.
A
x
x
C
B
o
Fig. 16.
c
a
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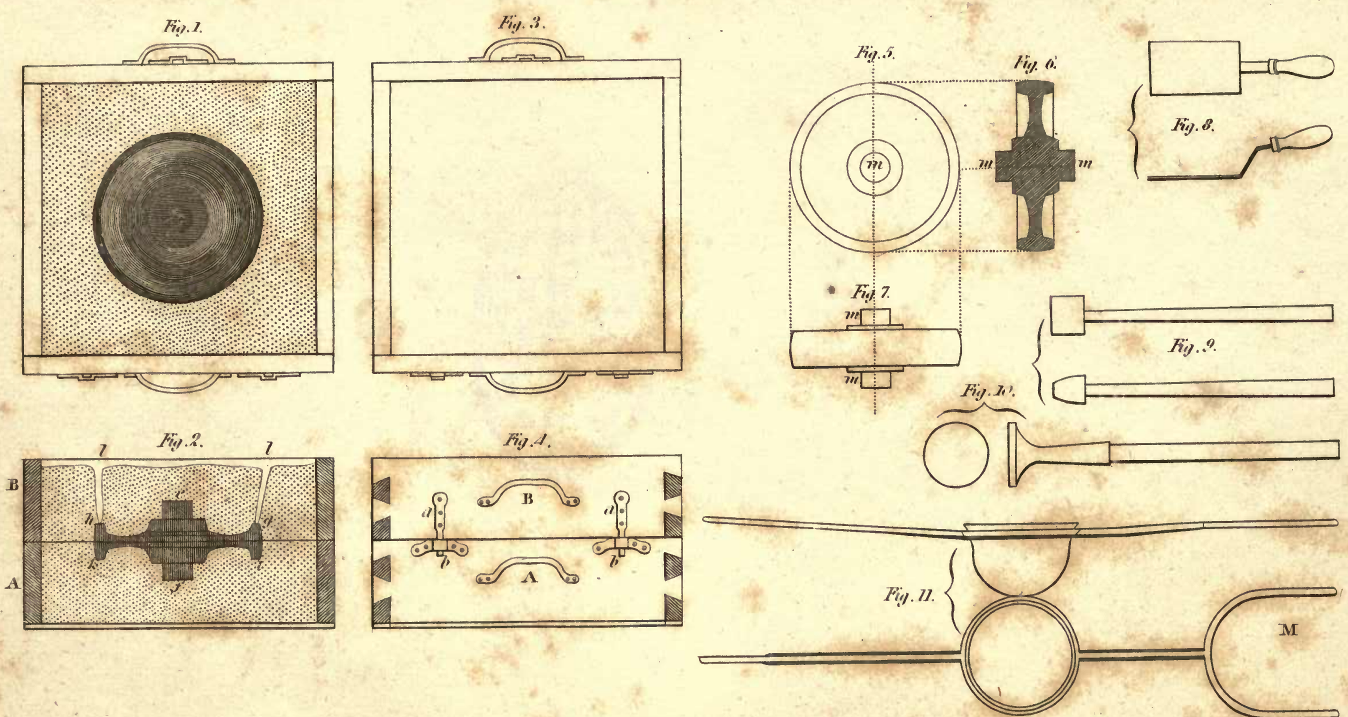
c
b
d
Fig. 17.
A
Fig. 18.
q
p
o

IRON FOUNDRY.



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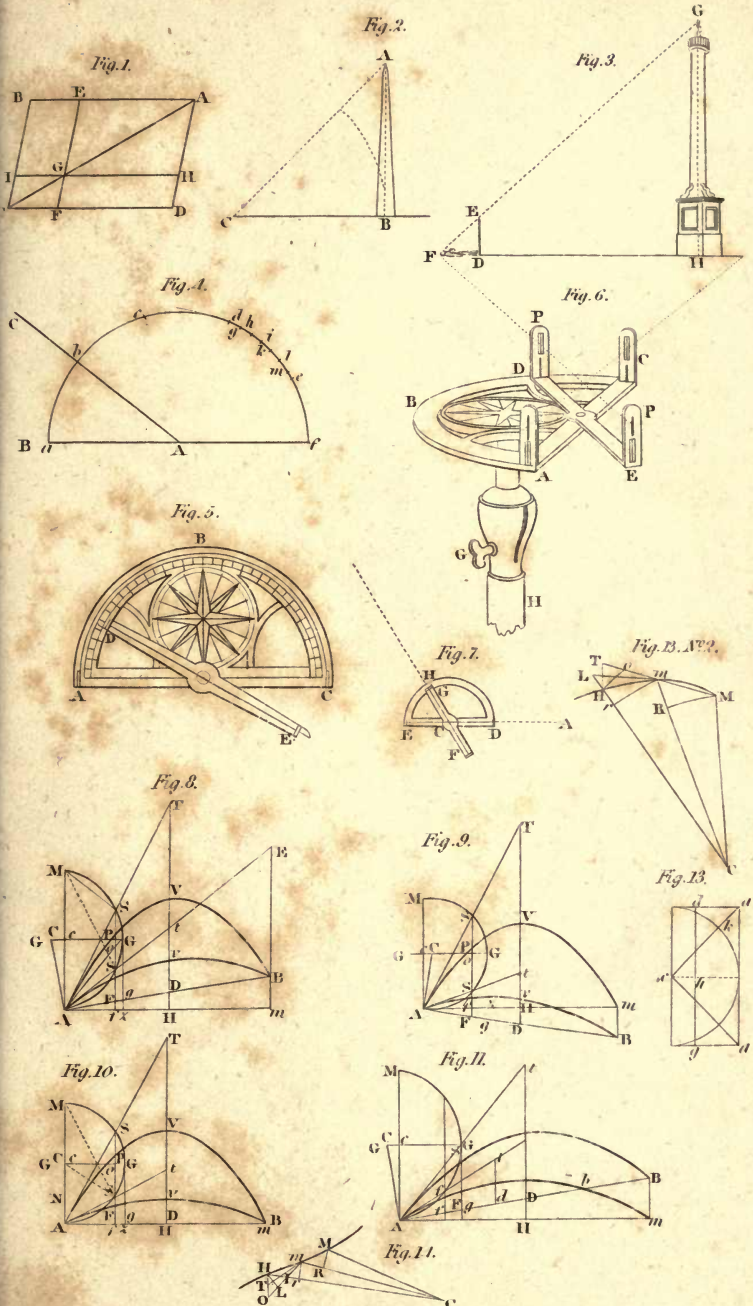

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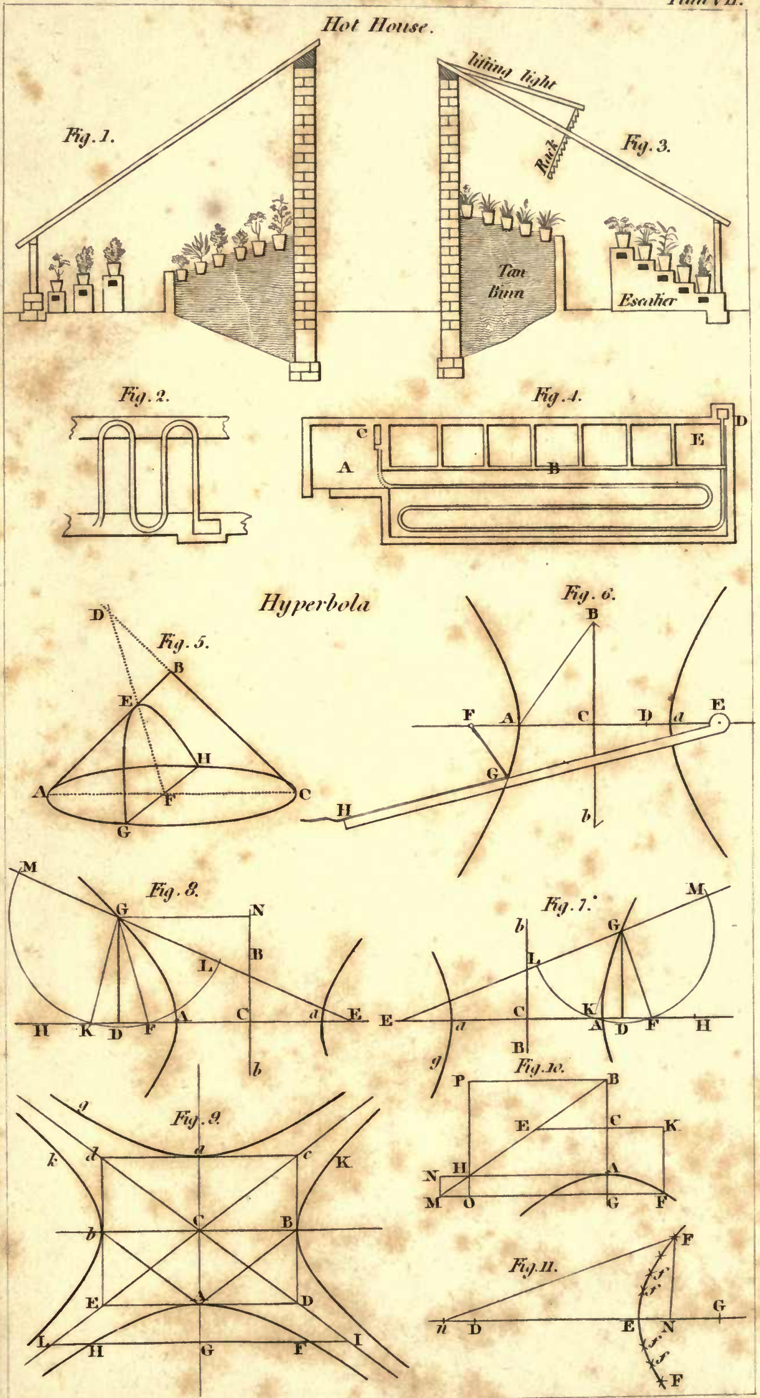

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