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.

1819

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BRITISH ENCYCLOPEDIA,

OR

DICTIONARY

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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.

VOL. X. PHO......RYN.

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tain none of it are incombustibles. All combustibles are composed of an incombustible body and phlogiston united; and during the combustion the phlogiston flies off, and the incombustible body is left behind. Thus, when sulphur is burnt, the substance that remains is sulphuric acid, an incombustible body. Sulphur therefore is said to be composed of sulphuric acid and phlogiston. This theory has long since given place to that established by Lavoisier. See COMBUSTION. It must, however, be observed, that Professor Davy, in his late discoveries, seems inclined to admit of an inflammable principle, which pervades the whole of nature. How far his future experiments may lead to the establishment of the Lavoisierian theory, or that of Stahl, time only can show. See POTASSIUM, &c.

PHLOMIS, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ or Labiatæ. Essential character: calyx angular; corolla upper lip incumbent, compressed, villose. There are twenty-two species.

PHLOX, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Rotaceæ. Polemonia, Jussieu. Essential character: corolla salver-shaped; filaments unequal; stigma trifid; calyx prismatical; capsule three-celled, one-seeded. There are twelve species, natives of North America.

PHOCA, the *seal*, in natural history, a genus of Mammalia of the order Feræ. Generic character: fore teeth, in the upper jaw, six, sharp, parallel, and the exterior ones larger; in the lower jaw four, distinct, parallel, equal, and rather blunt; tusks one on each side in both jaws, large and pointed, the upper remote from the fore teeth, the lower from the grinders; grinders five on each side above, and six below, tricuspidated. There are nineteen species, of which we shall notice the following:

P. vitulina, or the common seal, or sea-calf. These animals are found on the coasts of the polar regions, both to the north and south, often in extreme abundance, and are generally about five feet in length, closely covered with short hair. They swim with great vigour and rapidity, and subsist on various kinds of fish, which they are often observed to pursue within a short distance from the shore. They possess no inconsiderable sagacity, and may, without much difficulty, if taken young, be familiarized to their keepers, and instructed in various gesticulations. They are supposed to attain great longevity. The female is particularly attentive to her young, and scarcely ever produces more than two at a birth, which, after being suckled a fortnight on the shore, where they are always born, are conducted to the water, and taught by their dam the means of defence and subsistence; and when they are fatigued by their excursions, are relieved by being taken on her back. They distinguish her voice, and attend at her call. The flesh of seals is sometimes eaten, but they are almost always destroyed for their oil and skins. The latter are manufactured into very valuable leather, and the former is serviceable in a vast variety of manufactures. A young seal will supply about eight gallons of oil. The smell of these animals, in any great number upon the shore, is highly disagreeable. In the month of October they are generally considered as most valuable, and as they abound in extended caverns on the coast, which are washed by the tide, the hunters proceed to these retreats about midnight, advancing with their boat as far into the recess as they are able, armed with spears and bludgeons, and furnished with torches, to enable them to explore the cavern. They begin their operations by making the most violent noises, which soon rouse the seals from their slumbers, and awaken them to a sense of extreme danger, which they express by the most hideous yellings of terror. In their eagerness to escape they come down from all parts of the cavern, rushing in a promiscuous and turbulent mass along the avenue to the water. The men engaged in this perilous adventure oppose no impediment to this rushing crowd, but as this begins to diminish, apply their weapons with great activity and success, destroying vast numbers, and principally the young ones. The blow of the hunter is always levelled at the nose of the seal, where a slight stroke is almost instantly fatal.

P. ursina, or the ursine seal, grows to the length of eight feet, and to the weight of a hundred pounds. These are found in vast abundance in the islands between America and Kamtschatka, from June till September, when they return to the Asiatic or American shores. They are extremely strong, surviving wounds and lacerations which almost instantly destroy life in other animals, for days, and even weeks. They may be observed, not merely by hundreds, but by thousands on the shore, each male surrounded by his females, from eight to fifty, and his offspring, amounting frequently to more than than that number. Each family is preserved separate from every other. The ursine seals are extremely fat and indolent, and remain with little exercise, or even motion, for months together upon the shore. But if jealousy, to which they are ever alive, once strongly operate, they are roused to animation by all the fierceness of resentment and vengeance, and conflicts arising from this cause between individuals, soon spread through families, till at length the whole shore becomes a scene of the most horrid hostility and havoc. When the conflict is finished, the survivors plunge into the water, to wash off the blood, and recover from their exhaustion. Those which are old, and have lost the solace of connubial life, are reported to be extremely captious, fierce, and malignant, and to live apart from all others, and so tenaciously to be attached to the station, which preoccupancy may be supposed to give each a right to call his own, that any attempt at usurpation is resented as the foulest indignity, and the most furious contests frequently occur in consequence of the several claims for a favourite position. It is stated, that in these combats two never fall upon one. These seals are said, in grief, to shed tears very copiously. The male defends his young with the most intrepid courage and fondness, and will often beat the dam, notwithstanding her most supplicating tones and gestures, under the idea that she has been the cause of the destruction or injury which may have occurred to any of them. The flesh of the old male seal is intolerably strong; that of the female and the young is considered as delicate and nourishing, and compared in tenderness and flavour to the flesh of young pigs.

The bottle-nosed seal is found on the Falkland Islands, is twenty feet long, and will produce a butt of oil, and discharge, when stuck to the heart, two hogsheads of blood.

PHŒNICOPTEROS, the *flamingo*, in natural history, a genus of birds of the order Grallæ. Generic character: bill naked, toothed, bending in the middle, as if broken; nostrils covered above with a thin plate, and linear; tongue cartilaginous and pointed; neck, legs, and thighs exceedingly long; feet webbed, back-toe very small. The P. rubra, or common flamingo, the only species noticed by Latham, is nearly of the size of a goose, and upwards of four feet long. When mature in plumage, these birds are all over of the most deep and beautiful scarlet; but this maturity they never acquire till their third year. They are found in America, as far north as the southern borders of the United States; France, Spain, and Italy, in Syria and in Persia, but more frequently than any where else, on the coast of Africa downwards to the Cape. They build their nest of mud, in the shape of a hillock, and in a cavity on the top of it the female deposits two white eggs, on which she sits, having her legs dependent one on each side of the hillock. The young ones run with great swiftness, but are unable to fly till they have attained nearly their complete growth. They subsist chiefly on small fishes, ova, and water insects, and frequent, during the day, the borders of rivers and lakes, withdrawing at night to the high grounds, and lodging amidst the long grass. They are extremely shy, and are stated, almost always, unless in the breeding season, to keep together in flocks, having a centinel, ever vigilant at his post, by whom the slightest approaching danger is announced, by intimations which produce immediate flight. Their flesh is thought by some not inferior to that of the partridge, but their tongue was one of the most valued dainties of Roman epicurism. They have been sometimes reared tame, but are with difficulty preserved, and their susceptibility of cold is exquisite.

PHŒNIX, in astronomy, one of the constellations of the southern hemisphere, unknown to the ancients, and invisible in our northern parts. This constellation is said to consist of thirteen stars.

Phœnix, in botany, a genus of the Appendix Palmæ. Natural order of Palms. Essential character: calyx three parted; corolla three-petalled: male, stamina three; female, pistil one; drupe ovate. There are two species, *viz.* P. dactylifera, date palm-tree, and P. farinifera, natives of the Levant and Coromandel.

PHONICS, the doctrine or science of sounds. See Acoustics. This science has been considered as analogous to that of optics, and is divided into direct, refracted, and reflected; these have been called phonics, diaphonics, and cataphonics; but the terms are now well nigh obsolete. Phonics is a science that may be improved with regard to the object, the medium, and the organ.

The object may be improved with respect to the production and propagation of sounds. With regard to the medium, phonics may be improved by its thinness and quiescency, and by the sonorous body being placed near a smooth wall, either plain or arched, more especially if it be formed after some peculiar curve, as from this arises the theory and practice of whispering places. Sound is much sweetened if it is propagated in the vicinity of water; and on a plain, it will be conveyed much further than on uneven ground.

PHORMIUM, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Asphodeli, Jussieu. Essential character: calyx none; corolla six-petalled, the three inner petals longer; capsule oblong, three-sided; seeds oblong, compressed. There is but one species, *viz.* P. tenax, New Zealand flax-plant. The inhabitants of New Zealand make a thread of the leaves, with which the women weave a variety of fine matting for clothing, and several other purposes. It is also manufactured in Norfolk Island for canvass and coarse linen cloths.

PHOSPHATES, in chemistry, salts formed of the phosphoric acid, with earths, alkalies, &c. The alkaline phosphates are soluble and crystallizable; they are also fusible, forming a kind of glass, and facilitate the fusion of a number of other substances. They may be decomposed in the humid way, by sulphuric and some other acids; but in the dry way these decompositions do not often happen. The phosphate of soda is much used in medicine; it is purely saline, without any bitterness, which renders it a good substitute for Epsom and Glauber's salts. As it melts easily, and promotes the fusion of the earths and metallic oxides, it is used in chemical operations as a flux. Phosphate of ammonia exists in the urine of carnivorous animals, in considerable quantity, united with phosphate of soda, forming a triple salt, formerly denominated microcosmic, or fusible salt, in urine.

PHOSPHITES, are salts formed of the phosphorous acid, with alkalies, earths, &c. In several of their properties they resemble the phosphates; but may be distinguished from them, by appearing luminous when heated with the blowpipe, and by affording, by distillation, a small quantity of phosphorus. They detonate, too, with oxy-muriate of potash, and precipitate gold from its solution in a metallic state. By exposure to the air, they pass into phosphates.

PHOSPHORESCENCE, } See LIGHT.
PHOSPHORI, }

PHOSPHORIC *acid.* When phosphorus undergoes combustion in oxygen gas, a great quantity of white fumes are produced, which are deposited in white flakes. These are phosphoric acid; so that it is a compound of phosphorus and oxygen. The phosphoric acid was first shewn to be distinct from all other acids, in the year 1743, by Margraaff. He found that it existed in the salts which were taken from human urine, and that phosphorus could only be obtained from this acid; as well as that it could be converted into phosphoric acid. This acid was found to exist in some vegetable substances, although it was formerly supposed to be peculiar to animal matters. Phosphoric acid may be obtained, not only by the method just mentioned, but also by transmitting a current of oxygen gas through phosphorus melted under water. The acid, as it is formed, combines with the water, from which it may be obtained in a state of purity by evaporation. The specific gravity of this acid varies according to the different states in which it exists. In the liquid state it is 1.4; in the dry state it is 2.7; in the state of glass 2.85. It changes the colour of vegetable blues to red; has no smell, but a very acid taste. When it is exposed to the air it attracts moisture, and is converted into a thick viscid fluid, like oil. It is very soluble in water. When in the form of dry flakes, it dissolves in a small quantity of this liquid, producing a hissing noise like that of a red-hot iron plunged into water, with the extrication of a great quantity of heat. The component parts of this acid have been accurately ascertained by Lavoisier, and it consists of,

Oxygen	60
Phosphorus	40
	100

It combines with the alkalies, earths, and metallic oxides, and forms salts which are denominated phosphates.

PHOSPHORITE, in mineralogy, is of a yellowish white, frequently spotted with grey: it occurs massive; internally it is glistening, sometimes dull; it is translucent on the edges, soft, brittle, and not very heavy. It forms a great bed in the province of Estremadura in Spain. In appearance it resembles curved, lamellar, heavy-spar; but it is harder and lighter than this kind of heavy-spar.

PHOSPHOROUS *acid*, is obtained by the slow combustion of phosphorus at the common temperature of the air. If phosphorus, in small pieces, be exposed to the air in a glass funnel placed in a bottle, it attracts the oxygen and moisture from the atmosphere, and runs down into the bottle. This is the phosphorous acid. By this process, about three times the weight of the phosphorus is obtained. It is then in the form of a thick liquid, adhering to the sides of the vessel. It varies in consistence according to the state of the air. Its specific gravity is not known. It has an acid pungent taste, not different from phosphoric acid. It also reddens vegetable blue colours. The phosphorous acid is not altered by light. When exposed to heat in a retort, part of the water combined with it is first driven off, and when it is concentrated, bubbles of air suddenly rise to the surface, and collect in the form of white smoke, and sometimes inflame, if there be any air in the apparatus. If the experiment be made in an open vessel, each bubble of air, when it comes to the surface, produces a vivid deflagration, and diffuses the odour of phosphorated hydrogen gas. This acid is composed of the same constituent parts as the phosphoric, and is considered by some as the phosphoric acid holding in solution a small quantity of phosphorus. Phosphorous acid forms compounds with alkalies, earths, and metallic oxides, which are known under the name of phosphites.

PHOSPHORUS. This singular substance was accidentally discovered in 1677 by an alchymist of Hamburgh, named Brandt, when he was engaged in searching for the Philosopher's stone.—Kunkel, another chemist, who had seen the new product, associated himself with one of his friends, named Krafft, to purchase the secret of its preparation; but the latter deceiving his friend, made the purchase for himself, and refused to communicate it. Kunkel, who at this time know nothing further of its preparation than that it was obtained by certain processes from urine, undertook the task and succeeded. It is on this account that the substance long went under the name of Kunkel's phosphorus. Mr. Boyle is also considered as one of the discoverers of phosphorus. He communicated the secret of the process for preparing it to the Royal Society of London in 1680. It is asserted, indeed, by Krafft, that he discovered the secret to Mr Boyle, having in the year 1678 carried a small piece of it to London, to shew it to the royal family; but there is little probability that a man of such integrity as Mr. Boyle would claim the discovery of the process as his own, and communicate it to the Royal Society, if this had been the case. Mr. Boyle communicated the process to Godfrey Hankwitz, an apothecary of London, who for many years supplied Europe with phosphorus, and hence it went under the name of English phosphorus. In the year 1774, the Swedish chemists, Gahn and Scheele, made the important discovery, that phosphorus is contained in the bones of animals, and they improved the processes for procuring it.

The most convenient process for obtaining phosphorus seems to be that recommended by Fourcroy and Vauquelin, which we shall transcribe. Take a quantity of burnt bones and reduce them to powder. Put 100 parts of this powder into a porcelain or stone-ware bason, and dilute it with four times its weight of water. Forty parts of sulphuric acid are then to be added in small portions, taking care to stir the mixture after the addition of every portion. A violent effervescence takes place, and a great quantity of air is disengaged. Let the mixture remain for twenty-four hours, stirring it occasionally, to expose every part of the powder to the action of the acid. The burnt bones consist of the phosphoric acid and lime; but the sulphhuric acid has a greater affinity for the lime than the phosphoric acid. The action of the sulphuric acid uniting with the lime, and the separation of the phosphoric acid, occasion the effervescence. The sulphuric acid and the lime combine together, being insoluble, and fall to the bottom.—Pour the whole mixture on a cloth filter, so that the liquid part, which is to be received in a porcelain vessel, may pass through. A white powder, which is the insoluble sulphate of lime, remains on the filter. After this has been repeatedly washed with water, it may be thrown away; but the water is to be added to that part of the liquid which passed through the filter. Take a solution of sugar of lead in water, and pour it gradually into the liquid in the porcelain bason. A white powder falls to the bottom, and the sugar of lead must be added so long as any precipitation takes place, The whole is again to be poured upon a filter, and the white powder which remains is to be well washed and dried. The dried powder is then to be mixed with one-sixth of its weight of charcoal powder. Put this mixture into an earthenware retort, and place it in a sand bath, with the beak plunged into a vessel of water. Apply heat, and let it be gradually increased, till the retort becomes red hot. As the heat increases, air bubbles rush in abundance through the beak of the retort, some of which are inflamed when they come in contact with the air at the surface of the water. A substance at last drops out similar to melted wax, which congeals under the water. This is phosphorus. To have it quite pure, melt it in warm water, and strain it several times through a piece of shamoy leather under the surface of the water. To mould it into sticks, take a glass funnel with a long tube, which must be stopped with a cork. Fill it with water and put the phosphorus into it. Immerse the funnel in boiling water, and when the phosphorus is melted, and flows into the tube of the funnel, then plunge it into cold water, and when the phosphorus has become solid, remove the cork, and push the phosphorus from the mould with a piece of wood. Thus prepared, it must be preserved in close vessels, containing pure water. When phosphorus is perfectly pure, it is semi-transparent, and has the consistence of wax. It is so soft that it may be cut with a knife. Its specific gravity is from 1.77 to 2.03. It has an acrid and disagreeable taste, and a peculiar smell, somewhat resembling garlic.

When a stick of phosphorus is broken, it exhibits some appearance of crystallization. The crystals are needle shaped, or long octahedrons; but to obtain them in their most perfect state, the surface of the phosphorus, just when it becomes solid, should be pierced, that the internal liquid phosphorus may flow out, and leave a cavity for their formation. When phosphorus is exposed to the light, it becomes of a reddish colour, which appears to be an incipient combustion. It is therefore necessary to preserve it in a dark place. At the temperature of 99° it becomes liquid, and if air be entirely excluded, it evaporates at 219°, and boils at 554°. At the temperature of 43° or 44°, it gives out a white smoke, and is luminous in the dark. This is a slow combustion of the phosphorus, which becomes more rapid as the temperature is raised. When phosphorus is heated to the temperature of 148° it takes fire, burns with a bright flame, and gives out a great quantity of white smoke. Phosphorus enters into combination with oxygen, azote, hydrogen, and carbon. Phosphorus is soluble in oils, and when thus dissolved, forms what has been called liquid phosphorus, which may be rubbed on the face and hands without injury. It dissolves too in ether, and a very beautiful experiment consists in pouring this phosphoric ether in small portions, and in a dark place, on the surface of hot water. The phosphoric matches consist of phosphorus extremely dry, minutely divided, and perhaps a little oxygenized. The simplest mode of making them is to put a little phosphorus, dried by blotting paper, into a small phial; heat the phial, and when the phosphorus is melted turn it round, so that the phosphorus may adhere to the sides. Cork the phial closely, and it is prepared. On putting a common sulphur match into the bottle, and stirring it about, the phosphorus will adhere to the match, and will take fire when brought out into the air.

PHOSPHURETS, in chemistry, are substances formed by an union with phosphorus; thus we have the phosphuret of carbon, which is a compound of carbon with phosphorus: we have also the phosphuret of lime, hydrogen, &c.

PHOSPHURETTED *hydrogen*, phosphorus dissolved in hydrogen gas; which may be done by introducing phosphorus into a glass jar of hydrogen gas standing over mercury, and then melting it by means of a burning glass; the gas dissolves a large proportion of it. The compound has a very fetid odour, something like that from putrid fish. When it comes into contact with common air, it burns with great rapidity, and if mixed with that air it detonates violently. Oxygen gas produces a still more rapid and brilliant combustion than common air. When bubbles of it are made to pass up through water, they explode in succession as they reach the surface of the liquid; a beautiful column of white smoke is formed. This gas is the most combustible substance known. Its combustion is the combination of its phosphorus and hydrogen with the oxygen of the atmosphere, and the products are phosphoric acid and water. These substances mixed or combined, constitute the white smoke.

PHOTOMETER, an instrument intended to indicate the different quantities of light, as in a cloudy or bright day, or between bodies illuminated in different degrees. The ratio of the intensities of two luminous objects has been attempted to be measured, by placing them at different distances from a given object, until that object cast two shadows of equal darkness; or by observing when two equal objects appeared to be equally illuminated each by one of the luminous objects; for then, by a well known and established law, the proportion of the intensities of their light was supposed to be as the squares of the distances. Thus if two equal objects appear to be equally illuminated, when one of them is three feet from a tallow candle, and when the other is nine feet from a wax candle, then it is inferred that the intensity of the light of the former candle is to that of the latter as nine to eighty-one. Mr. Leslie has more recently invented an instrument of this kind, the essential part of which consists of a glass tube like a reversed syphon, whose two branches should be equal in height, and terminated by balls of equal diameter; one of the balls is of black enamel, and the other of common glass, into which is put some liquid.

The motions of the liquor, which is sulphuric acid tinged red with carmine, are measured by means of a graduation, the zero is situated towards the top of the branch that is terminated by the enamelled ball. The use of this instrument is founded upon the principle, that when the light is absorbed by a body, it produces a heat proportional to the quantity of absorption. When the instrument is exposed to the solar rays, those rays that are absorbed by the dark colour, heat the interior air, which causes the liquor to descend at first with rapidity in the corresponding branch. But as a part of the heat, which had introduced itself by means of the absorption, is dissipated by the radiation, and as the difference between the quantity of heat lost and that of the heat acquired goes on diminishing, there will be a point where, these two quantities having become equal, the instrument will be stationary, and the intensity of the incident light is then estimated by the number of degrees which the liquor has run over. The author of this ingenious instrument, has pointed out its advantages in determining the progressive augmentation undergone by the intensity of the light, and the gradation in a contrary sense, which succeeds to that progress, both from the beginning of day to its end, and from the winter solstice to the end of the succeeding autumn. With the help of such an instrument, one might also compare the action of rays of light in different countries, of which some dart with sufficient constancy from a fine and serene sky, while others seem to be covered with a veil which dims and obscures their lustre. Mr. Leslie, having proposed to himself to measure the energy of the several coloured rays which compose the solar spectrum, caused a beam of light to pass through a prism of flint glass; and the indications of the photometer presented successively to the different parts of the spectrum, have furnished nearly for the relation, between the degrees of force of the blue, green, yellow, and red rays, that of the numbers 1, 4, 9, 16; a relation which, considered in the two extreme terms, is more than quadruple that which was substituted for it by Dr. Herschel, who has made experiments for the same purpose.

PHRYGANEA, in natural history, a genus of insects of the order Neuroptera. Generic character: mouth with a horny short curved mandible; feelers four; three stemmata; antennæ setaceous, longer than the thorax; wings equal, incumbent, the lower ones folded. There are nearly sixty species, in two divisions. A. Tail with two truncate bristles. B. Tail without bristles. The insects of this genus are seen in a summer's evening floating in the air in large masses, and are eagerly devoured by swallows. They resemble moths, particularly the division called Tineæ; but may readily be distinguished by their feelers, and also by the stemmata situated at the top of the head. The phryganeæ proceed from aquatic larvæ of a lengthened shape, residing in tubular cases, which they form by agglutinating various fragments of vegetable substances, &c. These tubular cases are lined within by a tissue of silken fibres, and are open at each extremity. The included larvæ, when feeding, protrude the head and fore-parts of the body, creeping along the bottom of the waters they inhabit, by means of six short and slender legs; on the upper part of the back is a sort of prop, preventing the case, or tube, from slipping too far forwards during the time the animal is feeding. One of the largest species is the P. grandis, (see Plate IV. Entomology, fig. 2.) This insect is about an inch in length, very like a phalæna; the upper wings are grey, marked by various darker and lighter streaks and specks, and the under wings yellowish brown, and semitransparent. The larvæ of this genus is known by the name of cadew-worm, and is frequently used by anglers as a bait. When arrived at full growth, it fastens the case or tube, by several silken filaments, to the stem of some water plant, or other convenient substance, in such a manner as to project a little above the surface of the water, and casting its skin, changes to a chrysalis of a lengthened shape, and displaying the immature limbs of the future phryganea, which in a fortnight emerges from its confinement. It inhabits Europe.

PHRYMA, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Personatæ. Labiatæ, Jussieu. Essential character: seed one. There are two species, *viz.* P. leptostachya and P. dehiscens; the former is a native of North America, the latter was found at the Cape of Good Hope, by Thunberg.

PHRYNIUM, in botany, a genus of the Monandria Monogynia class and order. Essential character: calyx three-leaved; petals three, equal, growing to the long channelled tube of the nectary; nectary tube filiform; border four-parted; capsule three celled; nuts three. There is but one species, *viz.* P. capitatum, which is a native of Malabar, China, and Cochin China, in shady moist places.

PHTHISIS, a species of consumption, arising from an ulcer of the lungs. See MEDICINE.

PHYLACTERY, in antiquity, a charm, or amulet, which being worn, was supposed to preserve people from certain evils, diseases, and dangers.

PHYLLACHNE, in botany, a genus of the Dioecia Monandria class and order. Essential character: calyx three-leaved, superior; corolla funnel-form; female stigma four-cornered; capsule inferior, many seeded. There is only one species, *viz.* P. uliginosa, a small mossy plant, growing in tufts; stems closely approximating, covered with imbricate leaves, proliferous into two or three branchlets; leaves small, awl-shaped, flowers terminating, sessile, white; this plant has the structure of a moss, but adorned with flowers of a very different kind. It is a native of Terra del Fuego.

PHYLLANTHUS, in botany, a genus of the Monoecia Triandria class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: male, calyx six-parted, bell-shaped; corolla none; female, calyx six-parted; corolla none; styles three, bifid; capsule three-celled; seeds solitary. There are eleven species, among which we shall notice the P. niruri, annual phyllanthus; this is a plant, with an herbaceous stalk a foot and a half in height; the leaflets contract every evening, turning their under side outwards; the flowers are produced on the under side of the leaves along the midrib, and turn downwards; it usually flowers here from June to October; the seeds ripen in succession, and are cast out of the capsules, when ripe, with so much force, as to be thrown to a considerable distance: it is very common in Barbadoes and Japan.

PHYLICA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: perianth five-parted, turbinate; petals none, but five scales defending the stamens; capsule tricoccous, inferior. There are twenty species, of which P. ericoides, heath-leaved phylica, is a low bushy plant, seldom more than three feet in height; the stalks are shrubby and irregular, dividing into many spreading branches; at the end of every shoot, the flowers are produced in small clusters, sitting close to the leaves, of a white colour; they begin to appear in the autumn, continue in beauty all the winter; they decay in spring; it grows naturally at the Cape of Good Hope; it also occupies large tracts of ground about Lisbon, in the same manner as many lands in England are covered with heath.

PHYLLIS, in botany, a genus of the Pentandria Digynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: stigmas hispid; fructifications scattered; calyx two-leaved, obsolete; corolla five-petalled; seeds two. There is but one species, viz. P. nobla, bastard hare's ear, a native of the Canary islands.

PHYSALIS, in botany, *winter-cherry*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla wheel-shaped; stamina converging; berry within an inflated calyx, two-celled. There are seventeen species, of which the P. alkekengi, common winter-cherry, has a perennial root, creeping to a considerable distance; it shoots up many stalks in the spring; leaves of various shapes, of a dark green colour, on long foot stalks; flowers axillary, on slender peduncles; berry round, the size of a small cherry, inclosed in the inflated calyx; it is a native of the south of Europe.

PHYSETER, the *cachalot*, in natural history, a genus of Mammalia, of the order Cetæ. Generic character: teeth perceivable in the lower jaw only; spiracle on the head. There are four species, P. macrocephalus, or the spermaceti whale, is sixty feet in length, and the head is nearly one-third of the bulk of the whole animal. It is found in the European seas, and on the coasts of New England; swims with extreme swiftness, and persecutes the white shark with violent and fatal enmity. The lump fish, also, it pursues with great avidity. It is one of the most difficult of all whales to be taken, and survives for several days, the deepest wounds given it by the harpoon. Its skin, oil, and tendons are all converted by the Greenlanders to some valuable purpose, and its flesh is not altogether rejected by them. The spermaceti is found in a vast hollow in the head of this animal, and, when warm, is nearly fluid, but dries by exposure to the air into flaky masses. Ambergris, also, is produced by this species, and consists, in fact, of the fæces of the animal. The origin of this substance had long baffled the curiosity of the enquirer, but is at length unquestionably ascertained.

PHYSICIANS. By statute 3 Hen. VIII. c. 11, no person within London, nor within seven miles of the same, shall practice as a physician or surgeon, except he be examined and approved by the Bishop of London, or by the Dean of St. Paul's, assisted by four persons of the faculty, under a penalty of *5l.* per month, half to the King, and half to the informer. A doctor of physic of the Universities must still have a licence from the College of physicians to enable him to practice in London, and within seven miles of the same. In the country such a doctor of physic may practice, but no other, without licence from the College. It has been said, it is murder if a person die under the care of a medical practitioner not qualified; but although it might be punishable as a misdemeanour, yet it certainly cannot be murder.

PHYSICS, a term made use of by Dr. Keil and others, for natural philosophy, explains the doctrines of natural bodies, their phenomena, causes and effects, with the various affections, motions, and operations. Experimental physics inquire into the reasons and nature of things by experiments, as in hydrostatics, pneumatics, optics, &c. but more particularly in chemistry, in which more has been done the last thirty years than could possibly have been conceived by the imagination. Mechanical physics explain the appearances of nature from the matter, motion, structure, and figures of bodies, and their parts, according to the settled laws of nature. See MECHANICS.

PHYSIOGNOMY, is the peculiar combination of features, which designates the feelings and dispositions of the mind. That every individual of the human race possesses a set of distinctive marks, in the form of the head and the outlines of the countenance, is visible to the most inattentive observer; and it is well known, that those marks insensibly lead us to form conclusions as to the nature and inclinations of persons to whom we are introduced for the first time, which may sometimes be correct, but are frequently erroneous.

Every man is unconsciously a physiognomist, he feels a partiality or dislike, which partakes exceedingly of the sense of the lines in one of Richardson's novels.

"I do not like thee, Dr. Fell,
The reason why I cannot tell;
But I do not like thee, Dr. Fell."

Admitting this fact, as to mankind in general, it will be proper to observe, that however the study of physiognomy may be commended and recommended, it should be exercised with great discretion and judgment, or very fatal, or, at least, very disagreeable consequences may be the result; for it must be remembered, that numerous causes exist to derange and discompose the human frame during infancy, and even before the birth, which may impress a character or expression on the features, descriptive of evil passions that never existed in the mind of the unfortunate person so situated; for instance, it would be inhuman to judge of the soul of one who has had the vertebræ of his back doubled, from the expression of his face, which is uniformly that of peevishness and confirmed ill-nature; nor would it be just, to think a man capable of every kind of wickedness, whose head and face bear the marks of malice, through a deformity existing perhaps before his birth. Were the bones incompressible from the instant they are formed, and the muscles incapable of being moulded to their shape, in short, did mankind receive a decided and unalterable outline from the Creator, we should then make correct conclusions from the beauty or irregularity of his face.

Having thus hinted at the impropriety of forming hasty conclusions, we shall give a sketch of what has been advanced on this subject by a person of great observation, and extremely capable of drawing just inferences, but who was rather tinctured by enthusiasm. Lavater asserts, that "each creature is indispensable in the vast compass of creation; but each individual," he adds, "is not alike informed of the truth of this fact, as man only is conscious that his own place cannot be supplied by another." The idea thus conceived, he thinks one of the best consequences of physiognomy, and he exults, that the most deformed and wicked persons are still superior to the most perfect and beautiful animal, because they always have it in their power to amend, and in some degree to restore themselves to the place assigned them in creation; and however their features may be distorted by the indulgence of their passions, still the image of the Creator remains, from which sin only is to be expelled, to render the likeness nearer perfection.

The aid of Lavater is not necessary to inform us, that there exists a national physiognomy, by which a stranger in any given country may be known, by those who are possessed of previous observation, to be a Spaniard, a German, or a Frenchman, and which impels even the very vulgar to exclaim, "He is a foreigner," though they cannot appropriate him to his country; but the mind of Lavater, being almost exclusively turned to this pursuit, we must profit and be informed by his relation of the distinguishing traits which point out the natives of different regions. This great physiognomist observes, that the placing of several persons together, selected from nations remotely situated from each other, gives at one glance their surprising varieties of visage; and yet he acknowledges, that to point out those variations is a task of considerable difficulty, and his assertion, that this may be done with more facility from an individual than the mass of population, seems extremely probable. The French, he thinks, do not possess equally commanding traits with the English, nor are they so minute as those of the Germans, and it is to the peculiarities of their teeth, and manner of laughing, that he attributed his power of deciding on their origin. The Italians he appropriated by the form of their noses, their diminutive eyes, and projecting chins. The eye-brows and foreheads are the criterion by which to judge of the natives of England. The Dutch possess a particular rotundity of the head, and have weak, thin hair: the Germans, numerous angles and wrinkles about the eyes and in the cheeks; and the Russians are remarkable for black and light-coloured hair, and flat noses.

It must be extremely grateful to the natives of England to reflect, that Lavater considers them, in the aggregate, the most favoured upon the earth with respect to personal beauty; he says, they have the shortest and best-arched foreheads, and that only upwards, and towards the eye-brows, sometimes gradually declining, and in other cases are rectilinear, with full, medullary noses, frequently round, but very seldom pointed, and lips equally large, well defined, curved, and beautiful, with the addition of full round chins. Still greater perfections are attributed to the eyes of Englishmen, which are said to possess the expression of manly steadiness, generosity, liberality, and frankness, to which the eye-brows greatly contribute. With complexions infinitely fairer than those of the Germans, they have the advantage of escaping the numerous wrinkles found in the faces of the latter, and their general *contour* is noble and commanding.

Judging from the ladies he had seen of our country, and from numerous portraits of others, Lavater was led to say, they appeared to him wholly composed of nerve and marrow, tall and slender in their forms, gentle, and as distant from coarseness and harshness as earth from heaven. His own countrymen he found to have many characteristic varieties; those of Zurich are generally meagre, and of the middle size, and either corpulent or very thin.

To pursue this subject something further, it will be found, that the people of Lapland, and parts of Tartary, are of very diminutive stature, and of extremely savage countenances, formed by flat faces, broad noses, high cheek bones, large mouths, thick lips, peaked chins, and their eyes are of a yellow brown, almost black, with the lids retiring towards the temples; nor are the females of this disagreeable race more favoured by nature; and each sex is distinguished by the grossest manners, and minds stupid beyond credibility; but of all the varieties of the human species, the inhabitants of the coast of New Holland seem the most debased and miserable; those are tall and slender, and to add to the deformity of thick lips, large noses, and wide mouths, they are taught from their infancy to keep their eyes nearly closed, to avoid the insects which swarm around them.

Turning to the more favourable side of this picture of national physiognomy, we shall find the people of Cachemire, the Georgians, the Circassians, and Mingrelians, erect, noble, and formed for admiration, particularly the females, whose charms of face and person are proverbial.

There are too many local and physical causes for this difference in the external appearance of the inhabitants of the different parts of the world, for enumeration and explanation in so confined a space as that to which we are limited. Professor Kant, of Konigsberg, in an essay on this subject, divides the human race into four principal classes, into which the intermediate gradations may readily be resolved: those are the Whites, the Negroes, the Huns, (Monguls or Calmucs), and the Hindoos, or people of Hindostan. Circumstances purely external may be the accidental, but cannot be the original causes of what is assimilated or inherited; as well could chance produce a body completely organized. " Man," says the Professor, " was undoubtedly intended to be the inhabitant of all climates and all soils. Hence the seeds of many internal propensities must be latent in him, which shall remain inactive, or be put in motion according to his situation on the earth: so that in progressive generation, he shall appear as if born for that particular soil in which he seems planted."

In the opinion of this gentleman, the air and the sun are the two causes which most powerfully influence the operations of propagation, and give a lasting development of germ and propensities, or in other words, the above powers may be the origin of a new race.

Food may produce some slight variations; those, however, must soon disappear after emigration, and it is evident, that whatever affects the propagating powers, does not act upon the support of life; but upon the original principle, the very source of animal conformation and motion. It has been observed that man degenerates in stature and faculties the nearer he is situated to the frigid zone; this seems a necessary consequence of that situation, for this obvious reason; were men of the common stature in those regions of extreme cold, the impelling power of the heart must be increased, to force the blood through the extremities, which would otherwise chill and become totally useless; but as the Creator did not think it useful to adopt this mode of preserving the limbs, they have been shortened, for the purpose of confining the circulating fluid to the trunk, where the natural heat accumulating, the whole body has a greater proportion of that comfortable sensation than strangers feel when visiting those northern countries.

The propensity to flatness observable in the prominent parts of the countenance of the persons under consideration, exposed to the effects of cold, is accounted for by that very circumstance; and it appears probable, that their high cheek-bones, and small imperfect eyes, are so contrived, to preserve the latter from the piercing effects of the wind, and the offensive brilliancy of the almost eternal snows. The Abbe Winkelman attributes the enormous and disgusting lips of the Negroes to the heat of the climate they inhabit; others account for the blackness of their skin by supposing, " the surplus or the ferruginous, or iron particles, which have lately been discovered to exist in the blood of man, and which, by the evaporation of the phosphoric acidities, of which all Negroes smell so strong, being cast upon the retiform membrane, occasions the blackness which appears through the cuticle, and this strong retention of the ferruginous particles seems to be necessary, in order to prevent the general relaxation of the parts."

Professor Camper concludes, from long and attentive observation, applied to the skulls of the inhabitants of many different nations, which he had dissected in numerous cases soon after death, that it is extremely difficult to draw any head accurately in profile, and to define the lines of the countenance, and their angles with the horizon; but he thinks he has been thus led to the discovery of the maximum and minimum of this angle. He commenced his operations with the monkey, and proceeded with the Negro and European; and, finally, he examined the profiles of the most valuable statues of antiquity. With respect to the breadth of the cheek-bones, he found that the largest were amongst the Calmucs, and considerably smaller amongst the Asiatic Negroes. The Chinese, the natives of the Molucca and other Asiatic Islands, appeared to him to have broad cheeks and projecting jaw bones, particularly the under, which is very high and almost forms a right angle: on the contrary, those of Europeans are extremely obtuse, and of Negroes even more so. Succeeding thus far, the Professor acknowledges he was foiled in his attempts to discriminate the differences in the European nations; nor was he more successful with the Jews, whose countenances are possessed of many marked peculiarities; and yet this gentleman asserts, he never had been able to draw them with any tolerable accuracy; and, in this particular, the Italian face was equally difficult.

PHYSIOGNOMY.

Making due allowance for the aberrations of the imagination, the Professor either had, or conceited he had, attained the faculty of distinguishing the heads of English, Scots, and Irish soldiers; but he was incapable of describing the marks which announced their profession. More reliance may, however, be placed on his assertion, that the upper and under jaws of Europeans are less broad than the breadth of the skull, and that among the Asiatics they are much broader.

The most unequivocal proofs exist of family physiognomy, or, in other words, family resemblance. Buffon, Bonnet, Haller, and many others, have endeavoured to account for this circumstance, but, as may be supposed, without the least probable success; we shall therefore pass this part of the subject in silence, as it must be evident that we have no kind of data on which to argue, nor can the secret operations of nature ever be penetrated which relate to the formation of man. Much of the general resemblance between members of a family depend upon a congeniality of sentiments and manners; each turn of thought gives a peculiar expression to the features, and as those are sufficiently strong to explain to what class they belong, to an indifferent spectator it is by no means improbable that they assist at least in designating a family. Very intimate friends are sometimes thought to resemble each other, and a real or fancied resemblance often occurs between man and wife; when it is considered that connections of the above descriptions are very often formed by persons who had never previously seen each other, it is impossible to doubt but that the similarity of mind thus generated influences the muscles, and disposing them into the same kind of expression, a muscular likeness occurs, which has no influence upon the bones, and would proably vanish were the connection dissolved, and the parties examined after long separation. Lavater indulged in many flights of fancy when treating on this part of the science of physiognomy; he even imagined, that a person deeply enamoured of another, and thinking intensely on the form and position of their features, might assume a resemblance of the admired object, though miles of space intervened between them; and pursuing his mental dream he adds, that it is equally probable an individual meditating revenge in secret may compose his countenance into a likeness of him who was to be its victim. The incorrectness of the latter fancy may be exposed by merely observing that the person under the influence of the passion of revenge, must bear in his countenance the lines expressive of that restless affection; now as the object intended to be injured is unconscious of the secret machinations against him, he may at the instant be engaged in some benevolent pursuit, or may feel some internal joy, which moulds his features into an expression directly opposite to that of his adversary, who may have generally seen him thus; for revenge is often aimed by the wicked, at the best of men; consequently the countenance of a fiend grinning with malice cannot at the same time beam with a complacency arising from a set of features entirely unruffled.

Before we enter upon a description of the marks, which, according to Lavater, point out the character of the possessor, it may be proper to give one or two instances of the fallacy, and of the truth, of the conclusions drawn from them, in order that our readers may form their own conclusions, as to the folly or propriety of entertaining a propensity to form a judgment of mankind from the shapes of their noses, eyes, foreheads, and chins.

M. Sturtz declared to Lavater, that he "once happened to see a criminal condemned to the wheel, who, with satanic wickedness, had murdered his benefactor, and who yet had the benevolent and open countenance of an angel of Guido. It is not impossible, adds this gentleman, to discover the head of a Regulus among guilty criminals, or of a vestal in the house of correction." Lavater admits this assertion in its fullest extent, but his reasoning to reconcile it to his system is by no means conclusive.

When we hear of any atrocious act, the natural abhorrence of vice and cruelty implanted in us, leads the imagination to form a portrait of the perpetrator, suited to the deformity of the mind capable of committing it; without reflecting, that had such an index existed in the countenance of the abhorred object, it is most probable, his murderous and horrible exterior would have placed mankind so far on their guard as to detect his intentions. Upon viewing the culprit we are perhaps surprized to find that there is nothing particularly indicative of cruelty in the outlines of his face, and we industriously endeavour to force each into the immediate form of our pre-conceived portrait. This occasions us to read lurking villainy in his eyes, and converts the wrinkles of disease, or approaching age, into the frown of a dæmon; and we depart, exclaiming against the striking contour of the miserable wretch, when perhaps many of our friends, and even relatives, would suffer by a comparison, and yet had led uniformly innocent lives. On the other hand it must be admitted, that vice generally stamps her votaries with marks, which may be known at a glance, but this admission applies only to the confirmed enemies of virtue, those whose habits of living are so uniformly vicious, that very little propriety occurs in their conduct.

The following anecdote related by Lavater, may serve as a partial illustration of the assertion, that the features are affected by the turn of the mind; or, perhaps more correctly speaking, the muscles of the face. An innocent, amiable, and virtuous young lady, of high birth, who had been educated in the retirement of the country, happened one evening to pass a mirror, immediately after having attended evening prayers, and with a candle in her hand was depositing a bible on a table, when she observed her image reflected in the glass: affected with a sense of humility, and of extreme modesty, she averted her eyes and retired. A succeeding winter was passed in the amusements and dissipation of a city, where this lady had the misfortune to forget all her previously devout pursuits; but returning to the country, she once more passed the glass and the bible, and saw her features reflected, now deprived of those fascinating graces which belong alone to the serene and happy state of mind she had lost. Alarmed at the change, she fled from the spot, and retiring to a sofa, ejaculated sentences of penitence, and formed resolutions of future amendment.

Lavater begins his remarks on the human face with the forehead. According to this observer, the general form, proportion, the arch, obliquity, and position of the scull of the forehead, denotes the degree of thought, the sensibility, the mental vigour, and the propensities of man; and at the same time the skin of this part of the head explains, by its hue, tension, or wrinkles, the state of the mind at the moment of observation, and the passions which influence it, the bones affording the internal quantity, and the covering the application of power: however the latter may be affected, it is well known that the bones must remain unaltered, and yet they regulate the wrinkles by their variation of component form. Wrinkles are produced by a certain degree of flatness; others arise from arching, and those considered separately will give the form of the arch, and *vice versa*. Some foreheads are furnished with wrinkles that are confined to horizontal, perpendicular, curved, and others confused and mixed lines; those least perplexed when in action are usually observed in foreheads without angles.

Lavater appears to have been the first who attended to the peculiar turns of the position and outline of the forehead, which he considered the most important part presented for the study of the physiognomist. This he divides into three classes, and those he termed the perpendicular, the projecting, and the retreating, each possessing a number of variations; the principal, however, are rectilinear, "half round, half rectilinear, flowing into each other; half round, half rectilinear, interrupted: curve-lined, simple; the curve-lined double and triple."

A long forehead denotes much capacity of comprehension, and less activity; a compressed, short and firm forehead, more compression, stability, and little volatility; severity and pertinacity belong to the rectilinear; and the more curved than angular portends flexibility and tenderness of character; deficiency of understanding is discoverable in those whose foreheads are perpendicular from the hair to the eye-brows; but the perfectly perpendicular, gently arched at the top, signifies that the possessor thinks coolly and profoundly. The projecting forehead indicates stupidity and mental weakness; the retreating, exactly the reverse; the circular and prominent above, with straight lines below, and nearly perpendicular, shews sensibility, ardour, and good understanding; the rectilinear, oblique forehead has the same properties; arched foreheads are considered as feminine; an union of curved and straight lines, happily disposed, with a similar position of the forehead, gives the character of consummate wisdom. "Right lines, considered as such, and curves, considered as such, are relaxed, as power and weakness, obstinacy and flexibility, understanding and sensation." When the bones surrounding the eye project, and are sharp, the person thus formed possesses a powerful stimulus to exercise a strong mental energy, which is productive of excellent and well digested plans, and yet this doth not seem a peculiar mark of wisdom, as many wise men have been known without it: those thus circumstanced have more firmness, when the forehead rests perpendicularly upon horizontal eye-brows, and is considerably rounded towards the temples. Perpendicular foreheads, which, however, project so as not to rest on the nose, and which are short, small, shine, and are full of wrinkles, give undoubted indications of a weakness of the thinking faculties; perseverance and oppressive violent activity, united with vigour and harshness, belong to the forehead composed of various confused protuberances; and on the other hand, when the profile of this part of the head affords two well proportioned arches, the lowest projecting, it is a certain sign of a good temperament and a sound understanding. All great and excellent men have been found to have their eye bones firmly arched, and well defined; and circumspection, followed by stability, attends square foreheads, with spacious temples, and eye-bones of the above description; when perpendicular natural wrinkles appear, they express power of mind and application; but horizontal, interrupted in the middle, or broken at the extremities, betray, in general, negligence, if not want of ability.

Deep indenting in the bones of the forehead, situated between the eye-brows, and extending in a perpendicular direction, mark the happy few who possess generous and noble minds, connected with excellence of understanding; besides, a blue vena frontalis, in the form of a Y, situated in an arched smooth forehead, is an indication of similar advantages. Lavater having given the above hints, describes the following characteristics, which, he asserts, give "the indubitable signs of an excellent, a perfectly beautiful and significant, intelligent, and noble forehead." Such must be one-third of the face in length, or that of the nose, and from the nose to the chin; the upper part must be oval, in the manner of the great men of England, or nearly square; the skin must be smooth, and wrinkled only when the mind is roused to just indignation, or deeply immersed in thought, and during the paroxysms of pain; the upper part must recede, and the lower project; the eye-bones must be horizontal, and present a perfect curve upon being observed from above; an intersecting cavity should divide the forehead into four distinct parts, but with that slight effect as to be only visible with a clear descending light; and all the outlines should be composed of such, that if the section of one-third only is observed, it would be difficult to decide whether they were circular or straight; to conclude this portrait of a transcendent forehead, the skin must be more transparent, and of a finer tint, than the remainder of the face.—Should an infant, a relative, or friend, who possesses a forehead resembling the above description, seriously err, the good enthusiast entreats, that the corrector may not despair of success, as in all human probability the latent seeds of virtue may be roused into growth by perseverance, and finally produce the desired fruit.

The eyes of mankind are composed of various shades of colour, the most common of which are grey mixed with white, grey tinged with blue, and shades of green, orange, and yellow. According to Buffon, the orange and blue are most predominant, and those colours often meet in the same eye; those generally supposed be black are not really so, and may be found on attentive examination, and with a proper disposition of the light, to consist of yellow, a deep orange, or brown, which being violently opposed to the clear white of the ball, assumes a darkness mistaken for black. The same naturalist observes, that shades of yellow, orange, blue, and grey, are visible in the same eye, and when blue, even of the lightest tint, appears, it is invariably the predominant colour, and may be found in rays dispersed throughout the iris: the orange is differently disposed, at a trifling distance from the pupil, is in flakes, and round; but the blue so far overpowers it, that the eye assumes the appearance of being wholly of that colour. The fire and vivacity emitted by the eye cannot be so powerful in those of the lighter tints; it is therefore in the dark ones alone that we look for the emotions of the soul; quiet and mildness, and a certain degree of archness, are the characteristics of the blue. Some eyes are remarkable for the absence of colour; the iris is faintly shaded with blue or grey, and the tints of orange are so light that they are hardly observable; in eyes thus constituted, the black of the pupil appears too conspicuous, and it may be said that portion is alone visible at a little distance, which circumstance gives the person a ghastly and spiritless appearance.

There are eyes whose iris may be said to be almost green; but these are very uncommon. It would require the pen of an inspired writer to describe the astonishing variety of expression of which the eyes are capable: being situated near the supposed seat of the soul, every sensation of that invisible spirit appears to rush in full vigour from those intelligent organs: all the passions may be seen in them: we shrink from their indications of anger, we find pleasure with all her train of joys dancing in them, we feel their force in love, and melt into tears upon observing them suffused with the moisture of grief; in short their language is far more powerful than that of the tongue. The transitions are so rapid in the expression of the eyes, that it requires very close and attentive examination to catch and describe the emotions of the mind visible in them; admitting this fact, it will appear that the physiognomist is liable to numerous and egregious errors in drawing his conclusion of propensities from them. Paracelsus, a man of strong genius, and, like Lavater, misguided in many instances by enthusiasm, and a kind of superstition allied to the study of this art or science, pronounced that those eyes generally termed black frequently denoted health, firmness, courage and honour; but the grey, deceit and instability. Thus far probability at least accompanies his remarks. It is, however, impossible to subscribe to his assertion, that short-sighted persons are deceitful and crafty, or that those who squint have similar propensities to evil, as it is evident both the peculiarities alluded to are the consequences of injury, and are never found in people whose organs of vision are perfect: indeed many instances might be cited of the actual and known causes of squinting and near sight, which frequently occur in adults from extreme anxiety and disease.

Small eyes situated deep in the sockets are said, by Paracelsus, to indicate active wickedness, with a mind calculated to oppose with vigour, and suffer with perseverance; and their opposites, or very large prominent eyes, he conceived, explained the avaricious, covetous, propensities of their possessor; those in constant motion denote fear and care; winking is the mark of foresight, of an amorous disposition, and quickness in projecting; and the eye fearful of looking directly forward, decides upon innate modesty.

Lavater thought blue eyes, in general, signified effeminacy and weakness, and yet he acknowledged that many eminent men have had blue eyes; still he was convinced that strengh and manhood more particularly belong to the brown: in opposition to this opinion, the Chinese, who are known to be an imbecile people, rarely have blue eyes; these contradictions, it must be confessed, weaken the reliance we are inclined to place on appearances during the quiescent state of the eyes, and the indications of their colour. Men intemperate in anger, and easily irritated, may be found with eyes of all the usual colours; when they incline to green, ardour, spirit, and courage, are constant attendants. People of a phlegmatic habit, but who may be roused to activity, have clear blue eyes, which never belong to those inclined to melancholy, and they rarely belong to the choleric. Benevolence, tenderness, timidity, and weakness, are exhibited by the perfectly semicircular arch formed by the under part of the upper eye-lid: persons of acute and solid understandings have a generous open eye, composing a long and acute angle with the nose; and when the eye-lid forms a horizontal line over the pupil, it is a strong indication that he who possesses it is subtile, able, and penetrating. Widely opening lids, shewing the white of the ball under the other colours, may be observed in the phlegmatic and timid, as well as in the courageous and rash; but upon comparing these marks in the different characters just mentioned, a very perceptible difference is discovered in the characteristics of the eyes; the latter are less oblique, better shaped, and more firm.

The eye-brows are essential in the expression of the eyes, in anger they are brought down and contracted; in all pleasant sensations, and in astonishment, they assume a fine arch; in youth they are naturally and regularly arched; the horizontal and rectilinear eye-brow belongs to the masculine bias of the soul; and the above designations combined shew strength of understanding, united with feminine kindness; those that are deranged in their appearance, and the hairs growing in various directions, demonstrate a wild and perplexed state of mind; but if the hair is fine and soft, they signify gentle ardour. The compressed firm eye-brow, formed of parallel hairs, is a certain proof of profound wisdom, true perception, and a manly firm habit of thought. There are eye-brows which meet across the notes; this circumstance gives the person an air of ferocious gloom, which is admired by the Arabs, but the ancients, versed in physiognomy, conceived such to be characteristic of cunning; Lavater, on the contrary, observes, that he had discovered them on the most worthy and open countenances, admitting at the same time that they may denote a heart ill at ease. Those who think profoundly, and those equally prudent and firm in their conduct, never have high and weak eye-brows; in some measure equally dividing the forehead, they rather betray debility and apathy, and though men of an opposite character may be found with them, they invariably signify a diminution of the powers of the mind. Thick angular eye-brows, interrupted in their lengths, signify spirit and activity; and when they approach the eyes closely, the more firm, vigorous, and decided, is the character; the reverse shews a volatile and less enterprizing disposition; when the extremes are remote from each other, the sensations of the possessor are sudden and violent. White eye-brows are demonstrative of weakness, in the same degree that the dark-brown are of firmness.

The good Lavater considered the nose as the abutment, or buttress, of the forehead, the seat of the brain, without which the whole face would present a miserable appearance; indeed an ugly or disagreeable set of features is never accompanied by a handsome nose: but there are thousands of fine and expressive eyes where a perfectly formed nose is wanting; he describes this portion of the face as requiring the following peculiarities: "Its length should equal the length of the forehead; at the top should be a gentle indenting; viewed in front, the back should be broad, and nearly parallel, yet above the centre something broader; the bottom, or end of the nose, must be neither hard nor fleshy, and its under outline must be remarkably definite, well delineated, neither pointed nor very broad; the sides, seen in front, must be well defined, and the descending nostrils gently shortened; viewed in profile, the bottom of the nose should not have more than one third of its length; the nostrils above must be pointed below, round, and have in general a gentle curve, and be divided into equal parts by the profile of the upper lip; the side, or arch of the nose, must be a kind of oval; above, it must close well with the arch of the eye-bone, and near the eye must be at least half an inch in breadth. Such a nose is of more worth than a kingdom." Numbers of great and excellent men have flourished in all ages of the world, whose noses would suffer essentially by a comparison with Lavater's description of a nose, more valuable to the possessor than extensive empire; indeed, he is compelled to acknowledge this indisputable fact, and observes that he has seen persons endowed with purity of mind, noble in their conceptions, and capable of exertion, whose noses were small, and the arches of their profiles inverted; and yet, true to his first principles, he discovered, or imagined he discovered, their worth to consist chiefly in the elegant effusions of their imaginations, their learning, or fortitude in suffering, and this is accompanied with a proviso, that the remainder of their form must be correctly organized.

Noses arched near the forehead belong to those who possess the energy to command, are capable of ruling, acting, overcoming, and destroying; others, rectilinear, are the medium between the extremes above noticed, and are appropriated by nature to persons who act and suffer with equal power and patience. Socrates, Lairasse, and Boerhaave, were great men, and had ill-shaped noses, and were distinguished for meekness and gentleness. Were it possible to attribute a general prevalence of disposition to a general form of the nose, individuals of every nation would be found to resemble the Tartars, who have flat indented noses, the Negroes, who have broad, and the Jews, who have high arched noses, in their propensities, and it must follow that whatever qualities the physiognomist may apply to those individuals, must also belong to the whole people whose noses bear a resemblance to them; were this particular accurately examined into, it would tend, in a great measure, to confirm the correctness or incorrectness of the science, as it has hitherto been practised.

The admirers of this study attribute great powers to the mouth, in expressing the emotions of the mind; and Lavater expatiates on it with enthusiastic fervour indeed: "Whoever," he exclaims, "internally feels the worth of this member, so different from every other member, so inseparable, so not to be defined, so simple, yet so various; whoever, I say, knows and feels this worth, will speak and act with divine wisdom." He then proceeds to call it "the chief seat of wisdom and folly, power and debility, virtue and vice, beauty and deformity, of the human mind; the seat of all love, all hatred, all sincerity, all falsehood, all humility, all pride, all dissimulation, and all truth." Granting the benevolent pastor full assent to these observations on the mouth, it becomes the indispensable duty of all men to notice the physiognomy, or indications of that organ; in making those observations it will be necessary to examine the lips separately, and to ascertain when they are closed, during the moments of perfect tranquility, whether that operation is performed without a forcible exertion of the muscles, particularly the middle of the upper and under lips, the bottom of the middle line at each end; and finally, the extending of the middle line on both sides.

The character of the man is proclaimed in the lips; the more firm the latter, the more fixed the former; the weak and irresolute man has weak lips, with rapidity in their motion. The vicious, cringing, mean, and bad countenance is never formed with lips well defined, large, and justly proportioned to the other parts of the face, and the line of which is equally serpentine on each side; such, though they may denote a tendency to sensuality, belong exclusively to a character deserving of admiration in most relations of life.

A mouth, the lips of which are so thin as to present, at first view, little more than a line, is said to indicate apathy and quiet, but industrious when roused. When this description of mouth is raised at the extremities, vanity or vain pretensions, affectation, and probably deliberate malice, distinguish those so formed. The opposite of this kind of lips, swelled into considerable size, is a mark of indolence and sensuality. The "cut through, sharp drawn lip," as Lavater terms some, has to contend with avarice and anxiety. Lips closed accurately, without exertion, and handsome in their outline, belong to the exercise of discretion and firmness. Lips with the latter advantage, and the upper projecting, are generally appropriated to the virtuous and benevolent, though there are, without doubt, numberless persons of excellent characters whose under lips project, but in Lavater's opinion, the last peculiarity implies a well meaning man, whose goodness consists rather of cold fidelity than ardent friendship. The under lip, hollowed in the middle, denotes a fanciful character. Let the moment be remarked, when the conceit of the jocular man descends to the lip, and it will be seen to be a little hollow in the middle.

The mouth remaining naturally closed, invariably signifies fortitude and courage. When the latter quality is in operation, the mouth closes insensibly; the naturally open mouth makes a disposition to complain; the closed, on the contrary, designates endurance. "Though physiognomists," adds Lavater, "have as yet but little noticed, yet much might be said concerning the lips improper, or the fleshy covering of the upper teeth, on which anatomists have not, to my knowledge, yet bestowed any name, and which may be called the curtain, or pallium, extending from the beginning of the nose to the red upper lip proper. If the upper lip improper be long, the proper is always short; if it be short and hollow, the proper will be large and curved; another certain demonstration of the conformity of the human countenance. Hollow upper lips are much less common than flat and perpendicular; the character they denote is equally uncommon."

The ancients who studied the physiognomy of man, supposed that diminutive short teeth betrayed the weakness of those who possessed them; more modern observers contradict this supposition, and declare that men of uncommon strength have such, but they are rarely of that pure white so necessary to preserve the general beauty of the countenance. Teeth of unusual length, and narrow, are signs of weakness and cowardice; those justly proportioned to each other, white and transparent, which appear immediately upon opening of the mouth, though not projecting, and intirely exposed to view from the insertion in the gums to the opposite extremities, are seldom to be met with in the jaws of persons who possess unamiable propensities; when teeth of a different description are discovered belonging to amiable and worthy characters, enquiry will generally satisfy the physiognomist that his conclusions on this head were just, and that the blackness and derangement were occasioned by disease.

In one way the observer and admirer of this art cannot possibly be mistaken, for he that neglects his teeth, suffering them to decay through contempt of public opinion and indolence, may be safely pronounced an unhappy character, with many evil propensities.

The chin alone remains to be noticed in this slight survey of the human face, as connected with the internal operations of the soul or mind. The projecting chin is said to mark something decided, and the receding the reverse; and it has been asserted that the presence or absence of strength is frequently demonstrated by the form of this part of the countenance; it has also been remarked, that sudden indentings in the midst of the chin are peculiar to men of excellent cool understandings, unless attended by marks of a contrary tendency. When the chin is pointed, those so formed are supposed to be penetrating and cunning, though it seems there are people with pointed chins who are different at least in the latter particular; and here again the chin offers a certain criterion for the physiognomist, who may securely pronounce a large fat double chin an appendage of gluttony. "Flatness of chin speaks the cold and dry; smallness, fear; and roundness, with a dimple, benevolence."

After all, it will be admitted, that this science, if such it can fairly be denominated, must be precarious, and, in some respects, delusive. It cannot, however, be doubted, that there is an apparent correspondence between the face and the mind: the features and lineaments of the one are directed by the motions and affections of the other; there is, perhaps, even a peculiar arrangement of the members of the face, and a peculiar disposition of the countenance to each particular affection of the mind. Some, indeed, have asserted, that the language of the face is as copious, and as distinct and intelligible as that of the tongue: to this, however, we must beg leave to object; it may be as sincere, but certainly not so intelligible. The face has been said to act the part of a dial-plate, and the wheels and springs within the machine actuating its muscles, shew what is next to be expected from the striking part. But if, by repeated acts, or the frequent entertaining of a favorite passion or vice, the face is often put into that posture which attends such acts, it may, in some measure, become fixed, and almost unalterable, in that posture, unless some present object distort it therefrom, or some dissimulation hide it; and hence it has been assumed that much accuracy would enable one to distinguish, not only habits and tempers, but also professions.

We have asserted that all men are involuntarily physiognomists, but the impression made by the first sight of a person, is generally too slight to leave an injurious bias upon the mind of the observer; and it is fortunate for man that this is the case, otherwise prejudices would be generated which might set half the world at variance with the remainder. We have thought it necessary to explain the nature of the science under consideration, but we by no means recommend its study, as nothing can be more dangerous to the existing harmony of society; besides, every person is not prepared for this pursuit, which requires a sound judgment, a good education, a perfect knowledge of what human features are in their pristine shape, and of the numerous causes which occasion their derangement. For instance, it is very evident that a peevish habit, and a melancholy countenance, may be produced by a series of misfortunes; besides, the writer of this article has had an opportunity of observing two persons who have been the victims of excessive anxiety, whose faces now possess a character totally foreign to that which they possessed a few years past, one a handsome man with perfectly regular features, passing through the streets under the influence of deep thought and perplexity, suddenly perceived that every object changed its place; in short, the eyes were turned inwards towards the nose, in which position they remain, and he will squint, as the term is, to the last moment of his life: a physiognomist, a stranger to this fact, must conceive a very different character of the man from the truth: the other person, enduring the same species of mental perturbation, experienced a slight paralytic affection, and from that moment the right corner of his mouth has been drawn downwards, producing an appearance of immoderate grief, even when the rest of his features are enlivened with pleasure. "No one," says Lavater, "whose person is not well-formed, can become a good physiognomist. Those painters were the best whose persons were the handsomest. Reubens, Vandyke, and Raphael, possessing three gradations of beauty, possessed three gradations of the genius of painting. The physiognomists of the greatest symmetry are the best. As the most virtuous can best determine on virtue, so can the most handsome countenances on the goodness, beauty, and noble traits of the human countenance, and consequently on its defects and ignoble properties. The scarcity of human beauty is the reason why physiognomy is so much desired, and finds so many opponents. No person, therefore, ought to enter the sanctuary of physiognomy, who has a debased mind, an ill-formed forehead, a blinking eye, or a distorted mouth. "The light of the body is the eye; if therefore thine eye be single, thy whole body shall be full of light! but if thine eye be evil, thy whole body shall be full of darkness: if therefore that light that is in thee be darkness, how great is that darkness?"

PHYSIOLOGY is, according to the derivation of the term, a discourse on natural bodies: but it formerly denoted only an internal reasoning, which terminates in speculation, or abstract contemplation of its object; namely, natural appearances, their causes, &c.: but the usual acceptation of the word is very different in the present state of science, as we shall see by the following article.

Physiology is the science which treats of the powers that actuate the component parts of living animal bodies, and of the functions which those bodies execute. It presupposes, therefore, a knowledge of the structure of the body, which is the object of anatomy; the latter may be called the science of organization, while physiology is the science of life. The two subjects are so closely connected, that they would be most advantageously considered in connection with each other. Hence the reader will find many physiological considerations under the articles Anatomy and Comparative Anatomy, which indeed he should peruse as an introduction to the present article.

General View of the Functions exercised by the animal Body.

The term life denotes one of those general and obscure notions produced in our minds by certain series of phenomena, which we have observed to succeed each other in a constant order, and to be connected together by mutual relations. Being ignorant of the bond of union which connects these, although we are convinced of its existence, we have designated the assemblage of phenomena by a name which is often regarded as the sign of a peculiar principle; although it should indicate nothing more than the collection of appearances, which have given rise to its formation. Thus, as our own bodies, and several others, which resemble them more or less strongly in form and structure, appear to resist for a certain time the laws which govern inanimate matter, and even to act on surrounding objects in a manner quite contrary to these laws, we employ the expressions of life and vital power, to designate these at least apparent exceptions to general rules. Our only method of fixing the meaning of these words is, to determine exactly in what these exceptions consist. With this object, let us consider the bodies alluded to in their active and passive relations to the rest of nature. Let us contemplate, for instance, the body of a female in the vigour of youth and beauty: those rounded and voluptuous forms; those graceful and easy motions; those cheeks glowing with the roses of pleasure; those eyes sparkling with the inspirations of genius, or fired by the warmth of love; that physiognomy enlivened by the sallies of wit, or animated by the fire of the passions; all unite to form a truly enchanting object. A single moment is sufficient to destroy this pleasing illusion: sensation and motion often cease on a sudden, without any apparent pre-existing cause; the muscles, losing their plumpness, shrink, and expose the angular projections of the bones; the lustre of the eyes is gone, the cheeks and lips grow livid. These are only the prelude to still more unpleasant changes: the flesh turns successively to blue, green, and black; it imbibes the moisture of the atmosphere, and, while one part is evaporated in pestilential emanations, the other melts into a putrid sanies, which also is speedily dissipated. In short, after a few days, nothing remains but a few earthy, or saline principles; the other elements having been dispersed in the air, or waters, to form new combinations.

This separation is the natural effect of the action of air, moisture, and heat, that is, of all the surrounding external agents, on the dead body; and it arises from the elective attractions which these agents possess for the materials of the body. Yet it was equally surrounded by them during life: their affinities for its component parts were the same; and the latter would have yielded in the same manner, if they had not been held together by a superior power, the influence of which continues to operate until the moment of death.

This resistance then, of the laws which act on dead matter, is one of the particular ideas entering into the general notion of life, which seems, in a more especial manner, to constitute its essence; for without it life cannot be conceived to exist, and it continues uninterruptedly until the moment of death.

Almost endless disputes have arisen among physiologists concerning the essential nature of this vital principle. Vitality is one of those attributes which can be more easily discerned and recognized when present in any object, than accurately defined. Definition indeed would be more likely to confuse than to illustrate it. It is manifested most incontestibly by certain effects, referrible to peculiar powers, which are justly called living or vital, because the actions of the living body are so far depending on these powers, that they can, by no means, be explained by the physical, mechanical, or chemical qualities of matter. Yet the operation of the latter can be clearly discerned in many instances in the animal economy; thus the humours of the eye variously affect the rays of light according to their figure and density: and the mechanical elasticity of the epiglottis, and the chemical affinities exercised in respiration, are further examples to the same effect. Yet the energy and power of the vital force is most clearly evinced in resisting and overcoming, as we have already stated, the common laws of matter. Stahl and his followers, were so struck with the circumstance of living bodies resisting those affinities, which produce putrefaction in dead animal matter, that they made life itself to consist in this antiseptic property. The celebrated experiment of Borelli, in which a muscle, deprived of life, was immediately torn by a weight which it could lift easily during life, shows how the laws of gravity are overcome. This vital power, in the explanation and illustration of which all physiology is concerned, is so apparent in every living process, that it has been observed by the physiologists of every age, although designated by very various appellations, and defined in very different ways. Calidum innatum, archæus, spiritus vitalis, principium sentiens, &c. are among its numerous appellations. Let it be remembered, that neither these, nor the phrases of vital principle, &c. express any being existing by itself, and independently of the actions by which it is manifested; they are only to be considered as denoting the assemblage of powers that animate living bodies, and distinguish them from inert matter. Some writers, realizing the offspring of a mere abstraction, have talked of the living principle as something distinct from the body, to which they have ascribed powers of seeing and feeling, and even of acting with design.

A more close inspection of any living body will speedily convince us, that this force, which holds together its component parts, in spite of the external powers, which tend to separate them, does not confine its influence to this passive result, but that its operation extends even beyond the limits of the living body itself. It seems, at least, that this power does not differ from that by which new particles are attracted, and interposed between the old constituent ingredients of the body; the latter effect seeming to be exerted as constantly as the power by which the materials of the body are held together. For, besides the absorption of alimentary matter from the intestines, and its entrance into the circulating fluid, carrying it to all parts, which processes experience no interruption, but are continued from one meal to another, there is another kind of absorption constantly going on from the surface of the body, and a third which takes place by means of respiration. The two latter alone exist in such living bodies as have not the function of digestion; *viz.* in plants. Now, since living bodies do not grow indefinitely, but have certain limits assigned by nature to their size; they must lose on one side at least, a large part of what they receive on the other; and, in fact, attentive observation shows us, that perspiration, and several other processes, are constantly destroying parts of their substance.

Hence the idea which we formed at first of the principal phenomenon of life, must be considerably modified. Instead of a constant union of the composing particles, we observe them in a state of continual circulation from without inwards, and from within outwards. Thus, a living body is a structure into which dead particles are successively brought, for the purpose of combining together in various ways, occupying places and exercising offices determined by the nature of the combinations into which they enter, and departing, after a certain period, to be brought under the action of those laws which regulate inanimate matter. We must observe, however, that the proportion of particles, entering into, or quitting the system, varies according to the age and health of the individual, and that the velocity of the general motion differs according to the different states of each living body.

It appears, too, that life is arrested by causes similar to those which interrupt other known kinds of motion; and that the induration of fibres, and obstruction of vessels, would render death an inevitable consequence of life, as rest necessarily follows all movements which are not performed in vacuo, even if the hour of its approach were not hastened by a multitude of extraneous causes.

This general and common motion of all parts constitutes the very essence of life, insomuch that parts separated from a living body immediately die, because they have no power of motion within themselves, and only participate in the general motion produced by the assemblage. Thus, the peculiar mode of existence of any part of a living body arises from the whole; while, in dead matter, each particle has it within itself.

When this nature of life was once clearly recognised by the most constant of its effects, physiologists naturally attempted to discover its origin, and the mode of its communication to bodies which it animates. They looked at them in their earliest state, approaching as nearly as possible to the instant of their formation; but they could only discover them completely formed, and already possessing that circulatory motion, of which they were investigating the first cause. However delicate the parts of a fœtus, or a vegetable, in the first moments that we can perceive them, they still possess life, and have within themselves the germ of all the phenomena which this life will develope in the sequel. These observations having been repeated in every class of living bodies, have led to the general conclusion, that there is none which has not formerly constituted part of a body like itself, from which it has been detached; all have participated of the life of another body, before the vital motions were carried on independently in themselves; and it is, indeed, through the means of the vital powers, inherent in the bodies of which they formed part, that they have been so far developed as to become susceptible of an isolated life. For although copulation is necessary in the act of reproduction in several species, it is by no means an essential circumstance, and does not, therefore, change the nature of generation. In reality, then, the peculiar powers of living bodies have their origin in those of the parents; this is the source of the vital impulse, and, consequently, it follows, that life is only produced from life, and that no other exists, except what has been transmitted from living bodies to living bodies, in an uninterrupted succession.

Since we cannot go back to the first origin of living bodies, our only resource in investigating the true nature of the powers which animate them consists in examining their structure, and tracing the union of their elements. Our knowledge of these points is too imperfect for us to draw all the necessary inferences. The minute branches of vessels and nerves, and the intimate structure of the organs in general, elude our imperfect means of research: our analysis of fluids is also very incomplete, and there are, probably, several of which we have no means at all of subjecting to examination. Yet, though our knowledge of organization be not sufficient to enable us to explain all the facts presented to our observation by living bodies, we may, by means of it, recognise them, even in an inactive state, and trace their remains after death. No inanimate matter has that fibrous and cellular texture, nor that multiplicity of volatile elements which form the characters of living bodies, whether alive or dead. Thus, while inorganic solids are only composed of many-sided particles, attracting each other by their surfaces, and receding only for the purpose of separating; while they are resolved into a very limited number of elementary substances, and are formed merely by the combination of these elements, and the aggregation of these particles; while they grow only by the juxta-position of new particles, which are deposited exteriorly to those already existing, and are destroyed only by the mechanical separation of their parts, or the decomposing agency of chemical means; organized bodies, made up of fibres and laminæ, whose intervals are filled by fluids, are resolved almost entirely into volatile elements, grow on bodies similar to themselves, and separate from these only when they are sufficiently developed to act by their own powers; constantly assimilate foreign matters to themselves, and, interposing these between their own particles, grow by the operation of an internal power, and perish at last by this interior principle; indeed, by the very effect of their life.

An origin by generation, a growth by nutrition, and a termination by death, are the general characters common to all organised bodies; and if several of such bodies possess these functions only, and such as immediately depend on them, and have only the organs required for their performance, there are many others exercising particular functions which require appropriate organs, and also modify the general functions and their organs.

Of all the less general powers, which presuppose organization, but which do not seem to be necessary results of structure, those of sensation and voluntary motion are the most remarkable, and exert the greatest influence over the other functions. We are conscious of the existence of these powers in ourselves, and we attribute them, by an analogical mode of reasoning, to many other beings, which we therefore name animated beings or animals. They seem to be necessarily connected together; for the idea of voluntary motion contains in itself that of sensation; since volition cannot be conceived without desire, and without a feeling of pleasure or pain. The goodness, which we observe in all the works of nature, will not allow us to believe that she has formed beings with the power of sensation, that is, with a susceptibility of pleasure and pain, without enabling them at the same time to approach to the one and fly from the other, at least to a certain degree. And if, among the too real misfortunes which afflict our species, one of the most affecting is the sight of a man of sensibility deprived by superior force of the power of resisting oppression; the poetic fictions, most apt to excite our pity, are those which represent sensible beings inclosed in immovable bodies; and the tears of Clorinda, flowing with her blood from the trunk of a cypress, ought to arrest the blows of the most savage man.

Independently of the chain, which unites these two powers, and of the double apparatus of organs which they require, they produce also several modifications in the faculties common to all organized bodies; and these modifications, joined to the two peculiar powers, constitute more particularly the essential nature of animals. Thus, in respect to nutrition, vegetables being attached to the earth, absorb nutritive fluids directly by their roots; these almost infinitely subdivided, penetrate the smallest intervals of the soil, and, if we may use the expression, travel to a distance in quest of nourishment for the plant to which they belong; their action is quiet and constant, being liable to interruption only when drought deprives them of the necessary juices. Animals, on the contrary, fixed to no spot, but frequently changing their abode, required the power of transporting with them the provision of fluids necessary for their nutrition; they have therefore an interior cavity to receive their food; and on its inner surface there are the openings of absorbing vessels, which, to use the energetic language of Boerhave, are real internal roots. The size of this cavity, and of its orifices, allowed in several animals the introduction of solid substances. These required instruments for their division, and liquors for their solution; in a word, nutrition was no longer performed by the immediate absorption of matters in the state in which the earth or atmosphere furnished them; it was necessarily preceded by various preparatory operations, which, taken altogether, constitute digestion.

Thus digestion is a function of a secondary class, peculiar to animals. Its existence, as well as that of the alimentary cavity in which it takes place, is rendered necessary by the power which animals have of voluntary motion; but it is not the only consequence of that power.

Vegetables, having few faculties, are simple in their organization; being composed almost entirely of parallel or slightly diverging fibres. Moreover, their fixed position admitted of the general motion of their nutritive fluid being kept up by simple external agents; thus it ascends by means of suction in their spongy or capillary texture, and also through the influence of evaporation, from the surface; it is rapid in a direct ratio to this evaporation, and may even become retrograde when that process ceases, or when it is changed into absorption by the moisture of the atmosphere.

It was necessary that animals should have within themselves an active principle of motion for their nutritive fluid, not only because they were destined to constant changes of situation and temperature; but also from their more numerous and highly developed faculties requiring a much greater complication of organs. Hence the component parts became very intricate in their composition, and often very distant, and possessed in many instances a power of changing their relative position, consequently the means of carrying the nutritive fluid through such multiplied intricacies must be more powerful than in vegetables, and differently arranged. It is contained, in most animals, in innumerable canals, which branch out from two trunks, that communicate together in such a way, that the fluid urged into the branches of one is received by the roots of the other, and carried back to a common centre, from which it is propelled afresh.

At the point of communication between the two great trunks is placed the heart, whose contractions impel the nutritive fluid into all the branches of the arterial trunk; for the orifices of the heart possess valves, disposed in such a way that the circulating juices can only move in the directions now described, *viz.* from the heart towards all parts by the arteries, and from all parts to the heart in the veins.

In this rotatory motion consists the circulation of the blood, which is another secondary function peculiar to animals, chiefly performed and regulated by the heart. This, however, is not so essentially connected to the faculties of sensation and motion as the business of digestion; for whole classes of animals (as insects) possess no circulation, and are nourished, like vegetables, by the mere imbibing of fluids prepared in the intestina canal.

The blood seems to be merely a vehicle, receiving constantly from the intestines, skin, and lungs, different substances, which it incorporates intimately, and by which its losses, arising from the preservation and growth of parts, are supplied. The nutrition of the body is performed during the course of the blood in the minute extremities of the arteries; here the fluid changes its nature and colour; and it is only by the addition of the various substances just pointed out, that the venous blood again becomes proper for the purposes of nutrition, or, in one word, again becomes arterial.

The venous blood receives the supplies furnished to it by the skin and alimentary canal, by a particular set of vessels, called lymphatics; in the same way it receives also the particles detached from various organs, in order to be sent out of the body by the different secretions.

The air entering the lungs, seems to produce a sort of combustion in the venous blood, which is necessary for the support of life in all organized bodies. Vegetables, and such animals as have no circulation, respire (for that is the name given to this action of the atmosphere on the nutritive fluid) by their whole surface, or by means of particular vessels which convey air into the interior of the body.—Those only, which enjoy true circulation, breathe by means of a particular organ; because, in them, the blood constantly flowing to and from the common source, its vessels have been so arranged, that it is not distributed to the other parts of the body until after passing through the lungs; a circumstance which could not take place where the nutritive fluid is distributed uniformly through the body without being contained in vessels. Thus respiration is a function of a third order, depending entirely on circulation, and arising as a remote consequence from the faculties which characterise animals.

Generation is the only process in animals, the mode of which does not depend on their peculiar faculties, at least as far as the fecundation of the germs is concerned. Their power of moving and approaching to each other, of desiring and feeling, has allowed them to receive all the enjoyments of love, while the spermatic fluid is conveyed uncovered immediately upon the germs; in vegetables, on the contrary, which have no power of propelling this fluid, it is inclosed in small capsules, capable of being transported by the wind, and forming what is called the dust of the stamina. Thus, while the organs of the other functions are more complicated in animals, on account of their peculiar functions, generation is exercised in them, for the very same reason, in a more simple way than in vegetables.

Such are the principal functions that compose the animal economy; they have usually been arranged in three orders. Some of them constitute animals what they are, render them proper to fill the space which nature has marked out for them, in the general arrangement of the universe, and would be sufficient for their existence, if that were momentary. These are the faculties of sensation and motion; of which the former determines them in the choice of such actions as they are capable of, and the latter enables them to execute these actions. Each animal may then be considered as a partial machine, co-ordinate to all the other machines, which, by their assemblage, form this world: the organs of motion are the wheels and levers: in a word, all the passive parts; but the active principle, the spring which sets all in motion, resides only in the sensitive faculty, without which he animal would be lost in a constant sleep, and be really reduced to a merely vegetative life. These two functions, then, form the first order, or the animal functions.

But the animal machine, in addition to the powers which those of human construction possess, is endowed with a principle of preservation and repair, consisting in the assemblage of functions which contribute to nutrition, viz. digestion, absorption, circulation, respiration, and secretion; these form the second order, or the vital functions. Lastly, as the duration of each animal is limited according to its species, the generative form a third order of functions, by means of which the individuals that perish are replaced, and the existence of the species preserved.

This threefold division of the objects of physiology is open to many objections, which we have not room to consider in this place; and we therefore add another more complete and natural classification, which will be sufficiently explained in the subjoined tabular view.

PHYSIOLOGY.

CLASSIFICATION OF FUNCTIONS.

- **CLASS I.** FUNCTIONS CONTRIBUTING TO THE PRESERVATION OF THE INDIVIDUAL . . (*Individual life*)
  - **FIRST ORDER.** By assimilating alimentary matters to his own substance (*Assimilating, internal, or nutritive functions.*)
    - **GENUS I. DIGESTION.** Extracts from it the nutritive parts . . .
      - Prehension of food.
      - Mastication.
      - Salivary secretion.
      - Deglutition.
      - Digestion.
      - Chylification.
      - Excretion of feces & urine.
    - **II. ABSORPTION.** Carries it into the circulating fluid . . .
      - Absorption of chyle.
      - ——— lymph.
      - Action of vessels.
      - ——— glands.
      - ——— thoracic duct.
    - **III. CIRCULATION.** Conveys it to all the organs . . . .
      - Action of the heart.
      - ——— arteries.
      - ——— capillary vessels.
      - ——— veins.
    - **IV. RESPIRATION.** Combines it with the oxygen of the atmosphere . . . . .
      - Action of the parietes of the thorax.
      - ——— lungs.
      - Changes in the air.
      - ——— blood.
      - Animal heat.
    - **V. SECRETION.** Makes it undergo various modifications.
      - Transudation of serum.
      - Mucous secretion.
      - Action of glands.
    - **VI. NUTRITION.** Applies it to the organs for the purposes of growth and repair . . . . .
      - Differing in every part according to its peculiar composition.
  - **SECOND ORDER.** By establishing his relations to surrounding beings . . . . (*External, or relative functions*)
    - **GENUS I. SENSATIONS** Inform him of their presence . . . . . .
      - Organs
        - Of sight.
        - — hearing.
        - — smelling.
        - — tasting.
        - — touching.
      - Action of the nerves.
      - ——— brain.
      - Human understanding.
      - Perception.
      - Memory.
      - Judgment.
      - Volition.
      - Sleeping and waking.
      - Dreams.
      - Somnambulism.
    - **II. MOTIONS.** Enable him to approach to or avoid them . . . .
      - Muscular organs & actions.
      - Skeleton.
      - Articulations.
      - Standing.
      - Progressive motions.
      - Motions of the upper extremities.
    - **III. VOICE & SPEECH** Give him the power of communicating with his species, without change of situation . . . . . .
      - The voice
        - articulated; or speech:
        - modulated; or singing.
      - Stammering.
      - Lisping.
      - Dumbness.
      - Ventriloquism.

CLASS II.

Functions contributing to the preservation of the species . . . .

(Life of the Species.)

- **First Order.** Whether they require the co-operation of both sexes.
  - **Conception . . . .** / **Generation . . . .**
    - General difference of sex.
    - Hermaphrodites.
    - Systems of generation.
- **Second Order.** Or belong exclusively to the female.
  - **Gestation . . . . .**
    - Pregnant uterus.
    - History of the embryo.
    - ——— ——— fetus.
    - ——— ——— coverings of the fetus.
  - **Parturition . . .**
    - State of the uterus after parturition.
    - Lochia.
  - **Suckling . . . .**
    - Action of the breasts.
    - Milk.
- **Growth of the Body . . . . .**
  - Infancy—Dentition—Ossification.
  - Puberty—Menstruation.
- **Manhood.**
  - Temperaments
    - Sanguineous.
    - Choleric
    - Melancholic.
    - Phlegmatic.
  - Idio-syncracies.
  - Races of mankind.
    - Caucasian.
    - Negro.
    - Mongul.
    - Malay.
    - American.
- **Decline of the Body . . . .**
  - Age of decrease.
  - Old Age.
  - Decrepitude.
- **Death.**
- **Putrefaction.**

To trace out completely all the subjects which this table exhibits, would lead into a very wide field of discussion; we shall, after devoting a short space to the consideration of those vital powers which animate living bodies, shortly consider the principal functions.

Of the Vital Powers, Sensibility and Contractility.

Struck with the numerous differences that are observable between organized and living, and inorganic matters, philosophers have admitted in the former a peculiar principle of action, a force which maintains the harmony of their functions, and directs them all to one object; the preservation of the individual and of the species. No one at present doubts the existence of a living principle, which subjects the beings endued with it to a different order of laws from those which govern inanimate things, and whose principal effects are seen, in its removing the bodies which it animates from the agency of chemical affinities, to which the multiplicity of their elements would otherwise have rendered them prone; and in its maintaining their temperature at an uniform standard. All the phenomena observed in the living animal body might be cited in proof of this principle. The effects produced on the food by the digestive organs; its absorption by the lacteals; the circulation of the nutritive juices in the blood-vessels; the changes which they undergo in the lungs and secretory glands; the capability of receiving impressions from external objects, and the power of approaching to, or avoiding them, all demonstrate its existence. But we prove it more directly by means of the two properties, with which the organs of these functions are endued. These are, sensibility, or the faculty of feeling; the aptness to receive, from the contact of foreign bodies, more or less vivid impressions, which change the order of their motions, accelerate or retard, suspend or terminate them; and contractility, by which parts, when irritated, contract, act, or execute motions.

By means of the senses, and of the nerves which are continued from them to the brain, we perceive or feel the impression made on our bodies by external objects. The brain, which is the true seat of this relative sensibility, (or, as it might well be called, perceptibility), being excited by these impressions, influences the moving powers of the muscles, and determines the exercise of their contractility. This property, subjected to the command of the will, is manifested by the sudden shortening of the muscular organ, which swells, becomes hard, and causes those parts of the skeleton to which it is attached to move. The nerves and the brain are the essential organs of these two properties; division of the former destroys sensation; and the voluntary motion of those parts to which the nerves are distributed. But there is another kind of sensibility, quite independent of the presence of nerves, existing in all organs, even where no nervous filaments are distributed. Bones, cartilages, ligaments, arteries, and veins, in short, all parts which are not influenced by the will, posssess no nerves. Yet, though in their natural state they transmit to the brain no perceptible impression, though they may be injured without giving the animal any pain, and though the will has no influence over them, yet they enjoy a sensibility and contractility, by virtue of which they perceive impressions, and contract in their own manner, recognize in the fluids which circulate through them what is proper for their nutrition, and, separating this part, appropriate it to their own substance.

We recognize then in the parts of our body two modes of sensation, as well as two species of motion: a sensibility, by means of which certain parts transmit to the brain impressions which they feel, and of which we therefore become conscious: a second kind, pervading every part without exception, and presiding over the assimilating functions. We observe also two kinds of contractility corresponding to the differences of sensibility: the one by which the voluntary muscles perform the contractions determined by the action of the will; the other manifested by actions which are equally unknown as the causes which give rise to them.

When we have once clearly distinguished these two grand modifications of sensibility and contractility, we shall find out, without difficulty, the source of those eternal disputes, raised by Haller and his followers, concerning the irritable and sensible nature of parts. Bones, tendons, cartilages, &c. to which this great physiologist denied these two properties, enjoy only that lateral sensibility and obscure contractility which are common to all living beings, and without which we cannot conceive the existence of life. In the healthy state they are completely destitute of the power of transmitting perceptible impressions to the brain, or of being influenced by that organ to any manifest motion. It has also been disputed whether sensibility and contractility depended on the existence of nerves; whether these were its necessary instruments, and whether their injuries were followed by a loss of those vital powers in the parts which have nerves. We may answer in the affirmative, as far as regards perceptive sensibility, and voluntary motion, which is entirely subordinate to it; but in the negative, with respect to the sensibility and contractility which are indispensable in the processes of assimilation.

Sensibility may then be either perceptive or latent. The former is attended with a conscience of the impressions or perceptibility, and requires a peculiar apparatus. The latter, unaccompanied by consciousness, is common to every thing that lives; it has no particular organs, but is universally expanded in all living parts, whether of vegetables or animals. Contractility may be either voluntary and sensible (*vis nervosa*), which is subordinate to perceptibility; involuntary and insensible, which corresponds to latent sensibility; or involuntary and sensible (*vis insita*), as in the action of the heart, stomach, &c.

The former species of sensibility being that which is observed in the functions, which connect the animal with external objects, is called by Bichat, animal sensibility; and the corresponding contractility is distinguished by the same term. The other kind of these two vital powers, which are exerted in the internal processes of nutrition, &c common to animals and plants, that is, to all organized bodies, is named the organic.

Organic sensibility is merely the faculty of receiving an impression; animal sensibility is the same faculty, with the additional power of conveying it to a common centre. In the former case the effect terminates in the organ. The latter belongs only to animals, whose perfection is in a direct ratio to the quantity of this sensibility. There is some reason for supposing that these two are not different powers, but that they differ only in quantity. For inflammation, which is an increased action of parts, raises organic into animal sensibility in diseases of bones, &c.

Different stimuli, applied to the same organ, determine the developement of one or other of these powers: thus no sensation is transmitted to the brain from the passage of blood in the arteries, but when an extraneous fluid is injected, the animal's cries shew that he feels it. The coats of the stomach experience in the healthy state no perceptible impression from the food, but very distinct and even painful sensations are transmitted to the brain when a few grains of poisonous matter are mingled with the aliment. The animal sensibility excited on mucous membranes by foreign bodies (as bougies in the urethra, &c.) is quickly lost, and subsides into organic.

Each organ seems to have, independently of accidental variations, an original quantity or dose of sensibility, to which it returns after any deviation. In this consists the peculiar life of each organ, and from this arise the relations which it has to extraneous substances. Hence excretory ducts, opening on mucous membranes, refuse admission to the substances passing along those canals. Hence the lacteals absorb the chyle only. These particular relations may also take place with matters foreign to the body, as well as with animal fluids, as we see in the case of medicines acting on particular organs, as cantharides, mercury, &c.

Contraction is the common, but not the universal mode of animal motions. For the iris, corpus cavernosum, &c. dilate when they move. Organic contractility is always and immediately connected with organic sensibility, for there is no intermediate function between these; the organ itself is the point in which the sensation ends, and from which the principle of contraction begins. The animal sensibility and contractility are not so closely united; we may feel without moving: here the nerves and brain perform their functions between the action of the two powers.

Sensible organic, or, in other words, involuntary and sensible contractility, corresponds very nearly to irritability; while the insensible seems more like tenacity. To consider irritability as the exclusive endowment of muscles, is taking a very contracted view of the subject. These organs have indeed the largest portion, but every part possessing life reacts, although less manifestly, on the application of certain stimuli. No rule is more fallacious than that of estimating the muscularity of a part by the action of artificial irritants. The organic and animal contractilities cannot be converted into each other as the corresponding sensibilities can.

The parts of the living body possess also some powers which result merely from their organization, and have been denoted by physiologists under the epithet of *vis mortua*. Thus they admit of extension beyond the natural state from extraneous impulse, and of contraction when that impulse ceases to operate. This extensibility and contractility are independent of life, and are terminated only by death. The stretching of muscles by moving a limb, the extension of the skin over a tumour, its retraction when divided, &c. are examples of these powers. They have been confounded by some physiologists with the insensible organic contractility.

A muscle exhibits all the powers now enumerated. It contracts, in obedience to the will, by its animal contractility; from the application of stimuli, by its organic sensible contractility. Its nutrition and growth show the existence of organic insensible contractility; and its retraction on a section exemplifies the contractility of organization. The internal organs of the body have only the three last powers, and the white organs (cartilage, tendon, ligament, &c.) only the two last. While, therefore, the two first properties exist only in certain parts, the latter are found in all. Hence the organic insensible contractility may be selected as the general character of all living parts; and the contractility of organization as the common attribute of all living or dead parts that are organically constructed.

As for porosity, divisibility, elasticity, and the other properties which living bodies have in common with inanimate matter; they hardly deserve mention here, because they are never exerted in their whole extent, or in their genuine purity, if we may use that phrase. Their results are always affected by the influence of the vital powers, which constantly modify those effects which seem to flow most directly from physical, mechanical, or chemical causes.

PHYSIOLOGY.

Digestion. Is a function common to all animals, by which foreign substances, introduced into their bodies, and submitted to the action of certain organs, change their qualities and form a new compound, fit for the purposes of nourishment and growth. Animals alone are provided with digestive organs; all, from man to the polype, have an alimentary cavity, and its existence is, therefore, an essential character of animals. The loss which the body sustains in performing the various actions that take place in the living animal machine, is supplied by means of the food. Hunger and thirst admonish us of the wants of our frame, and the pleasures of the palate are a no less strong inducement to the procuring and taking of food.

The cause of hunger has been placed in the mutual attrition of the rugæ of the empty stomach; in the irritation produced by the gastric juice, &c. Perhaps it may be derived more justly from a sympathy between the stomach and the body at large. For when, in diseases of the pylorus, the food cannot be transmitted into the intestines, and does not therefore enter the system, great hunger is experienced, even although the stomach may be filled. Much depends on habit, and on the operations of mental causes: hunger is felt at the usual periods of our repasts; and, if it be not then removed by eating, will often cease spontaneously. The man of letters, absorbed in meditation, often forgets the natural wants of his body. Whatever diminishes the sensibility of the stomach makes hunger more tolerable. Thus, the Indian and Turkish fanatics (Mollahs and Fakirs) are said to support their long fasts by the habitual use of opium. Thirst seems to consist more in a very troublesome dryness of the fauces and œsophagus, and in a peculiar irritation of these parts from the admixture of acrid, and particularly saline matters, with the food. The necessity of obeying both these calls varies according to the age, constitution, and particularly the habits of individuals: yet we may state, on the whole, that a healthy adult could not abstain from food for a whole day without bringing on considerable weakness; and that this abstinence could not be continued to the eighth day without the most imminent risk of life. Continued abstinence diminishes the weight of the body to a degree which becomes sensible in twenty-four hours, causes absorption of fat, great prostration of strength, increased sensibility with watchfulness, and a most painful dragging at the epigastric region. Hunger is more speedily fatal in proportion to the youth and strength of the individual. Thus, the wretched father, whose dreadful history is immortalised by Dante, shut with his children in a dungeon, perished last, on the eighth day of confinement, after witnessing the death of his four sons, amid the convulsions of rage and cries of despair. We meet with a large collection of examples of long abstinence in the great work of Haller; but they do not seem to possess, in every instance, the requisite authenticity. Many of the subjects were weak and delicate women, living in a state of almost complete inaction, where the powers of life, almost extinct, were only evinced by a very low pulse and respiration repeated at long intervals. They might be compared to hybernating animals, where the waste, occasioned by the functions of active life, does not take place, and where consequently the usual supplies cannot be needed. Although the admonitions of thirst are very imperious, yet drink does not seem so necessary to life and health as solid food. The mouse, quail, parrot, and several other warm-blooded animals never drink, and instances have been known in the human subject. Thirst always becomes greater when any watery secretions are much augmented, as in dropsy, and particularly in diabetes.

In the dispute, whether man be naturally carnivorous or herbivorous, we are inclined to suppose that truth lies on neither side. That the structure both of the teeth and intestines, as well as of the joint of the lower jaw, occupies a middle place between the two just mentioned, and constitutes him an omnivorous animal. This, indeed, seems to follow necessarily from the unlimited extent of his habitation; he can dwell in every country and climate of the globe; and makes use, in various situations, of every variety of alimentary matter, furnished by the animal and vegetable kingdoms.

The food of man, and probably of every animal, is derived from organized matter. Nothing seems capable of furnishing nourishment that has not lived: the mineral kingdom, indeed, supplies some articles of seasoning, which are mixed with our food, and various medicines and poisons, which do not seem to be nutritious.

As man on the one hand is a most truly omnivorous animal, and capable of converting into nourishment almost every production of the animal and vegetable kingdoms, so on the other side he may continue strong and healthy although using one, and that a very simple kind of aliment. A woman, whose case is related in the memoirs of the Medical Society of Edinburgh, lived on whey for fifty years. Many men live only on certain vegetables, as potatoes, chesnuts, dates, &c. Some wandering Moors, according to Adamson, live almost entirely on gum Senegal. Fish is the only food of numerous uncivilized tribes on different coasts: and flesh of others. Some barbarous hordes still eat raw meat, and even the human body sometimes serves them as a repast. In several islands between the tropics, particularly in the South Sea, there is no fresh water, and the milk of the cocoa-nut is used instead: various other singular facts relating to the food and drink of man, might be collected here, showing very clearly that he is an omnivorous animal.

Whatever be the diversity of food, the action of our organs always separates the same nutritive principle from it: in fact, let the diet be totally vegetable, or totally animal, the peculiar composition of our organs does not alter, an evident proof that the matter we extract from aliment to appropriate to ourselves, is always alike.

It has been a matter of dispute, whether pure water furnish any nourishment, or be a mere diluent.

We have nothing further to say concerning the processes of mastication and deglutition, than what the reader will find in the article ANATOMY, under the head of "Organs of Mastication and Deglutition."

Salivary Secretion. This has been estimated by Nuck at the quantity of one pint in twenty-four hours. Although it probably goes on, to a certain degree, at all times, yet it is more copious when we take food; and the augmentation of quantity arises partly from stimulus, partly from mechanical pressure. When any acrid matter is taken into the mouth, an increased flow of saliva is produced; and this may also follow the mere sight of food, and hence has arisen the well-known expression of the "mouth watering."

All the salivary glands are so situated that the motions of the jaw, and other instruments of mastication, necessarily subjects them to considerable pressure, by which their secretory tubes are evacuated, and new secretion promoted.

The saliva is conveyed into the mouth by the contractile power of the salivary ducts, which, in some rare instances, are said to have projected it even from the cavity of the mouth. The great number of vessels and nerves which belong to, and are placed near these glands, correspond to the copious supplies of fluid which they furnish.

Besides the simple water furnished by the true salivary glands, the mucous follicles, which abound on the surface of the mouth supply a considerable proportion of that fluid, to be mixed with the food. These additions being, by means of mastication, intimately blended with the food, not only reduce it to a soft pultaceous mass, more fit for the process of deglutition, but also bring it into a state of convenient preparation for the subsequent process of digestion and assimilation. In this point of view, mastication is very important, as we may observe from the ill effects which ensue when the loss of the teeth renders it imperfect in old persons.

For the chemical analysis of SALIVA, the reader will look to that word; and for an account of the digestive process itself, to the article DIETETICS; in which are also several observations respecting food.

While the dissolution of the food, produced by the solvent action of the gastric juice, is going on, the two orifices of the stomach remain accurately closed. No gas ascends through the œsophagus, except when the digestive process is imperfect. Soon the muscular fibres of the organ begin to act: the circular ones, contracting at first in a vague and oscillatory manner, soon act more uniformly from above downwards, and from right to left; that is, from the œsophagus to the pylorus; while the longitudinal part approximates the two openings. The pylorus seems to possess a peculiar and exquisite sensibility, by which it distinguishes whether the substances brought in contact with it have been sufficiently acted on by the gastric juice; if that is the case, it releases and allows them to pass, while it remains closely contracted against those which are not thoroughly digested.

The time occupied by the digestive process must be expected to vary according to the constitution, age, and health of the individual, and the nature of the aliment; but it may be stated, in general, at four hours.

The action of the stomach is sometimes inverted, and the contractions, which in that case are forcible, rapid, and convulsive, cause vomiting. The exertions of the respiratory muscles are, however, necessary to the production of this effect.

Although the stomach belongs to those organs whose action is independent of the will, and goes on, therefore, without the attraction of the individual, yet it is so far influenced by the brain, that the section of its nerves entirely obstructs digestion. It sympathises most remarkably both with the constitution at large, and with particular organs.

The chyme, or semifluid substance, into which the action of the stomach reduces the food, is propelled by the muscular power of that bag into the duodenum, where it undergoes new changes, particularly from the admixture of other animal fluids, the bile and pancreatic juice: and this process is termed chylification.

The secretion of the pancreas seems to bear a considerable analogy, both in its nature and office, to the saliva and gastric juice. It is very difficult to procure it in a pure and unmixed state from a healthy animal, but the facts which we hitherto possess, shew, that its properties are very like those of saliva. It is poured into the duodenum by the contractile power of the pancreatic duct: and its secretion, like that of the salivary glands, is said to be promoted by the pressure of the stomach in its filled state; and by the stimulus of the chyme and bile on the orifice of its duct.

The bile is the fluid furnished by the liver, the largest viscus of the human body, whose importance in the animal economy is evinced by its large apparatus and complicated distribution of blood-vessels, as well as by its constantly existing in all animals which have a heart.

The source of the bile has been questioned, whether it be secreted from the hepatic artery, or vena portarum? The analogy of other secretions, which are all made from arteries, favours the former opinion; but the blood of the vena portarum seems to be the fittest, from its nature, for the secretion of bile. The hepatic artery probably serves to nourish the liver, as the lungs are nourished by the bronchial artery. The distribution of the vena portarum is like that of an artery. If we suppose the hepatic artery to furnish the bile, the excretory duct would be disproportionately large.

The bile, when secreted, passes by a slow but constant stream through the hepatic duct; but a greater or less proportion is conveyed by the cystic duct into the gall-bladder, in which it is accumulated, as in a reservoir, and undergoes certain changes of properties, which make it cystic bile. The biliary fluid probably flows directly into the intestine, while the assimilation of the food is going on; and, when the empty state of the duodenum causes the end of the ductus communis choledochus to be compressed by its muscular coat, it regurgitates into the gall-bladder.

There is no direct communication between the liver and gall-bladder, and consequently no other way for the bile to enter that bag, except by the cystic duct. The hepatic bile is a thin fluid, of a clear orange colour, and slightly bitter; the cystic is viscid and tenacious, intensely bitter, and very dark coloured. The bile, thus changed by its residence in the gall-bladder, is expelled by the contractile powers of the gall-bladder and cystic duct into the ductus communis, and thence passes to the duodenum. This bladder absorbs the watery parts of the hepatic bile, and adds a mucous secretion to it.

The chemical analysis, and the uses of the bile, are considered under that article.

Function of the Spleen. The situation and attachments of this organ lead us to suppose, that its uses are in some way connected with the functions of the stomach; yet there is nothing more than conjecture to be offered on this subject. The removal of the part has been performed in dogs without any material injury to the animal. Its size differs, according the quantity of blood contained in its cells. Physiologists have stated, that its blood possesses peculiar properties; that it is more fluid, does not coagulate, nor separate readily into serum and crassamentum; is more livid, and possesses a greater quantity of carbon. As this blood goes to the liver, and as the part possesses no excretory duct, it has been argued, that its function is subservient to that of the liver, in imparting to the blood those properties which fit it for the secretion of bile.

By others, the spleen has been regarded as a sponge, swelling with blood when the stomach is empty, and squeezed out by the pressure of the stomach when that organ is full. Thus, it is said, more blood will go into the stomachic arteries when the secretion of the gastric juice is going on, and the superfluous part in the inactive state of the stomach will distend the spleen.

Action of the small Intestines. The chyle, formed in the duodenum, passes through the tube of the small intestine, which is the organ for absorbing its nutritive parts.

The description of this fluid will be found under the article CHYLE. Its progress through the intestine is retarded by the numerous convolutions of the tube; and the chyle, separated from the excrementitious part of the food, is brought into contact with the inhaling orifices of the lacteals, that commence, according to Lieberkühn and other microscopical observers, by patulous orifices on the surface of the villi. The latter projections, so named from a comparison with the pill of velvet, are very numerous on the circular projecting folds of the internal coat, called valvulæ conniventes. These latter not only render the progress of the chyle slower, but increase very greatly the absorbing surface, and penetrate, in consequence of the intestinal contractions, into the midst of the chyle, in quest of its nutritive particles. A fluid is secreted from the intestine, analogous to that furnished by the stomach, although an accurate examination of its nature and properties is one of the physiological desiderata (succus intestinalis). At the same time that the absorption of the chyle from the villous surface of the intestine is going on, it is moved gradually downwards, towards the large intestine, by the peristaltic motion. This is an undulatory and gentle constriction, taking place in several parts of the tube at once, and producing therefore a singular appearance, compared to the crawling of worms, and hence termed vermicular. It moves the chyle repeatedly over the surface of the intestine; and though it must urge that fluid partially upwards, yet its chief effect in the healthy state is exerted in the opposite direction. It is chiefly in disease that an antiperistaltic movement occurs, which conveys bile into the stomach, and even the whole contents of the small and large intestine.

By the powers now explained, which propel the alimentary mass by their contractions, and by the admixture of the various fluid menstrua which dilute and alter its properties, those memorable changes are effected, by which our food is said to be animalized or assimilated. In the duodenum and upper part of the jejunum it forms an equably mixed fluid, of the consistence of thick cream, greyish, and rather acid. Lower down it separates into two parts; the excrementitious of a pale brown or yellow colour, and nauseating smell; and the true chyle, separated from the former by the bile, and swimming on its surface.

Action of the large Intestine. The excrementitious portion of the chyme, deprived almost entirely of every nutritive portion, enters the cæcum: its passage through the last part of the ileum being favoured by a copious secretion of mucous from the glands which abound in that part. The valvula coli, which is the boundary between the large and small intestines, is designed to prevent the contents of the former from regurgitating into the latter: and it performs this office in general; for nutritive clysters would otherwise enter the small intestines, and thus enable us to administer food enough for the support of life per anum: yet it occasionally fails in its office: hence vomiting of feces, and of tobacco clysters.

The large intestine may be regarded as the organ in which the residue of the chyme undergoes its last change; *viz.* the conversion into feces; as a reservoir, protecting us from the disgusting necessity of having that residue constantly flowing off; and as the instrument of its final expulsion from the body.

Some absorbents exist in this last part of the alimentary tube, and convey what nutritive parts still remain in the intestinal contents; but they are comparatively few, and hence the impossibility of nourishing the body by way of clyster.

The conversion of the alimentary residue into feces, is owing to some active operation of the intestine; as these are very different from the mere putrid remains of animal or vegetable matter. And when this operation is deficient, portions of the food are seen in the evacuations per anum, but slightly changed. The fecal matter is conveyed onwards by the peristaltic motion of the large intestine: it become thicker and more consistent in its progress, and is usually formed more or less decidedly by the cells of the colon. Its natural consistence is just sufficient to retain these marks; and its appearance throughout should be homogeneous. The colour depends on the admixture of bile, and in the most natural state is of a yellow brown. Although the change which reduces the residue of our food to feces, is so far from being mere putrefaction, that the excrement is in fact less prone to putrefy than other animal matter; yet there is, as in putrefaction, a disengagement of gaseous products, particularly of sulphurated hydrogen. The colouring matter of the vegetables is often seen in the feces, as the green of spinach, and red of beet root; and the fibrous indigestible parts of vegetables, as the skin of fruits, husks of grain, &c. The latter, indeed, is so little affected by the powers of digestion, that when the covering is entire, a grain may pass through the body, and still retain the power to germinate.

The expulsion of the feces take place when they arrive in the rectum, which is speedily irritated by their presence; and is performed partly by the muscular coat of that intestine, and partly by the muscles of respiration, producing the effort called straining. The periods of voiding the excrement vary, from several causes: they are more frequent in the young subjects, where the stools are more liquid. In the adult they should not be less, in a healthy state, than once in twenty-four hours.

Urinary Secretion. The liquids which we drink, absorbed by the lacteals, together with the nutritive part of the solid aliment, dilute the latter, and serve as a vehicle for it. They increase the quantity of the blood, and render it more fluid; conveyed into every part of the circulating system, they penetrate all our organs, carry away the particles detached from them in the different vital processes, and are then separated from the mass of fluids by the urinary organs, together with various other substances, whose retention in the body would produce injurious effects. The kidneys, therefore, dispose of the residual part of our liquid ingestu, as the feces are formed by the more solid foods, and the quantity of urine may, of course, be expected to vary according to that of the drink. All the old parts of the frame, which are constantly removed by the absorbents, while new depositions are formed by the nutrient arteries, go off in the same way; and hence the urine, although apparently a watery fluid, and called in common language water, contains a great deal of animal matter.

From the above account it will be readily understood, that the properties of the urine must vary according to the time at which it is voided after meals, the quantity of food and drink, the age and complaints of individuals, &c. Physiologists have distinguished urine of the drink, chyle, and blood. The first is a watery fluid, almost colourless, evacuated very soon after drinking, and possessing very slight urinous characters; the second, evacuated two or three hours after meals, is better elaborated, but not yet complete in its constituent principles; the last, voided after the repose of the night, has all the properties of urine in an eminent degree. In infants it possesses no phosphate of lime nor phosphoric acid, as those substances are employed in the business of ossification, which is then active. In old persons, on the contrary, where the bony system, already overcharged with phosphate of lime, refuses to admit any more, this substance is carried off by the kidneys. It is removed in the same way in rachitis and mollities ossium, where the bones become softened by its absence.

The great quantity of saline and crystallizable elements contained in the urine, account for the frequency of calculous concretions, which are found by recent and accurate analysis to vary very considerably in their composition. As there it no substance in the body which may not be evacuated by the urine, and manifest itself in that liquid, so, under different circumstances, every thing possessing a power of concretion may become the subject of urinary calculus. This diversity of constituent elements, together with the want of characteric symptoms of the different species, and the irritation which the coats of the bladder must experience from chemical reagents, will convince us how extremely difficult, if not impossible, it must be, to discover a lithontriptic that would obviate the necessity of a surgical operation.

The urine is very speedily and sensibly affected by certain substances; thus asparagus occasions a remarkable fœtor in this fluid: and turpentine imparts to it a violet odour. For a further account of its composition and physiology, see the article URINE.

Almost every physiologist has noticed the rapidity with which this secretion is carried on: aqueous fluids, taken by the mouth, are sometimes separated so quickly by the kidneys, that an immediate communication has been suspected between the stomach and kidneys, on the supposition that there had not been a sufficient time for the fluid to arrive at the latter organ in the regular course of absorption and circulation. This conjecture derives no countenance from anatomy, and the size of the renal vessels explains the fact without any such supposition.

Absorption, or the process by which the chyle, separated from the food by the digestive organs, is carried into the blood, naturally follows the account of digestion. We have very little to add to what is stated on this subject in the article Anatomy.

The admission of matter into the orifices of the absorbing vessels has been accounted for in various ways. Some physiologists consider it as a case of capillary attraction. But a little reflection is sufficient to shew that the absorbents are not like capillary tubes immersed in a fluid. Besides, were such attraction the cause of absorption, that process should be carried on with regularity. On the contrary, absorption is occasionally very deficient, when abundance of fluids is presented to the mouths of the vessels, as in oedema; and in other cases, after being for a long time inactive, it is suddenly exerted to a great extent; thus large abscesses have been dispersed in one night. Others have endeavoured to discover some propelling power which should protrude the matter subject to absorption into the mouths of the vessels. The pressure of the atmosphere on the surface of the body has been considered adequate to this effect, and the deposition of new matter by the secerning artery has been assigned as the cause of the propulsion of the old particles into the orifice of the absorbent. On this theory, secretion and absorption should correspond more exactly than they are known to do. Mr. J. Hunter acknowledged that he was unable to account for the effects produced, unless by attributing to the mouths of the absorbing vessels powers similar to those which a caterpillar exerts when feeding on a leaf.

Some suppose that the absorbents cannot take up any matter that is not fluid; consequently, that animal solids must be converted into fluids before they can become fit subjects for absorption; and that probably some solvent fluid is secreted for this purpose. The latter fact rests on no direct proof, and the whole hypothesis is very unlike the simplicity observable in other parts of the animal economy. It seems better, in these difficult investigations, to note facts, than to form theories; and whoever contemplates the things done in the animal body, will be astonished at the power of the vessels, by whose agency they must be effected; a whole bone may perish, as, for example, that of the thigh, and may be increased by a new one; the vascular lining of the new bone will altogether remove the dead one.

Besides the great and leading office of the absorbents in conveying the chyle into the venous system, their agency is discerned in various other parts of the animal economy. The nearly transparent fluid that lubricates the interstices of the cellular substance, and the serous exhalation poured into circumscribed cavities, are taken up by the lymphatics, which must commence in all parts of the body by open orifices. When the due balance does not exist between the absorbing and secreting vessels, the cellular substance becomes loaded with fluid (anasarca), or circumscribed cavities are rendered dropsical. Together with the lymph or fluid which the absorbing vessels derive from the sources just mentioned, they convey from every part of the body the old constituent materials of our organs, in proportion as new particles are deposited by the arteries; and these different elements are intimately mingled and combined in their passage through the absorbent glands, and the plexures of lymphatic vessels.

It has been a disputed point whether absorption goes on from the surface of the skin, while the cuticle is entire; the arguments on the affirmative sides are an alleged increase of weight in the body after a walk in damp weather; the abundant secretion of urine after remaining for some time in a bath; the evident swelling of the inguinal glands after a long immersion of the lower extremities in warm water; the effects of mercury administered by friction, fumigation, &c. It has been stated in opposition, that oil of turpentine has not been absorbed after long immersion of the arm; that solutions of medicated substances have not been taken up under similar circumstances, &c. We think it is sufficiently proved, that absorption from the surface does take place in the human body, but whether this extends, as a modern physiologist has stated, to gaseous bodies, cannot yet be decided.

It appears probable that the internal surface of the bronchi and pulmonary vesicles is an absorbing surface. For when a person breathes air loaded with the vapour of turpentine, that substance very speedily shews itself in the urine, although the skin will not take it up. If the body really increase in weight in damp air, it might be accounted for by means of pulmonary absorption. It must probably be rather in this way, or by the skin, that contagious matters affect the constitution.

The absorbents are concerned in producing changes in the different secreted fluids: they remove the aqueous portions of the bile and urine, and often take up even the colouring parts of the former, and convey them into the blood, whence they are deposited in all our organs, and produce the yellowness of jaundice. They introduce various diseases into the human frame, as syphilis, hydrophobia, inoculated small-pox, &c.; and in other instances act in a curative manner by taking up extravasated blood, by reducing swollen parts, &c.

The circulation, is the motion by which the blood, setting out from the heart, is constantly carried to all parts of the body in the arteries, and returns to the same point in the veins. The uses of this circulatory motion are, to submit the blood altered by the mixture of lymph and chyle to the contact of the atmosphere in the lungs (respiration), to convey it to several organs in which various animal fluids are separated from it, (secretion); and to every part of the body, for supplying its growth and repairing its losses, by means of its nutritive particles when completely assimilated (nutrition). The conveyance or transport of our fluids, rather than their elaboration, is the office of the organs of circulation. In this view they may be compared to those labourers, who in a large manufactory, from which various products issue, carry the materials to the workmen employed in the actual fabrication. As among the latter there are some who purify and bring to perfection the materials furnished by others, so the lungs and secretory glands are constantly employed in separating from the blood all those heterogenous matters which could not be assimilated to the substance of our organs.

The word circulation, when used absolutely, comprehends the whole course of the blood, as well in the lungs, as in the arteries and veins of the body at large. The greater circulation is the passage of the blood from the left side of the heart, through the arteries, to the extremities of the body, and its return through the veins to the right side of the same viscus. The lesser circulation is the transmission of the blood from the right to the left side of the heart, through the lungs.

The course, which the blood takes, has been already explained in the article Anatomy. We subjoin the proofs and experiments, by which the facts there stated are supported.

The passage of the blood through the heart, *i. e.* from the right auricle to the left ventricle, by the medium of the lungs, is manifest from the structure of the heart itself. The valves, which are placed at its various apertures, actually will not admit of the blood's motion in any other direction than what we have described. That this fluid passes from the heart into the trunk of the aorta, thence into its branches, and so on to the most minute ramifications, is evinced; 1. By the effect of ligatures on these vessels; the artery becomes turgid between the heart and the ligature, and empty between the ligature and its distribution. 2. By opening an artery when tied, above and below the ligature; the blood in this case flows from that opening only, which is nearest to the heart. 3. By ocular testimony; the passage of the blood can be seen with the aid of glasses in frogs, fishes, &c. The passage of the blood through the veins, in a contrary course to that in which it flows along the arteries, *i. e.* from the minute ramifications towards the trunks, and thence to the heart, is proved. 1. By the structure and disposition of the valves, which afford an invincible impediment to all retrograde motion. 2. By ligatures on these vessels, which make the vein turgid between the extremities of the body and the ligature, and empty in the rest of its course. 3. By opening a vein, when tied, above and below the ligature. 4. By microscopical observation in animals.

The passage of the blood from the arteries into the veins seems to flow as a corollory, from what we have stated concerning the proofs of its course in these two systems of vessels. We have shewn that the ultimate arteries are continuous with the origins of the veins; that the blood moves from the heart to the extremities in the former vessels, and that it passes from the extremities to the heart in the latter. The intermediate passage is a direct consequence of these facts. But it may be demonstrated by direct proofs independently of this argument. If we tie the artery of a part, its correspondent vein receives no blood; if we take off the ligature the vein is again filled. The quantity of blood expelled from the aortic ventricle is so considerable, that the supply can only be kept up by its return to the heart. We calculate that two ounces are sent into the aorta at each pulsation; if we suppose 80 pulsations in a minute, 9,600 ounces will be thrown out in an hour; and 14,400 pounds in a day. The same blood, therefore, which the aorta received from the heart, must be returned to this viscus; and the only passage, by which it can return, is through the veins. Lastly, the passage of the blood from the arteries into the veins, may be proved by the direct testimony of the senses in living animals. The use of the microscope affords this proof in the transparent parts of cold blooded animals, as the mesentery and web of the foot in frogs, the tail of fishes, &c.

The motions of any part of the heart, considered singly and individually, consist in a constant series of alternate contractions and dilatations; or, as they are technically named, alternate states of systole and diastole. The contractions take place as in other muscles, the dilating cause consists in the forcible entrance of blood into the cavity. The auricles and ventricles, when viewed in relation to each other, are successively contracted and dilated; the corresponding parts acting at the same time on both sides of the heart. Thus, when the auricles contract, in order to expel the blood which they have received from the system at large, and from the lungs, the ventricles are relaxed, and therefore in a state fit for receiving this blood. When, in the following moment, the recently filled ventricles contract, in order to urge forwards the blood into the two arterial trunks, the auricles are relaxed, and become immediately distended by the current of venous blood.

The action of the heart, and of the vessels connected with it, may therefore be distributed into successive periods. In the first of these, the venæ cavæ and pulmonary veins pour their blood into the two auricles, and thus cause a diastole of these cavities. The systole of the auricles transmits the blood into the ventricles in the second period; and these latter cavities expel their contents into the arteries in the third portion of time. Thus the action of the veins takes place at the same point of time with that of the ventricles; and the contraction of the auricles is synchronous with that of the arteries.

The systole of the ventricles, which is supposed to occupy one third of the time of the whole pulsation of the heart, is accomplished by an approximation of the sides of the cavities to the middle partition, and of the apex to the basis of the heart. The whole viscus by this means becomes shorter and more obtuse. The well known fact of the heart striking against the left breast in its contraction, may seem on the first glance to refute this account of the systole of the ventricles. But, on a further examination, it can have no such effect; since the phenomenon in question depends on two causes amply sufficient to produce the effect. The swelling of the auricles, which are at the back of the heart, and particularly of the left auricle, which is interposed between the spine and the base of the left ventricle, necessarily causes the point of the heart to advance towards the side; and this motion may be imitated in the dead body by injecting or inflating the muscles. The other cause consists in the connection of the large arteries, particularly of the aorta, with the base of the heart. A curved and flexible tube, when suddenly distended, becomes in some measure straightened. Thus, when the blood is impelled into the aorta, the curve of that vessel approaches more nearly to a straight line. Its posterior end being firmly attached to the vertebræ is immovable; to its anterior and moveable part is fixed the heart, which, by the straightening of the vessel, is obliged to describe a portion of a circle, in doing which, the apex strikes against the side. These two circumstances occur simultaneously; the venous blood rushes into the auricles at the same time that the ventricle fills the aorta. The impulse of the blood expelled by the aortic ventricle is felt in the whole arterial system; and it produces in all arteries, which come within the sphere of the touch, and which have an area of not less than one-sixth of a line in diameter, an obvious and perceptible effect, called the pulse, which is a real state of diastole of the artery, and which is ascertained to correspond exactly, and to be perfectly synchronous with the systole of the heart. The number of pulsations in a given space of time varies infinitely in healthy persons. Age is the chief cause of these varieties; but other circumstances, which constitute the peculiar state of health of each individual, have considerable effect; so that no standard can be settled which shall prove generally correct. The following numbers afford, we believe, as near an approximation as can be expected amidst so much uncertainty; they will serve at least as a comparative view in subjects of different ages. The heart of an infant, sleeping tranquilly, performs in the first days of existence about 140 pulsations in a minute; at the end of the first year the pulsations are, in the same space of time, 124.

At the end of the second year	110
Third and following years	96
Seventh and following	86
Time of puberty	80
Manhood	75
Sixtieth year	65

The pulsations of the heart proceed in

a regular and continued succession to the last period of life, and then all its parts do not cease to act at once; but the right auricle and ventricle survive the opposite cavities for some little time, so that the former part has been called the ultimum moriens. The blood, which returns by the venæ cavæ after the last expiration, no longer finds the usual passage through the lungs, which are contracted, but it is still urged on from behind by that which the aorta has recently propelled. Hence it is forced into the right auricle, and excites contraction in that part, by the stimulus of its presence, some time after the left side has been at rest. This congestion on the right side of the heart in the last agony explains the empty state of the arteries, particularly the larger ones, after death.

It is hardly possible to determine the velocity of the blood's motion in the healthy state; for individuals differ from each other in this respect, and considerable variety probably takes place in different parts of the body. It is generally supposed, that the blood flows in a more gentle stream through the small arteries than in the arterial trunks; and that the velocity of its current is somewhat less in the veins than in the arteries of the body. These differences have, however, been exaggerated by former physiologists. The mean velocity of the blood in the aorta is calculated at eight inches for each pulsation, which gives about fifty feet in a minute. If we reflect, that the systole of the ventricle, which gives the whole impulse to the blood, occupies only one-third of the whole pulse, the velocity of the blood's motion must be trebled in that division of the time. It is said that this velocity, which we have assigned to the blood's motion at its departure from the heart, becomes speedily diminished in its further progress; and the diminution has been deduced from various causes. The first and most powerful of these is the constantly increasing area of the branches, when compared with the trunk of an artery. (See Anatomy.) It is a well-known law in hydraulics, that the velocity of a fluid passing through an inverted cone constantly decreases, and that the diminution of velocity is in the ratio of the increase of area. The mathematical physiologists have also noticed the effects of friction; deducing these from a comparison with the course of fluids in dead tubes. Other causes have been derived from the same source; hence the serpentine course of some arteries, the unfavourable angles by which they sometimes arise, and their communications with each other, are enumerated among the circumstances which retard the course of the arterial blood. But it must be remembered, that in viewing these retarding causes we are considering their action on the blood, as if this fluid were contained in inanimate tubes, and influenced merely by the contraction of the heart, without taking into the account any accessory impulse, which may be, and probably is, derived from the arteries. This retardation has been variously estimated by different calculators, who have all made it very considerable. Hales supposes the blood to flow through the capillary arteries of a frog at the rate of two-thirds of an inch in a minute, which will be about 650 times slower than in the human aorta. Robinson and Whytt have gone still further: the former stating, that the velocity of the blood's motion in the aorta is to that in the smallest vessels as 1100 to 1. We mention these calculations, to shew what absurdities have been committed by men of the greatest abilities, when they have applied the laws which regulate the properties of dead matter to the living functions of the animal machine. Haller's observations on the circulation in living animals, (Elem. Phys. lib. vi. sect. 1. §. 30) entirely overthrow these calculations. He found by his microscopical experiments, that the blood flowed generally as rapidly through the small as through the larger vessels. He states also, that in living animals it is poured out as far from a small as from a large artery. The numerous and diversified experiments of Spallanzani afford additional evidence of the same truth.

We have stated, that the blood is thrown into the arteries by separate contractions of the heart; yet these vessels are constantly full, as may be proved by opening them during the heart's diastole. For the blood flows on in such a way, that the subsequent quantity discharged from the right ventricle, overtakes that which is before, and thus causes the pulsation of the arteries. The excess of velocity in the blood coming from the heart, over that contained in the arteries, becomes constantly less; and at a certain point ceases altogether. Here the pulse ceases also: hence in microscopical observations on the course of the blood in small vessels, its stream appears to be uniform; and it is commonly stated, that the pulsation ceases in vessels of about one sixth of a line in diameter.

The motion of the blood in the minute veins seems to be equal to its velocity in the small arteries; this increases in the larger trunks; and there is a constant acceleration in the blood's course until it arrives at the heart. This fluid is passing through tubes which constantly decrease in area; and it follows of necessity, that by diminishing the channel of a fluid, its course must be accelerated. Hence the trunks of the venæ cavæ return to the heart, within a given time, as much blood as the aorta carried out of this viscus.

The motion of the blood along the veins must be derived from the impulse which it receives from the heart, and from the action (if there be any) of the arteries. Its circulation in these vessels is aided by the contraction of the muscles, which must urge on the contained fluid towards the heart; since their valves prevent any retrograde motion.

We shall readily perceive, that no certain calculation can be formed of the powers of the heart, when we consider that neither the quantity of blood expelled at one pulsation, nor the distance through which it passes in a given time, nor the velocity of its course, can be defined with any certainty; much less can we form any accurate estimate of the obstacles which occur to the blood's motion, which must considerably affect such a calculation. We may however approach in some degree to the truth, by collecting and comparing the results of probable conjecture. If we calculate the blood contained in the body at thirty pounds, the number of pulsations in one minute at seventy-five, and the quantity expelled from the left ventricle at each pulsation at two ounces and a half, the whole quantity will pass through the heart about twenty-two times in the course of an hour; and it will perform the circulation once in less than three minutes. The velocity with which this blood is propelled by the systole of the left ventricle may be collected from the violence with which it is ejected from a wounded artery, and the altitude to which it ascends. Blumenbach has seen it projected more than five feet from the carotid of an adult during the first contractions of the heart. Our countryman Hales calculated from his experiments, in which he measured the height of the blood's ascent in a glass tube, inserted into a large artery, that it would be thrown seven feet and a half from the human carotid: he estimates the surface of the ventricle at fifteen square inches; and thus finds that one thousand three hundred and fifty cubic inches, or about fifty-one pounds weight, press upon the left ventricle, and must be overcome by its systole. Many other calculations of the powers of the heart have been formed upon mathematical principles; but different persons have been led to such opposite results, that we are warranted from this circumstance in disregarding them altogether. Borelli makes the powers of the heart equal to an hundred and eighty thousand pounds; Keill to eight ounces. Senac observes, that if a weight of fifty pound be attached to the foot, with the knee of that side placed on the opposite one, the weight will be elevated at each pulsation: this weight is placed at a considerable distance from the centre of motion; and, allowing for this circumstance, he estimates the moving power at four hundred pound.

This power of the heart, so wonderful both in extent and duration, must be referred to the irritability of the organ, in which point of view it seems far to exceed all other muscular parts of the body. That the immediate cause of contraction in this viscus arises from the presence of blood in its cavities, is shewn by the celebrated experiment of Haller; in which the longer duration of action in the right or left cavities, was varied by influencing the supply of blood.

In the action of those muscles that depend on the will, a supply of nerves, and a distribution of blood to the moving fibres, seem to be essential conditions. It has been disputed whether or not these circumstances are necessary in the heart, and what share they may contribute to the heart's action. We may observe in the first place, that the actions of the heart are completely involuntary; that no exertion of the will can produce the smallest effect in accelerating, retarding, or otherwise affecting the actions of this part. Yet various arguments prove that the nerves exert an influence over this organ. Not to mention the peculiar arrangement of the cardiac nerves, the sympathy between the heart's action, and nearly every other function, even of the most different classes, suffices to demonstrate the connection. The vehement disturbance of the heart from the passions of the mind, must be familiar to every person from his own experience; its action is also strongly influenced by various states and affections of the alimentary canal.

The action of the heart is intimately

connected with the changes which the blood undergoes in its passage through the lungs; for when respiration is obstructed, the heart's action ceases, and it may be recalled by again introducing air into the lungs. Hence arises the importance of inflating the lungs in instances of apparent death from drowning, &c. in order to excite the heart to action. The mode in which the arteries and veins contribute to the circulation, will be understood from the account of those vessels in the article ANATOMY.

The circulation of the blood is different in the fœtus, in consequence of differences in the structure of the organs devoted to this function. See FŒTUS.

The situation of the child in utero precludes the access of atmospheric air to the lungs; these organs are consequently small and collapsed, and the lesser circulation can hardly be said to take place in the fœtal state. Although its circulation might, in this respect, be considered as more simple than that of the adult, this function becomes considerably complicated by the connection with the placentæ. A portion only of the child's blood circulates through this part, and it is no doubt so altered or modified by this passage through the vessels of the placenta, as to become more fit for the growth and nourishment of the child. No such alteration or modification has, however, been actually demonstrated in the fœtal blood. Physiologists have discovered no difference in this fluid in the various vessels of the fœtus. It is of the same dark colour in the arteries and veins. The interruption of the communication with the placenta, before respiration has commenced, is, however, suddenly fatal. Our ignorance of the functions of the placenta, and of the liver, which is of immense size in the fœtus, as well as of the changes which the fœtal blood undergoes in the complicated system of organs, which are connected with its circulation in this state of existence, leaves many parts of the subject in doubt and obscurity.

Respiration. The exposure of the blood to the atmospheric air, by which the chyle, that has entered the circulating system from the thoracic duct, is converted into blood, and by which those changes are effected in the whole mass of circulating fluid, which are essentially necessary to the continuation of life, takes place in the lungs.

The respiratory organ has been aptly compared to an empty bladder, placed in a pair of bellows, with its neck adapted to the instrument, and giving entrance to a column of air, when the sides are separated. In breathing, the dilatation of the chest occasions the lungs to enlarge by the entrance of air into them from without; these viscera not possessing any means of enlargement in themselves: this is termed inspiration. The expulsion of the air, after it has served the purposes of respiration, by means of a process exactly contrary to the former, is called expiration. The diaphragm and the abdominal muscles are the chief agents in enlarging and diminishing the chest. The former muscle in its relaxed state is strongly arched, and the convexity of this arch is towards the chest. Its curved fibres become straight by the contraction: the whole muscle descends towards the abdomen, and pushes the abdominal viscera, which lie against its under or concave surface, downwards and forwards. Hence the surface of the belly rises when we draw air into the chest. In the next moment, the abdominal muscles contract and push back the viscera, and thereby diminish the chest in a degree proportionate to its former enlargement. The increase of the thorax, effected in this way, takes place in the perpendicular direction; but it may also be enlarged in its whole diameter by means of the intercostal muscles, which, by elevating and twisting outwards all the ribs, push the sternum forwards, and enlarge the chest in every direction. When the action of these powers has ceased, the natural elasticity of the parts restores the parietes of the thorax to their former position. In natural respiration, both these methods of altering the capacity of the chest are employed; but females seem to use the intercostal muscles more than the male subject, as the heaving of their bosom demonstrates; yet breathing can be carried on by either method, to the exclusion of the other; as we sometimes see under circumstances of accident or disease. In the case of a broken rib, where the rubbing of the broken ends would be highly painful, the chest is bound up so as to render the ribs motionless, and the diaphragm and abdominal muscles perform the whole business of respiration. When the diaphragm and abdominal muscles act together, they compress the viscera between them, and the pressure thus produced, assists in the expulsion of their contents. This effort is termed straining, and is seen in vomiting, in the act of discharging the feces and urine, and in the propulsion of the child from the uterus.

The state of the mind considerably affects the mode of respiration, although the muscles of that function are so far independent of the will, that they act without any exertion of volition, and continue their functions during sleep, when all the voluntary powers are suspended. When the lover, plunged in a soft reverie, fetches a deep sigh, the physiologist observes a strong and protracted inspiration, followed by a similar expiration; crying and sobbing, differ from sighing only in the circumstance of the expiration being interrupted, or divided into several distinct periods. In gaping, which is attended with a sense of weariness, there is a large inspiration, accomplished in a gradual manner, and by a kind of effort; the entrance of a great quantity of air is facilitated by opening the mouth wide: this is followed by a complete gradual expiration. Sneezing is a strong and violent expiration, and the noise accompanying it is produced by the air passing out with rapidity, and striking against the winding parietes of the nasal fossæ. The effort, which is occasioned by the irritation of the pituitary membrane, is a convulsive motion of the muscles of respiration, and particularly of the diaphragm. In coughing, the expirations are shorter and more frequent; the expelled air carries off the mucus lodged in the trachea and bronchiæ, and this discharge constitutes expectoration. Laughing is a short inspiration, followed by several short and rapid expirations.

The alternate dilatation and contraction of the chest, proceed uninterruptedly from the moment of birth to the end of life, and in a healthy adult are repeated about fourteen times in a minute, so that each act of respiration corresponds pretty nearly to five pulsations of the heart. For an account of the changes which the blood experiences in respiration, as well as those which take place in the respired air, and for the composition of the blood itself, see Respiration and Blood.

The action of the lungs upon the blood is so essential to the continuance of life, that its interruption very speedily causes death. Yet, in these cases, absolute death does not occur instantly, but the vital processes, although suspended for a time, may be renewed by a proper treatment; and hence arises the possibility of recovering the apparently dead from drowning, &c. On the subject of sudden deaths, we may observe, that the organic functions may subsist after the animal are extinguished, as in apoplexy, concussion, &c. The latter, however, never continue after the former have ceased, as in great hæmorrhages, wounds of the heart, asphyxia, &c. Hence the cessation of organic life is a sure indication of general death, while that of animal life is a very fallacious one.

In explaining the effect which the cessation of respiration produces, some have stated, that the lungs, being no longer distended by the air in inspiration, have their vessels folded, and consequently mechanically unfit for the circulation of blood through them. Bichat, in his excellent "Recherches sur la Vie et la Mort," has fully disproved this statement, and has shown, by incontrovertible experiments, that neither the empty state of the lungs in complete expiration, nor their distended condition in the most full inspiration, produces any obstacle to the passage of blood through the pulmonary vessels. He proves, likewise, that when the cessation of the chemical phenomena of the lungs induces a cessation of the heart's action, this does not happen in consequence of the simple contact of black blood with the internal surface of the left ventricle; but in consequence of this blood, thus deprived of those principles which are necessary for maintaining the actions of parts penetrating the tissue of the heart, and coming into contact with its fibres. The brain is affected in the same way, in consequence of the cessation of respiration; and the arrival of venous blood in this organ, causes an immediate cessation of animal life, while the organic still subsists. The same blood, too, accumulated in every other structure, probably affects the whole body with its mortiferous qualities; and consequently, a mechanical inflation of the lungs with pure air, is the most powerful method of recovery that can be adopted in these cases.

The term asphyxia, signifying absence of the pulse, is applied to every apparent loss of vitality, produced by an external cause that suspends respiration, as drowning, strangling, disoxygenation of the air we breathe, &c. The difference between asphyxia and real death is, that in the former state the principle of life may be re-animated, while in the latter it is completely extinct. In those cases where it arises from drowning, strangulation, and some of the non-respirable gases, as carbonic acid; the cessation of respiration is the cause, and the treatment must be conducted on the principles just mentioned. Where noxious vapours, as those of privies, or burial places, or certain gases, as sulphurated and phosphorated hydrogen, produce it, there seems to be an action of some poisonous or deleterious substances on the nervous system through the medium of the lungs. Intoxication is quite different from asphyxia; it induces a profound sleep, or insensibility, in which the pulse still beats, and respiration goes on, although slowly.

The lungs are organs of secretion, and separate from the venous blood, circulating through them in the pulmonary artery, and loaded with serum, a very abundant watery vapour, called the breath, and shewing itself in separate globules when condensed by a cold and smooth surface, as that of glass or metals. As the cessation of respiration is one of the most obvious and easily recognizable symptoms of death, the intimate connection between it and life has been noticed even by the vulgar, and hence life itself, and even the soul, have been supposed to reside in the breath. Thus anima, in Latin, denotes the breath, the life, or the soul. The breath of life is a familiar phrase in our own language, and the "animam efflavit" of the poet, which literally means "blew out his breath," is employed to signify "died." We cannot admit that this watery vapour is formed by the oxygen of the atmosphere uniting with the hydrogen of the venous blood, as this combination, performed out of the body, is attended with phenomena of deflagration that do not occur in the present instance. The quantity of this secretion is said to equal that of the skin; it should be distinguished from the mucus secreted on the interior surface of the bronchiæ and trachea, which is thrown off by strong expirations, and forms the matter of expectoration.

Animal heat. The power which living bodies possess of maintaining the same degree of heat under every change of surrounding temperature, is one of their most surprising phenomena, and one which occupies a very prominent station in that complicated assemblage of circumstances denoted by the term life. The temperature of the blood, and of the internal parts of the body in general, is stated at about 98° Fahrenheit. In Mr. Hunter's experiment, he found the heat under the tongue, and at the bulb of the urethra, to be 97°; in the rectum $98\frac{1}{2}$°; in the rectum of an ox and rabbit $99\frac{1}{2}$°; of a hen 103; in the heart, liver, and stomach of animals 100° and 101°. These temperatures, instead of varying like those of inanimate bodies, according to the surrounding media, and consequently tending to a state of equilibrium, are maintained with very little deviation under very great varieties of atmospheric heat. Pallas sustained a cold of 80° below 0 in Siberia, and Gmelin of 126° in the same country. On the contrary, temperatures of 120° and more above 0 have been observed in Africa and America. Linings saw the thermometer at 126° in Carolina; but when placed under the tongue, or in the axilla, it sunk to the point of animal heat. Much higher degrees of artificial temperature have been supported by the human body. Girls in France staid in an oven where fruit and meal were baking for ten minutes, without inconvenience, the thermometer at 265°. Dr. Fordyce and Sir Joseph Banks supported nearly an equal degree of artificial heat in this country.

From these facts, it is obvious that, although in rare instances, the surrounding heat is greater than that of our own bodies, it is generally considerably less. Hence we must explain the powers by which our temperature is maintained so much above that of the medium in which we live. This explanation is now generally founded on the chemical changes which the blood undergoes in the lungs, and in its circulation through the body, which subject is considered under the article HEAT. There are many circumstances in favour of this explanation; as the increased heat produced by the acceleration of the circulation by exercise, &c. the coldness of a limb, when the nutrient artery is tied; the various degrees of temperature in different animals corresponding with the perfection of their pulmonary system, &c. There are also several facts which show, that the living powers of the constitution, or part, greatly influence the evolution of heat, independently of the consumption of oxygen in respiration. The coldness of palsied limbs, the increased heat of parts in inflammation, and of the whole skin in febrile complaints, are sufficient to prove this. But it is most clearly demonstrated by an experiment of Dr. Currie's. He placed a man in a cold bath of 40°, which at first diminished his temperature, but it soon regained the natural standard. Here there must have been a great evolution of heat to keep up the temperature under circumstances so strongly tending to depress it; yet the consumption of oxygen was less than usual, for both the pulse and respiration became slower. Mr. Hunter made many experiments on this subject, and concluded, that there is always an exertion or expense of animal power in resisting cold proportioned to the necessity of the case; that this exertion is in proportion to the perfection of the animal, and to the degree of heat natural to the species and that it is independent of circulation, volition, and sensation.

The power of resisting heat arises from the evaporation that is constantly going on from the surface of the skin, and which becomes extremely abundant when the temperature of the air is much raised. See the account of the organ of touching. This is a very powerful means of diminishing animal temperature, and consequently, when long continued, has a very weakening effect. Of fourteen persons shipwrecked in December, three sat on the deck, out of water, but exposed to sleet, snow, and wind; the evaporation from their surface must have been immense, and they died. All the others were up to the middle or shoulders in the water for twenty-three hours, yet survived.

Animal heat may be altered from its standard by external applications or disease; but the change can be carried much further below the standard than above it. A man could bear to have his penis cooled to 50°; but it could not be heated beyond 100½°; although the heat employed raised a dead penis to 114°.

Secretion. The blood, circulated in the manner we have just mentioned, and prepared by the organs of respiration, is the source from which the various fluids of the animal body are formed in the process of secretion.

The various arrangements of these products are, in a great measure, arbitrary. Milk seems to be formed by the most easy process, as it resembles so strongly the nature of chyle. Next come the watery fluids; (so called from their appearance, although in composition they differ considerably from water, chiefly in containing albumen). The humours of the eye, the tears, sweat, lymph of the cellular substance, vapour of the thorax, abdomen, and pericardium, and the water of the ventricles, belong to this class. The urine seems to come under the same head, although it is of a peculiar and compound nature; next follow the salivary and pancreatic juices; and then the mucous fluids poured into the alimentary, respiratory, and generative organs. The fat, marrow, grease of the skin, ear-wax, sebaceous matter of the eye-lids, and of the external organs of generation in both sexes, constitute the class of adipous fluids. The liquor of the amnion, the synovia of the joints, and the prostatic fluid, are of a gelatinous kind. The male semen, and the bile, are both of a very peculiar nature. The chemical analysis of these fluids will be considered under their proper articles.

These very various products are separated from the blood by very different organs. The most simple mode of secretion is that performed by the arteries of a part without any glandular apparatus; as the fluids of circumscribed cavities, the lymph of the cellular substance, and the fat and marrow.

Secretion is more complicated when performed by means of certain organs called glands. The most simple of these are the mucous follicles, found in various parts of the alimentary and respiratory canals; consisting of a small bag receiving the secreted fluid from the arteries, and expelling it through a short excretory duct. But the name of gland is applied more properly to the larger organs of complicated structure, as the pancreas, breast, salivary glands, &c. These, consisting of an aggregation of minute particles, are called conglomerate, to distinguish them from the lymphatic or conglobate glands. Each of them possesses an excretory duct, made up by the union of branches from the various component portions of the gland. The larger portions, into which each gland is resolved, may be divided into smaller and smaller particles, and ultimately into very minute portions; concerning the structure of which, anatomists have warmly disputed. Some describe them as being hollow, and called them acini, or cryptæ; while others asserted that they consist merely of convoluted blood-vessels: the latter opinion is the most prevalent at present. The structure of the liver and kidney is analogous to this, in its minute parts: both these organs, and particularly the latter, exhibit the acinous appearance. The ultimate blood-vessels are arranged in very different ways in various glands; coiled up in roundish masses, as in the kidney, arranged like stars in the liver, and forming an appearance like a camel's hair pencil in the spleen.

The various properties of secreted fluids depend, no doubt, more on the interior texture and vital powers of the secreting organs, than on their external habit and conformation. For comparative anatomy shows us instances of the same fluid secreted by organs of very different obvious structure.

How, or why, certain organs secrete certain liquors, is the most important and essential question in this subject; but one to which our ignorance will not enable us to reply in a satisfactory way. Probably the chief and proximate cause consists in difference of structure, and perhaps in the arrangement of the minute vessels, which are the organs of secretion. The peculiar powers of each part, its share of irritability, and contractility, must also have an important influence. The mechanical explanation of the phenomenon, by the straining of the fluids through different sized pores, cannot be admitted for a moment. We have one fluid, the blood, sent into different organs; each of which separates from it a different produce of matter, differing in many instances from any contained before in the blood. Here then must be a decomposition and a recombination of elements produced by the living action of the gland.

Nutrition may be considered as the completion of the assimilating functions; to which the processes hitherto described, under the heads of Digestion, Absorption, Circulation, Respiration, and Secretion, are only preliminary and preparatory. The food, changed in the manner we have already described, anamalised and rendered similar to the being which it is designed to nourish, applies itself to those organs whose losses it is to supply, and this identification of nutritive matter to our organs constitutes nutrition. The component parts of the living body are incessantly carried off by various causes. Thus the machine is continually destroyed, and at distant periods of life does not contain any of its original elements. Madder, mixed with the food, dyes the bones of a red colour, which disappears when the use of the root is suspended. These phenomena can only be explained by admitting an entire removal and renewal of the bony particles. Now if the most compact and solid parts be in a continual motion of decomposition and recomposition, this motion must be more rapid where the constituent principles are in the smallest degree of cohesion, as in fluids. Physiologists have endeavoured to determine the period of the entire renovation of the body, and have considered that an interval of seven years is necessary for the original particles to be totally obliterated, and their place supplied by others.

When the nutritive matter has been duly assimilated, the parts which it supplies retain it, and incorporate it with their own substance. This nutritive appropriation is variously effected in different structures; since each part converts to its own use, by a true secretion, that which is found analagous to its nature, and rejects the heterogeneous particles.

The mechanism of nutrition would be explained, if we could understand how each function divests the aliments on which we exist of their characters, to invest them with the properties of our organs; how each individual part co-operates in changing their nutritious principle into our own peculiar structure. Vegetables, which form the sole nourishment of man in many instances, and a very great share of it in all cases, consist chiefly of carbon, hydrogen, and oxygen, with sometimes a small quantity of azote and salts. In the organs of the man fed on these vegetables, azote predominates, and many new products are discovered, not distinguishable in the aliment, and, therefore, formed in the act of nutrition. Every living body, without exception, possesses this faculty of forming and decomposing substances, and of giving rise to new products.

The marine plant, whose ashes form soda, if sown in a box filled with earth that does not contain a particle of that alkali, and moistened with distilled water, furnishes it in as great a quantity as if the plant had been growing on the borders of the sea, and always supplied with salt water. Living bodies then are elaboratories, in which such combinations and decompositions occur, as art cannot imitate; bodies that to us appear simple, as soda and silex, seem to form themselves of other parts; while some, whose composition we cannot determine, as certain metals, suffer inevitable decompositions; from which we may fairly conclude, that the powers of nature in the composition and decomposition of bodies far surpass the science of chemists.

SENSATIONS.

Vision. The mode in which the rays of light are affected, in passing through the various parts of the eye, is explained under the article Optics. See also Vision. We have only to add a few remarks on the physiology of the eye.

The quantity of light that can enter the eye depends on the state of the pupil; which is again influenced by the motions of the iris. When, after shutting the eyelids, they are suddenly opened in a strong light, a disagreeable impression takes place on the eye, and the iris dilates or becomes broader: hence the pupil is contracted, and the quantity of light admitted into the eye diminished. An opposite change takes place when we go from a strong into a weak light. These motions depend entirely on the mode in which light affects the retina; for the iris is of itself insensible to luminous rays. The painful effect produced on the retina by a strong light is obviated by the contracted state of the pupil; while the opposite condition of that opening, in darkness, is designed to admit a sufficient quantity of rays, to produce a proper impression on the retina.

The seeing of bodies erect, although their images are painted inverted on the retina, is thus explained. An object is said to be inverted in respect to others which are erect: now all objects whatever are painted inverted on the retina, and all therefore correspond to each other in situation and connexion, just as if they had been represented in their natural position. All confusion is, therefore, guarded against in the mind; to which the image itself on the retina is not communicated, but only an impression caused by its formation.

The motion of the iris contributes to distinctness of vision by regulating the quantity of light admitted into the eye: and there is another provision tending to the same effect; *viz.* the absorption of any superfluous rays, which may have entered the eye by the black covering of the choroid coat. The utility of this dark pigment may be understood from observing the effects of its absence in the albino, where it causes a tenderness of the organ, and an impatience of the light.

Distinct vision also requires that the focus of the refracted rays should fall exactly on the retina, without falling short of it in the vitreous humour, or being elongated beyond it. The former fault constitutes near-sightedness (myopia); where the cornea and lens are too convex, and the sight of remote objects is imperfect. The latter defect is far-sightedness (presbyopia, as being common in old persons); where an opposite condition of the eye obtains, and near objects are seen imperfectly.

As the eye possesses a very considerable range of power in seeing distinctly both near and distant objects, it must possess some powers of accommodation adapting it to these differences of distance. Various opinions have been held on this subject; but none are supported by sufficiently direct and convincing arguments to command universal assent. The changes in the condition of the pupil have some effect: it contracts when we look at a near object, to exclude those rays which would be too divergent for the powers of the eye; and it dilates in the opposite case, to take in the divergent rays. Besides this, different physiologists have admitted a power of motion in the crystalline, by which its convexity may be altered; a movement of that body backwards and forwards, in the eye, by the ciliary processes, so as to place it at different distances from the retina; a compression of the globe by the four recti muscles, and consequent elongation and shortening of the optical axis.

That the retina, in the very axis of the eye, is insensible, owing to the entrance of an artery at that part, is shewn by experiments, in which objects vanish when their images are brought on that point.

Single vision, with two eyes, probably arises from habit; for children seem to see double; and the same affection, after diseases, has been conquered by use.

The sight would lead us into many errors concerning the distance and figure of objects, were it not corrected and assisted by the touch. The person born blind, mentioned by Cheselden, thought when he had gained his sight, that all objects touched his eyes. A square tower, at a great distance, appears round; and lofty trees, in a distant perspective, seem no larger than small bushes that are nearer to us.

Hearing. The undulations of the atmosphere, excited by the vibrations of sonorous bodies, are collected in the external ear and auditory passage, as in a hearing trumpet, and are conveyed to the membrana tympani, which they cause to vibrate. The effect is transmitted through the small bones to the watery fluid that fills the internal ear, in which the delicate filaments of the auditory nerve float; and by this nerve the sensation is conveyed to the brain. Muscles attached to the small bones of the tympanum have the power of stretching or relaxing the membrane; and probably thereby adapt the organ to various quantities of sound, by diminishing acute, and augmenting the force of grave sounds, as the changes in the pupil of the eye accommodate that organ to a greater or less number of rays, according to the effect they produce.

An entire state of the membrana tympani is not essential to hearing; for the sense remains, where an opening has taken place in that part; yet it is necessary that the tympanum should communicate with the fauces, for an obstruction of the eustachian tube causes deafness.

Vibrations may be transmitted to the auditory nerves through the bones of the head; thus a watch placed between the teeth is heard very distinctly, although the ears are stopped, &c.

Smelling. The odorous effluvia of bodies are disseminated in the atmosphere. The latter fluid passes through the nose in respiration, and thereby brings the odorous particles into contact with the olfactory nerves, which convey the impressions of odours to the brain. It is in the first pair of nerves only that the sense of smelling is supposed to reside, while the numerous twigs of the fifth pair that are distributed in the nose, are merely for the purpose of general sensibility. Hence we see two very distinct modes of sensibility in this part, one of which may be entirely obliterated, while the other is augmented; in violent coryza the ordinary feeling is very acute, for the pituitary membrane is painful; but the person at the same time is not conscious of the strongest odours.

As air is the vehicle of odours, its passage through the nose, in ordinary respiration, is sufficient for the purpose of smelling; but when any odour is particularly agreeable, we make short and repeated inspirations, and at the same time shut the mouth, that the air, which enters the lungs, may pass entirely through the nose. On the contrary, we breathe by the mouth, or entirely suppress respiration, when odours are unpleasant to us.

The small distance between the origin of the olfactory nerves in the brain, and their termination in the nose renders the transmission of impressions very sudden and easy. This induces us to apply to the nose stimuli that are proper to revive sensibility when life is suspended, as in cases of fainting, suffocation, &c.

Tasting. No body can affect the organ of taste, that is not soluble at the ordinary temperature of the saliva. Hence the chemical maxim, "corpora non agunt nisi soluta," may be very justly applied to this sense. If the tongue be completely dry, and a body applied to it be also dry, no sense of taste ensues, as any one may convince himself by wiping his tongue dry, and applying sugar to it. The state of the tongue's surface, which is well known to depend much on the condition of the stomach, also impairs our sense of taste; hence in some disorders every thing tastes bitter.

No sense approaches more nearly to feeling than this does; and the organ bears a considerable analogy to that of the sense of touch. The superior papillous surface of the tongue is the organ of taste, but we cannot deny the power of discerning savours to other parts of the mouth; bitter substances are particularly tasted about the throat; and in some instances, where large portions, or the whole tongue, have been cut away or destroyed, a perception of tastes has still remained. The lingual branch of the fifth pair is considered as the true gustatory nerve, while those sent to the tongue by the eighth and ninth are regarded as merely nerves of motion. Although the tongue appears to be a single organ, it consists of two symmetrical halves; and should be considered as a distinct right and left organ closely applied to each other. This is shewn in hemiplegia, where one-half only is paralysed.

Touching. The whole surface of the skin is the organ of this sense, which gives us information concerning more properties of extraneous bodies than any other of our senses. The sight, hearing, smell, and taste, are confined to circumscribed limits; while the touch, distributed on the whole surface, effectually provides for our preservation, by giving us notice of the approach of external bodies, and informing us of their properties. Every thing that is not sound, light, odour, or savour, is appreciated by this sense, as the temperature, consistence, dryness, or moisture, magnitude, distance, &c. of objects. It corrects the errors of sight and the other senses, of which it may indeed be justly termed the regulator; and, above all others, furnishes us with the most certain and exact ideas. Exercise and cultivation bring it to a wonderful degree of perfection, so that in blind persons it may almost be said to supply the loss of sight; in some such instances different colours and their various shades have been distinguished by its assistance.

Although the tangible qualities of bodies can be perceived by every part of the cutaneous organ, it possesses in some situations a more delicate structure, consisting of fine pointed prominences, called papillæ, endued with greater sensibility and vascularity, and thereby constituting in a more especial manner organs of touch. This is the case with the hands. The number of bones that compose these organs render them susceptible of infinitely varied motions, and enable them to explore with accuracy the surfaces of the most unequal bodies. The soft ends of the fingers receive large nerves and arteries, and possess very numerous and prominent papillæ. This finely organized skin is formed into a gently convex protuberance, by an accumulation of a soft fat under it, and it is defended and supported by the nail; and accordingly these pulpy extremities of the fingers are endowed with the most refined sense of touch. The lips and the glans penis have a similar structure, and receive from this organization a very exquisite sensibility, which is a modification of touch.

As the cutaneous papillæ are covered by the epidermis, it follows that the very superficies of the body is insensible. The cuticle and its appendages, the nails and hair, have neither vessels nor nerves, and possess no powers of life or growth in themselves. It forms a medium, moderating the impressions which would be too vivid from an absolute contact of substances; when preternaturally thickened, as in the hand of the labourer, it obstructs sensation; and when entirely removed, as by a blister, the contact of bodies excites pain. It is also important in preventing the action which the atmosphere would otherwise exert in drying the surface of the body; when removed in the dead subject the skin immediately becomes horny, and the same effect extends more or less to the subjacent parts; in the living body its removal is followed by incrustation or scabbing.

The skin is also to be considered as an organ of secretion, and perhaps of absorption. Under the former head we view it as the means of separating and expelling from the body extraneous matters, whose retention would be injurious to the system. This may be proved by eruptive disorders, by the odours of musk, garlic, &c. which affect the perspiration; by the phenomena of sweating, &c. by the injurious effects on the system at large, which a suppression of the cutaneous secretion causes, and the relief experienced by sudorific remedies in various cases.

The secretion from the skin has been divided into the sensible and insensible. An abundant vapour continually exhales from the whole surface, and has the name of insensible transpiration, or perspiration, when it is invisible to the naked eye, and passes off in the state of gas; but it is called sweat, when, becoming more copious, it flows in form of a liquid. The innumerable arteries, which pervade every part of the skin, are the source of these secretions; and their exhaling orifices are supposed to penetrate the cuticle in a state far too minute for any means of research that we possess. If the naked body be placed against a white wall in the sun during the summer season, a shadow produced by the cutaneous exhalation may be perceived; and the following is also a decisive experiment to the same point. Apply the end of the finger near a glass or finely polished metallic instrument, and the body will soon have its surface tarnished by a vapour, which is dissipated when the finger is removed.

A great resemblance exists between the cutaneous and pulmonary secretions; both are simple arterial exhalations, and the mucous membrane of the aerial passages is a continuation of the skin. The two secretions counterbalance each other; and the connection between them is evidenced by the remarkable distress of breathing attendant on extensive burns. There is a similar connection with the mucous exhalation of the intestinal canal; and a still more remarkable one with the kidneys.

The quantity of the insensible perspiration appears by experiments to be very great. Sanctorius, a Venetian physician, who first noticed its importance and extent (whence it has acquired the name of perspirabile sanctorianum) estimated it at five pounds in twenty-four hours, when the solid and liquid food amounts to eight pounds. In temperate climates it may be from two to four pounds daily; but it varies according to numerous circumstances.

The chief bulk of insensible transpiration and of sweat is water; it holds several salts in solution. Carbonic acid gas is also found in considerable quantity; and even according to some experiments, azote and hydrogen. An oily or sebaceous matter is secreted from the skin, to preserve the cuticle in a proper condition of suppleness; hence water is repelled from the naked body, when thrown on it. There are also some volatile and odorous particles furnished from the same source, in which the peculiar smell of individuals and of nations resides.

Sweat seems to be nothing more than an increase of the insensible perspiration produced by augmented action of the cutaneous vessels. Increased temperature and exercise give rise to it; and it furnishes the most powerful means of reducing that augmented temperature, according to the well known frigorific effects of evaporation. Hence the human body has borne a greater heat than that of boiling water, without having its own temperature raised.

Functions of the Brain and Nerves.—The organs of the animal functions, which keep up the connection between the body and the faculties of the mind, and are therefore found only in animated organized bodies, may be conveniently divided into two classes; the sensorium, and the nerves: the latter including the nerves and their origins from the brain; the former comprehending the rest of the cerebral organs, by which the offices of the nerves are connected with the more noble part of our frame, the faculties of the mind; and which may therefore not unaptly be termed the organ of the mind. For the differences which animals present in a comparison of the proportions of these parts, as well as in the size of the brain altogether, &c. see Comparative Anatomy.

The brain, when brought into view by a removal of the cranium, presents a double motion; it rises slightly during expiration, and subsides again when the thorax is dilated. This is explained from the temporary obstruction which the return of the venous blood experiences when the lungs are compressed. But a more conspicuous elevation and depression of the cerebral surface arises from the impulse of blood into the arteries of the head; this motion is therefore perfectly synchronous with the pulse, and may be felt in every infant whose fontanelle is not closed. The quantity of blood received by the brain is very considerable; according to Haller's calculation, between two-thirds and a half of the whole mass of blood that enters the aorta. This blood is circulated through all the minute and numerous arterial ramifications of the pia mater, before it enters the brain, as it should seem, in order to diminish its impulsive force; it rises contrary to its gravity, and its conducting tubes have an angular and tortuous course before they branch out on the pia mater; which circumstances augment the retarding effect. Every thing, on the contrary, facilitates the blood's return, and prevents venous distension.

The vast and wonderfully complicated vascular apparatus of the brain, and the large proportion of blood sent to the organ, naturally lead us to expect, that this part and the heart are closely dependant on each other. If the cerebral arteries be all tied, the animal perishes instantly. The influence of the heart, essential to the preservation of life, does not seem to consist so much in the agitation which the cerebral arteries communicate to its substance, as in the effect which the arterial or oxygenized blood exerts on it. For if venous blood be sent into the head, instantaneous death ensues; and this seems to be the way in which the cessation of respiration, by drowning, hanging, &c. proves fatal.

Nerves, which arise from the brain and spinal marrow, and are the organs conveying the impressions of external objects to those parts, are not found in all structures of the body. The cellular substance, cuticle, rete mucosum, hair and nails; cartilages, bones, teeth, periosteum, and marrow; tendons, aponeuroses, and ligaments; membranes, as the dura mater, pleura, pericardium, peritoneum, &c., the cornea, &c., the absorbent system, the secundines and umbilical chord, are in this predicament. For an account of the disputes which have arisen concerning the sensibility of these parts, see the introductory remarks on sensibility and contractility.

The ultimate points of origin of the nerves from the brain, are hitherto hardly determined; so that it is still questioned, whether or no the right and left nerves decussate. That this is the case in the optics is tolerably clear; and the fact, that injury of one side of the brain causes paralysis of the opposite side of the body, has led to an inference, that the same decussation obtains in all the nerves. The ganglia and plexuses, in which different nerves are united together, probably perform an office analogous to the arterial communications; that of preserving the connection of any part with the brain, when the direct communication is cut off.

Physiologists have endeavoured to trace the termination of nerves in the organs which they supply; but the research is almost too subtle for our imperfect modes of investigation. In some instances, as the optic and auditory, they are manifestly resolved into a soft pulp: and we conjecture, by analogy, that the same mode may obtain in others. There are some obvious differences, which may account for the different mode of affection in the various senses. The retina, which is the expanded end of the optic nerve, is of so delicate pulpy a nature, as to approach to fluidity, and it is acted on only by the rays of light, which are not perceived by any other sense: the auditory nerve, which alone perceives sounds, is rather firmer, &c.

That the mind is very immediately and essentially connected with the brain, and that the animal functions of sensation and voluntary motion, are no less intimately dependant on the same organ, may be proved by such an abundance of physiological and pathological phenomena, that no doubt can be entertained of the fact. An injury of this organ suspends or annihilates the whole, or a part, of the mental operations, and puts an end to all feeling and motion: the organs of the body remain entire, the nerves connecting these with the sensorium are uninjured; but the perceptive faculty is lost. Again, an injury of one side of the brain often causes a loss of feeling and motion in one side only of the body; which, in consequence of principles inexplicable by us, always affect the opposite half to the injury. That the sensible impressions made on our organs are conveyed by the nerves to the brain; and that the latter part is the seat of the sensation, although it is referred by the mind to the part itself; is proved by cutting or tying a nerve: in which case, the usual impression causes no perception. The truth of this assertion, which will hardly meet with credit among the uninformed, is illustrated by what happens to persons whose limbs have been amputated: they are constantly complaining of pains in the toes or fingers of the limbs they have lost. Here the middle of the nerve is irritated, but the pain is referred by the mind to its extremities.

Yet, although the influence of the brain be thus essential, in the business of sensation and voluntary motion, and an unimpaired state of the nerves passing between the organ and the sensorium, be consequently an indispensable condition in those functions, other departments of the animal economy are not so immediately subject to the power of the brain. The processes of digestion, absorption, circulation, secretion, and nutrition, those, in short, which constitute the internal life, still go on, when injuries of the brain have suspended the animal functions: nay, they may survive for months or even years. The ligature of the nerves of a part does not destroy its circulation or nutrition; although these processes may perhaps be impaired. How, then, will it be said, does an injury of the brain so often prove fatal? The individual ought still to live internally, although his external life has been annihilated. But here we notice a function that partakes of both: namely, respiration. The dilatation of the chest can only be performed by means of muscles, whose principle of action comes from the brain: as the injury of the latter organ has paralysed these, the blood can no longer receive those changes which it undergoes in respiration, and thereby becomes unfit to stimulate the heart to action, or to keep up the powers of life in any of the organs of the body.

That the nerves are, as we have described, the medium of connection between the mind and its organs, is clear; but how their offices are performed, is a much more obscure question. It has occupied the attention, and engaged the experiments of physiologists, in all ages; but nature has not hitherto lifted the veil. and the subject remains nearly in its original obscurity. An oscillatory or vibratory motion of the nerves, or a nervous fluid contained in or adhering to these organs, have been assumed in explanation of the facts. According to some, the latter is a liquid contained in tubes; while others liken it to caloric, light, oxygen, the electric, or magnetic fluids. The partisans of the latter opinions consider, that the recent discoveries of galvanism add much weight to their arguments. See GALVANISM.

A supposed central point, to which all sensations are carried, and from which all motions emanate, is called the sensorium commune; and is considered as the seat of the soul. Des Cartes placed this in the pineal gland, others in the corpus callosum, pons Varolii, corpora striata, &c. The learned Soemmerring has lately endeavoured to show, that the seat of the soul must be in the water of the ventricles, as he has succeeded in tracing the origins of all the nerves from the sides of these cavities. The records of morbid anatomy refute many of these opinions, as they show the parts considered as sensoria to have been diseased and destroyed without any impairment of the mental faculties.

The curious and complicated structure

of the brain has led some to suppose, that particular powers resided in certain eminences or depressions of the brain; and this is the foundation of the peculiar notions of Dr. Gall, whose speculations have attracted so much notice. He contends, that the inequalities of the brain's surface are the seat of the mental powers, and of the various proensities, &c. of the human species; and that these are accompanied by corresponding irregularities of the skull, discernible by external inspection. The whole fabric of his speculations is, however, too visionary for serious refutation. See Rees's "Cyclopædia," article Craniology.

The consideration of the various mental powers belongs to the science of metaphysics, and will be pursued under the proper articles.

Sleeping and Watching. Sleep is the repose of the organs of sense, and of the voluntary motions, by means of which the communication of the senses with external objects is interrupted. It is the result of that law, which subjects the actions of the exterior or animal life to periods of intermittence. The most perfect sleep is that in which all the functions of this class are suspended, as the sensations, perception, imagination, memory, judgment, locomotion, and the voice; the least perfect affects only a single organ. Between these extremes, every gradation may occur; and, from the partial suspension of some functions, while others are going on, arise dreams, and the various phenomena of somnambulism. It is, however, the same principle, whether observed in the relaxation that follows the contraction of a voluntary muscle, or in the entire suspension of the animal life.

Watching may be considered as a state of considerable effort and expenditure of the sensitive and moving principle, by the organs of our sensations and motions. This principle would soon have been exhausted, if its reparation were not facilitated by long intervals of rest. Sleep and watching, therefore, call for each other, and are of reciprocal necessity.

Sleep, however, only suspends that portion of life, the design of which is to maintain a commerce with external objects necessary to our existence. The interior, or assimilating, functions are still carried on. Digestion, absorption, circulation, respiration, secretion, and nutrition, are continued: the two former, indeed, seem to be performed with greater energy, while the rest are rather diminished. The pulse is slower, respiration less frequent, perspiration and urinary secretion less abundant.

Numerous causes of excitation constantly acting on our senses during the day, keep them in a state of activity; and the absence of these at night is favourable to the repose of our organs. By multiplying and increasing stimuli, the period of repose may be put off; but these gradually lose their powers, and after a certain time, nothing can hinder its approach. Exhausted by fatigue and watching, the soldier sleeps at the side of the cannon; the slave reposes under the blows of his master; and the criminal sinks to rest amidst the agonies of torture.

Sympathy. All parts of the living body are united by certain relative connections, namely, sympathies, which establish a concord and harmony between the actions of the animal machine. The nature of this phenomenon is still obscure: we know not why, when one part is irritated, another very distant organ should perceive this irritation, and even contract; nor are we agreed on the peculiar instruments of sympathy, that is, on the organs which connect two parts, one of which perceives or acts while the other is affected. That the nerves cannot be considered as the exclusive means of it is obvious; since muscles, supplied from the same source do not always sympathise, while a close intercourse sometimes subsists between parts whose nerves have no immediate connection. Often, also, the sympathy is not reciprocal. Examples of this principle may be seen in the swelling of the breasts from distension of the uterus; itching of the nose from worms in the intestines, and of the glans penis from stone in the bladder; contraction of the diaphragm from irritation of the pituitary membrane; pain in the shoulder from inflamed liver, &c.

The chief, and perhaps most extensive source of sympathy, must be referred to the nerves, and particularly to a reaction of the sensorium. When a part is stimulated, and the sensorium affected by its stimulation, the latter reacts through the nerves on another organ, and incites it to action, although there may be no immediate nervous connection between them. The motion of the iris, arising from the impulse of light on the retina; that of the diaphragm in sneezing, from irritation of the pituitary membrane, are examples.

Other modes of sympathetic connection, without the immediate concurrence of nerves, are pointed out by physiologists: as by blood vessels, in the sympathies of the uterus and breasts; from the anastomoses of the epigastric and internal mammary arteries; by lymphatics; by analogy of the respective functions, as the sympathy of the lungs and common integuments.

Habit, or the reiterated repetition of certain acts or motions, has a powerful influence in the animal economy. But it operates much more decidedly on the animal, or exterior, than on the organic, or interior life. It has the effect of diminishing the sensibility of our organs, as appears from the effect of using pessaries in the vagina, catheters in the urethra, &c. Relative pleasure or pain are brought by the influence of this principle to the state of indifference. Things are agreeable or disagreeable, by a comparison between the impression they make on the senses and the state of mind receiving that impression. Hence the impressions produced on our organs in the cases just mentioned, although at first painful, are soon disregarded. Pleasant sensations are the same. The cook and the perfumer are not alive to the enjoyments which they procure for others. The pleasing emotions connected with the sight and hearing are soon rendered obtuse by repetition; and any pleasure constantly repeated produces the same series of feelings; *viz.* pleasure, indifference, satiety, and even aversion. The mind is the centre of these changes. It institutes a comparison between the actual sensation and the preceding impressions, and in proportion to the difference between these will be the vivacity of the present impression. It belongs, therefore, to the nature of pleasure and pain to destroy themselves, and to cease to exist because they have existed. The art of prolonging the duration of our enjoyments consists in varying their sources.

Habit, however, which deadens sensation, augments and brings to perfection the judgment.

Most of the functions of the organic life are removed from the dominion of habit; *viz.* circulation, respiration, &c.; yet the influence of this principle is unquestionable in some parts of the organic functions, as the urinary secretion, evacuation of feces, hunger and thirst, &c.

Voluntary Motions and Muscular Action. Having already gone over the subject of sensation, one of the offices of the nerves, the other, motion, remains for consideration. The motions of the body have been commonly divided into two classes, the voluntary and involuntary. The action of the heart, stomach, and intestines, &c. exemplifies the latter; while the former are the actions of almost all the other muscles of the body. Some are of a doubtful nature, as those of respiration, of the ossicula auditus, and the cremasters. Different physiologists assign these to one of the above classes, or to a mixed division.

The arrangement is not unexceptionable. There are few functions entirely free from the operation of the will, if we consider the connection of the imagination and passions of the mind with that power: as, on the contrary, many muscular motions, which were originally arbitrary, become by the force of habit quite involuntary. Thus we can hardly bend the little finger without the ring finger; and cannot help winking, if a person brings his finger rapidly towards our eye, although we are certain that he will not strike us. Again, muscles which usually obey the will, refuse obedience under circumstances; hence the difficulty of describing a circle with the hand and foot of the same side in opposite directions, of moving the two hands with an opposite circular motion, &c. Numerous instances might be quoted of the power of the will over motions that are usually involuntary; we shall merely mention the fact, supported by the personal testimonies of Drs. Barnard and Cheyne, of an English officer who could influence the action of his heart and arteries ("Treat. on Nervous Diseases," p. 307.) Perhaps these phenomena may be accounted for by a reaction of the sensorium, excited by a mental stimulus.

We may observe of the voluntary motions in general, that they form the chief character that distinguishes the animal and vegetable kingdoms. No plant has yet been discovered that seeks its food by voluntary motion; nor, on the contrary, is any animal known, that does not either possess a power of locomotion, or at least procure its food by the voluntary motion of some organ or member.

These motions in our own bodies shew the very complete harmony between the mind and the material fabric, as we shall readily admit, when we observe the wonderful celerity with which the fingers of the violin player, or the organs of speech of a person speaking, move, and recollect that an act of volition is necessary for each motion.

The distinguishing characteristic of muscular fibres is their irritability, the quality by which they contract in obedience to the will, or on the application of stimuli. This is an endowment residing in all muscular organs, but not in equal degree. The hollow muscles, which are subservient to the vital functions, hold the first rank; these are followed by the muscles of respiration, and the other voluntary muscles close the enumeration. It is doubted whether the arteries or the large venous trunks be irritable.

The contraction of a muscle consists in a shortening of its fibres, which are marked by transverse rugæ, and feel indurated. But although its length is thus diminished, its circumference is proportionally enlarged. These circumstances produce an approximation of the moveable points to which the muscle is attached, and in this way all the motions of the body are performed.

An uninterrupted supply of blood, and connection with the brain by the nerves, is essential to the voluntary action of muscles: ligature of the arteries or nerves destroys this power. But these organs still retain the faculty of contracting on the application of stimuli, even after the connection with the brain be cut off, and the animal be in other respects dead: this power is the irritabilitas of Haller, the vis insita, or muscularis; which, as that great physiologist and his followers contend, is peculiar to the muscular fibres exclusively. That this property does not depend on the nerves is clear, from the fact of several parts supplied with nerves not possessing it; and from its remaining after the nerves of a part have been divided.

The nerves may perhaps be regarded as the more remote or exciting causes of muscular motion, of which irritability is the proximate or efficient cause. The passions of the mind act on the sensorium, which reacts on the nerves of the heart, and thus heightens the irritability of that organ, exciting palpitation and other irregular motions. The operations of the will on our organs of motion may be explained in the same way.

This distinction of the causes of muscular motion may be supported by the experiments, in which the irritability of the muscles has remained after paralysing a part, by tying or cutting its nerves; and by cases of paralysis, in which sensation has remained in a limb after its power of motion has ceased, or *vice versa.*

As it would be a fruitless labour to enumerate and consider all the hypotheses that have been framed concerning muscular motion, we shall pass over that part of the subject, and refer the reader to the article Galvanism for an account of the effects of that principle on the muscles.

The real power of muscles is immense. In the human body they are generally inserted near the centre of motion, and consequently with a mechanical disadvantage; so that much of their force is expended in overcoming this obstacle. Hence it has been calculated, that the deltoid exerts a force equal to 2568 pounds to surmount a resistance of 50 pounds. The force with which a muscle contracts is in a direct ratio with the number of its fibres; but the degree of its contraction, and consequently the extent of motions that it can effect on the limb, is relative to the length of the fibres. The precise limits of contraction in each fibre cannot be assigned; for though the long muscles of the extremities are supposed to diminish only a third of their length in contraction, the circular fibres of the stomach, which, in the state of extreme dilatation of this organ, from circles of nearly a foot in diameter, can contract to a ring of one inch in circumference.

Our body contains about four hundred and fifty muscles, which, when we consider their wonderful and artificial construction and collocation, and the united advantages of firmness and mobility in the instruments of motion to which they are fixed, bestow on us two endowments of the highest utility and consequence; the greatest agility of the whole body and of individual parts, combined with a wonderful strength and power of enduring continued exertions. Both these prerogatives arise partly from the perfection in the fabric of the muscles themselves; which, as well as the perfect state of the bones and joints, is most conspicuous in the adult stage of life; and partly from exercise and habit, the influence of which in augmenting the extent and celerity of muscular motion is most conspicuous in the feats of the opera and rope dancer, the runner, the boxer, the porter, &c.

Voice and Speech. The voice is a sound resulting from the vibrations which the air suffers during its passage through the glottis, when expelled from the lungs. Speech or articulated voice is produced by this sound, modified by the motions of the tongue, lips, and other parts of the mouth. It is obvious, therefore, that no animals can have a voice, unless they possess lungs.

The larynx is the instrument of the voice, of which the rima glottidis is the immediate organ. Hence, if the trachea be opened below, so as to prevent the air from passing through, the voice is destroyed; while, if the opening be made above, the speech only is destroyed.

It is universally agreed among physiologists, that the air, expelled from the lungs in expiration, striking against the sides of the rima glottidis (chordæ vocales) constitutes the voice. But it is necessary that the opening should be placed in some condition produced by an exertion of the will; for although air is constantly passing to and fro, the voice is not formed unless by an express effort for that purpose; neither is it formed during sleep; nor after the muscles of the arytenoid cartilages have been paralysed by dividing their nerves.

The manner in which the voice is changed from acute to grave, and *vice versa*, has been much disputed: whether it arise from dilatation and contraction of the aperture, or from tension and relaxation of the chordæ vocales. On the former supposition the human larnyx may be compared to a wind instrument, in which the enlargement of the aperture renders the sound grave, and its diminution acute. By the latter explanation it resembles a stringed instrument. After considering the arguments on both sides, we should be inclined to admit the operation of both causes. The change of the voice from acute to grave at the time of puberty, when the larynx undergoes a remarkable developement, as well as its acuteness in females, whose glottis is less by one-third than that of man, shew that the size of the aperture has a great influence Observing on the other hand that the vocal chords admit of considerable tension and relaxation, we must allow that these variations will render them susceptible of executing, in a given time, vibrations more or less extensive and rapid. And although they are neither dry, stretched, nor isolated, which are necessary conditions to the production of sound in those stringed instruments to which the larynx has been compared, yet they are analogous to vibrating bodies placed at the top of wind instruments, as the reed in hautboys, the mouth-piece in flutes, &c. and equally contribute to the formation and varied inflexions of vocal sound. That all the changes and conditions of the vocal organs, of whatever description, necessary to the production and modification of sounds, are produced by the muscles of the part, is rendered obvious by the elegant experiment, in which the ligature or section of one or both recurrent nerves, or paria vaga, either signally impairs, or entirely destroys, the vocal powers of the animal.

The modifications of the voice are also affected by the length of the trachea; hence the larynx is manifestly drawn up in the neck, in the utterance of acute sounds, and as plainly descends when a grave sound is produced. In singing, where these effects take place in a greater degree, the head is thrown back upon the neck in the former case, and brought forwards on the chest in the latter.

The voice is stronger in proportion to the capacity of the thorax; hence it is weaker after meals, when the stomach, distended by food, prevents the descent of the diaphragm, and in consumptive persons, where the capacity of the lungs is diminished by disease. It acquires more force and intensity, and becomes more sonorous, by its reflections in the mouth and nasal canals. Hence it is disagreeably altered when its passage in this direction is stopped by disease, as by polypus, and it is then commonly, but quite erroneously, said, that persons speak through the nose.

Whistling, which is common to man with singing-birds, is produced in the latter by their double larynx; but in the former it is effected by a contraction and corrugation of the lips, in imitation of the effect produced by birds.

In singing, the voice runs through the different degrees of the harmonic scale with more or less rapidity, changing from acute to grave, and *vice versa*, with an expression of the intermediate notes. It requires much more exertion than speech. The glottis enlarges and contracts, the larynx is elevated or depressed, the neck elongated or shortened, inspirations are accelerated, prolonged or retarded; expirations are long, or short and abrupt. The power of singing is peculiar to man, and forms the great prerogative of his vocal organs. Whistling is common also to birds; which are often taught to pronounce words without any great difficulty. On the other hand, parrots are said, in two or three instances, to have been taught, by vast labour, to produce a kind of imitation of singing; but no barbarous tribe has been hitherto met with, which has not been accustomed to employ singing as the natural expression of their feelings and passions.

Speech is a peculiar modification of the voice, formed during the expulsion of the air from the chest, chiefly by means of the tongue, which is applied to the neighbouring parts, as the palate and teeth, assisted by the various motions of the lips. A voice is common to brutes with man; it exists already in the newly born child, and has not been entirely wanting in those miserable children, who have grown up in a solitary and savage state, or who have been born dumb. Speech results from the enjoyment and cultivation of reason, and is, therefore, like that endowment, a peculiar and distinguishing gift bestowed on man alone. Instinct is sufficient for the purposes of brutes; but man, who does not possess this, or several other assistances, in supporting and defending himself by his own powers, has received the endowments of reason and speech. These have brought him into the social state, which seems to be his natural destination, in which they enable him to utter his ideas and impart his desires to others.

Articulated sounds are represented by letters that express all their power; and it will be readily admitted that man made a great step towards perfection, when he invented these signs, adapted to preserve and transmit his thoughts.—Sounds are expressed by the letters called vowels, which are letters produced by the mere passage of the voice through the mouth, requiring only a greater or less aperture of the mouth. Hence these are the first that the child utters. The consonants, which form the most numerous class of the alphabet, serve to connect the vowels, and are formed by a much more artificial process. These are classed into labial, nasal, oral, and lingual, according to the parts more particularly employed in their pronunciation.

Stammering is a corruption of pronunciation, arising from various causes. A tongue too large and thick, diminished power over its actions, as in drunkenness, and unusual length of the frenum, belong to this class. Yet sometimes the deficiency does not seem organic; at least, a person who stammers will pronounce perfectly if he speaks slowly; and it may even be entirely overcome by practice and instruction.

Similar causes give rise to lisping.—Want of the front teeth will have this effect.

Dumbness may be accidental, or may subsist from birth. In the former case, it arises from organic injury, which affects the mechanism of the parts. In dumbness from birth, deafness seems to be always the cause; so that the absence of speech should here rather be called silence. This, at least, is constantly the case, according to the observation of Sicard, on the numerous pupils committed to his care. Here there is an absolute ignorance of sounds, and of their representative value in letters of the alphabet. The vocal organs exhibit no marks of deficiency; they are fit, in short, to fulfil the uses for which nature has destined them, but they remain in a state of inaction, because the deaf infant is not conscious that he has the means of communicating his thoughts.

Perhaps the mechanism of *Ventriloquism* is not yet understood. The following quotation from Richerand's Physiology will be sufficient to give the reader an idea of the subject.

"At first I had conjectured that a great portion of the air expelled by expiration did not pass out by the mouth and nostrils, but was swallowed and carried into the stomach, reflected in some part of the digestive canal, and gave rise to a real echo; but after having attentively observed this curious phenomenon, in Mr. Fitz-James, who represents it in its greatest perfection, I was enabled to convince myself that the name ventriloquism is by no means applicable, since the whole of its mechanism consits in a slow, gradual expiration, drawn in such a way that the artist either makes use of the influence exerted by volition over the muscles of the parietes of the thorax, or that he keeps the epiglottis down by the base of the tongue, the apex of which is not carried beyond the dental arches.

"He always makes a strong inspiration just before this long expiration, and thus conveys a considerable mass of air into the lungs, the exit of which he afterwards manages with such address. Therefore repletion of the stomach greatly incommodes the talent of Mr. Fitz-James, by preventing the diaphragm from descending sufficiently to admit of a dilatation of the thorax, in proportion to the quantity of air that the lungs should receive. By accelerating or retarding the exit of the air, he can imitate different voices, and induce his auditors to a belief that the interlocutors of a dialogue, which is kept up by himself alone, are placed at different distances; and this illusion is the more complete in proportion to the perfection of his peculiar talent. No man possesses, to such a degree as Mr. Fitz-James, the art of deceiving persons who are least liable to delusion: he can carry his execution to five or six different tones, pass rapidly from one to another, as he does when representing an animated dispute in the midst of a popular assembly."

On the subject of the *Generative Functions*, we have very little to add to what the reader will find under the articles Anatomy, Comparative Anatomy, and Fœtus.

The bodies of the male and female present very obvious differences in appearance and character, which have been ascribed to the influence of the generative organs upon the constitution. The removal of the testes in the male, prevents those changes in the beard and voice, at the time of puberty, which would otherwise occur: and eunuchs even approach in other respects to the female character, as in the breadth and projection of the hips. Again, in some remarkable cases, where the organs of the female have been wanting, or malformed, similar effects have taken place in the constitution; so that there is some reason for saying with Van Helmont, *propter solum uterum mulier est, id quod est.*

Hermaphrodism, or the union of both sexes in the same individual, is impossible in man and the warm-blooded animals. All the supposed hermaphrodites hitherto examined were mal-formed beings, whose male organs were imperfect, or the female apparatus too prominent, so as to render the sex doubtful. No one has shown himself capable of impregnating his own person, so as to produce a being like himself; indeed, in most instances they were incapable of assisting in reproduction, as an imperfection of the organs employed for that purpose condemned them to sterility.

Man presents a peculiarity, in not being subject to the influence of the seasons in the exercise of his generative functions; while other animals cohabit at fixed periods and certain times of the year, and afterwards seem to forget the pleasures of love to satisfy other wants.

Conception. Physiologists have not hitherto succeeded in explaining the mechanism of that elongated and distended state of the penis, occurring under the irritation of the sexual passion, which adapts the organ to the performance of its natural functions. The obvious circumstances are, that the cells of the corpus spongiosum urethræ, and corpora cavernosa penis, are distended to the utmost with blood, poured into them from the arteries much faster than it can be, or at least is returned by the veins. The irritation, which affects the penis, extends to the internal parts. The secretion of the testes becomes more active, and these bodies are drawn up towards the abdomen; the vesiculæ seminales, and the ducts of the prostate, also pour out their contents into the urethra. The semen is a mixed fluid, derived from the three sources just mentioned; but the smallest part probably comes from the testes. The most remarkable circumstance in this fluid is, that it contains numerous microscopic animalcula, with a round head and slender tail, moving about with rapidity.

This prolific liquor is expelled from the penis by a spasmodic action of the accelerator urinæ muscle: the whole body seems to participate in the same convulsive state, and the instant of ejaculation is marked by an orgasm through every part. It seems that nature has forgotten, for the moment, every other function, and is totally occupied in collecting her powers, and directing them towards the same point. Hence an universal languor follows this general convulsion, and hence the old observation, *omne animal post coitum triste.*

The seminal liquor, thus propelled into the generative organs of the female, is supposed to pass through the uterus and fallopian tubes, and to come into actual contact with the ovaria. The closeness of the mouth, and indeed of the whole cavity of the uterus, together with the very small calibre of the fallopian tube, especially at its origin in the uterus, (where it will only admit a bristle) are difficulties in the way of this explanation, which have led to the opinion, that the semen itself does not penetrate into the uterus, but that an exhalation, or *aura seminalis,* comes into contact with the germs, and is sufficient for their fecundation. This is opposed by the experiments of Spallanzani and others, in which the ova of frogs were readily impregnated by contact of the seminal fluid, but were not at all affected by the vapour or aura.

The attachment of the fimbriæ of the tube to the ovarium, which experiment has shown to occur during coition, establishes an uninterrupted canal from the uterus to the ovarium, and prevents the semen from becoming diffused in the abdomen.

The germ of the future being preexists in the ovarium, where it is formed by a peculiar action of the part, in short, by a true secretion. This germ, in its original state, is a small vesicle of fluid, first noticed by De Graaf, whence the term of ovula Graafiana, applied to their appearance in the virgin ovary. Here we do not mean to countenance those doctrines of evolution which suppose, that generation only developes germs that have existed from the beginning of the world. We suppose, that the ova produced by the elaboration of blood, carried to the ovaria by the spermatic vessels, contain the rudiments of the new beings. But the germs in that state are inert, and require that the seminal spirit should be employed to rouse them from their inactivity. In birds and reptiles the formation of the germ by the female is incontestible; it is not quite so obvious in the class of mammalia; but we infer it here from analogy, and also from the experiment of Mr. Hunter, in which the removal of one ovarium from a sow, diminished in a remarkable degree the number of young produced.

Fœtal Existence. This is purely vegetative. The fœtus receives the fluids brought by the vessels of the mother to the placenta for its growth and nourishment. It may be considered as a new organ, the produce of conception, participating in the general life, but possessing a vitality peculiar to itself, and, to a certain degree, independent of that of the mother. To say that it is asleep is erroneous; for not only are the organs of sense and voluntary motion in a state of perfect repose, but also several of the assimilating functions are totally unemployed, as digestion, respiration, and the generality of the secretions. The fœtus, however, performs spontaneous motions, which accoucheurs enumerate among the signs of pregnancy. It is nourished, like every other organ, by appropriating to itself whatever is found in the blood, brought by the vessels of the uterus proper for its purpose; and the interception of this fluid by the ligature, or compression of the umbilical chord, occasions death.

Suckling. The close sympathy between the uterus and breasts is so obvious, as to attract the notice of every observer. Both these organs are developed at the same period of life, and cease together to perform their functions, when the female becomes incapable of contributing towards the continuation of the species. The breasts increase in size during pregnancy, but are never more swelled than after parturition. The infant applies its mouth to the nipple, and sucks; *i. e.* forms a vacuum by inspiring, in consequence of which the atmospheric pressure forces the milk through the lactiferous tubes into its mouth. The nipple experiences a vascular turgescence, or kind of erection; which also affects the excretory tubes of the mammary gland, so as to cause them sometimes to expel the fluid to some distance by jets. The structure of the breast is explained under the article MAMMARY GLAND, and the composition of their secretion under MILK.

Ages, Temperaments, &c. Having thus gone through the animal economy, according to its distribution into particular functions, we shall just contemplate man in a general view, passing through the whole course of his existence, and note the principal epochas of his life, from its commencement to the termination in death.

The first perceptible traces of the fœtus occur about three months after conception. It is then animated by a very slight kind of vegetable life, and possesses true blood, and motion of the heart, about the fourth week. The latter, as observed in the chicken, has been named, from the time of Aristotle, *punctum saliens.* The formation of the bones commences about the seventh or eighth week. The earthy particles are first deposited in nuclei in the clavicles, ribs, vertebræ, larger cylindrical bones of the extremities, lower jaw, and face: a very delicate network is also seen in some of the bones of the cranium.

As a general observation, it may be affirmed, that the growth of the embryo, as well as of the child, both before and after birth, is more rapid in proportion as it is younger.

About the middle of pregnancy, the operation of some vital functions is discerned: the secretion of fat and bile commences. At a more advanced period of utero-gestation, the scalp is covered with a short and delicate hair; the nails are formed; the membrana pupillaris destroyed; the external ear becomes firmer and more elastic; and the testes descend.

Besides the important changes in the whole economy which follow parturition, there are certain alterations in the external habit of the body. The down which covers the face at birth disappears; the rugæ of the skin are obliterated; the anus becomes hidden between the buttocks, which are now gradually formed.

The infant gradually brings into action the faculties of the mind. It perceives and attends to external objects, remembers, desires, &c. It smiles in the second month, and seems to dream at no great length of time after birth. The organs of sense become more complete in their formation. The bones of the skull become stronger, and the fontanells are diminished. Dentition commences about the eighth month. The infant may then be weaned, as his teeth enable him to commence the use of more solid food. About the end of the first year he learns to stand on his feet, and to assume the erect posture, that most distinguishing attribute of the human body.

When it has now been removed from the breast, and learned the use of the lower limbs, its powers and independence increase daily, and receive a vast accession from the developement of another peculiar privilege of the human subject, the enjoyment of speech; by which the tongue, under the direction of the mind, pronounces those ideas which are now become familiar.

At the seventh year the twenty milk teeth begin to fall out, and are succeeded in a gradual progress during the following years by the thirty-two permanent teeth. At this time the memory excels all the other faculties of the mind; whereas about the fifteenth year the powers of imagination begin to prevail. This is the time of puberty, in which the human subject is gradually prepared, by various important changes, for the exercise of the sexual functions. The breasts enlarge in the female, the chin becomes covered with hair in the male, and other similar signs of puberty are noticed in both sexes. The menstrual discharge commences in the softer sex; and this important era in the economy of the female is marked by an increased expression in the eyes, and redness of the lips, and more manifest sensible qualities in the matter of perspiration. The seminal secretion becomes active in the male, attended with an increase of the beard, and a deepening of the voice consequent on a remarkable developement of the larynx. The internal and spontaneous calls of nature now rouse the sexual instinct, for the exertion of which both sexes are prepared.

No definite and precise period can be assigned for the changes which constitute puberty: it varies according to climate and temperament. It is more early in the female than in the male; but in this climate girls may be said to attain it at the age of fourteen or fifteen, and men at seventeen or eighteen. Soon after these periods the growth of the body is completed; the stature of which varies much in different races, not to mention its varieties in individuals and families. The epiphyses, which have hitherto been distinct from the body of the bone, are now completely consolidated with it.

Virility, Manhood, or *Adult Age*, begins from the twenty-first to the twenty-fifth year. If the increase of the body in height have ceased at this time, it grows in other dimensions. The organs become firm and consistent; their functions are performed with vigour; the intellectual and moral faculties are perfected; and the dominion of the judgment succeeds that of the imagination. This period, which is called that of mature age, extends to the fiftieth or fifty-fifth year in men, but not much beyond the forty-fifth in women, in whom it begins earlier. During this long interval men enjoy all the plenitude of their existence.

Temperaments. As the characters of the human species are now fixed with stability, we may sketch the differences which mark individuals. Health, in the explanation of which all physiology is concerned, consists in such a harmony and equilibrium of the material fabric of the body, and of its animating powers, as is necessary for the performance of the various functions. It requires, therefore, fluids rightly prepared; solids duly formed from these; the latter thoroughly animated by their vital powers; and, lastly, a sound mind in this healthy body. These four principles are constantly acting and re-acting in the human body. The fluids act as stimuli on the solids; which possess vital powers, enabling them to receive those stimuli, and to re-act. The connection of the mind and body is not discerned merely in the influence of the will, in what physiologists call voluntary actions; since the affections of the body clearly act on the mind in many other ways than through the medium of sensual perceptions. The infinitely varied modifications, which the four principles admit of, show immediately with what latitude our notions concerning health should be formed. Hence arises the distinction of temperaments; that is, the different manner in which the living solid is affected by stimuli, particularly of the mental class, the different aptitude for such impressions, and the greater or less facility with which these stimuli may themselves be excited. There is such great variety of degrees and combinations of temperaments, that a wide field is open for those who wish to employ themselves in dividing and arranging them. The common division is sufficient for our purpose; it comprehends the sanguineous, which is very easily but slightly affected by stimuli; the choleric, which is easily and strongly excited; the melancholic, which is slowly but deeply moved; and the phlegmatic, which is the slowest of all in admitting the impressions of exciting causes. Together with these distinctions, there are numerous differences of bodily formation, of diversity in the proportion and connection of parts, as well as in the energy relative to certain organs, accompanying each temperament, which cannot be particularized here, without entering too much into detail.

Each individual has a particular manner of being, which distinguishes his temperament from that of every other, to which, notwithstanding, it may bear a very strong resemblance. These individual temperaments, the knowledge of which is of no small importance in the practice of physic, are called idio-syncrasies.

There are many both predisposing and occasional causes, which have an operation in producing this diversity of temperaments: as hereditary disposition, habit of body, climate, diet, religion, culture, luxury, &c.

For the account of the various races of mankind, see the article MAN.

Advanced Age and Decay. Cessation of the menses in women, which is occasionally accompanied by the production of a beard; an indisposition to venery in the male sex; and, in both, a peculiar dryness, and sensible decrease in the vital powers, are the signs of approaching old age. The body now diminishes, and loses the power it had acquired; the decrease following the same progression as the growth, and occupying about the same space of time, when no accident hastens the approach of death. The whole volume of the body diminishes, the skin wrinkles, particularly in the forehead and face; the hair turns grey, and organic action becomes languid.

The decay of the body is evidenced by an increasing dulness both of the external and internal senses, necessity of longer sleep, and general torpor of all the functions. The hair grows white, and falls off, the teeth drop from their sockets, the cartilages ossify, all the organs become hard, and the fibres more dry and contracted. The head is no longer supported by the neck, nor can the legs sustain the trunk; nay, the bones themselves, the foundations of the machine, partake of the general decay. On these phenomena we may observe, that the animal or exterior life ceases first, the senses fail in succession, and then the functions of the brain cease. The cessation of the locomotive and vocal powers follows as a necessary consequence. Here, then, the old man is dead to all surrounding objects, but his organic life still subsists; so that this state is analogous to that of uterine existence, where the life is nearly of the vegetable kind. Thus, the body gradually dies, life is extinguished by successive shades, and death is only the last term in this succession of degrees. We arrive now at the conclusion of physiology; *death without disease*; which is the object of all medicine, and the causes of which are necessary and inevitable. It is no more possible for us to avert the fatal term, than to change the laws of nature.

The phenomena of death consist in a coldness of the extremities, gradually mounting to the trunk; dimness of the eye; feeble, slow, and irregular pulse; respiration performed at longer intervals, and terminated at last by a strong expiration. In experiments on animals, a struggle is observed about the heart, and the right ventricle and auricle are found to survive the opposite cavities for a short time. That death has taken place is shown by coldness of the body, combined with rigidity; flaccidity of the cornea, relaxed state of the anus, lividity of the back, and a certain cadaverous odour. When all these circumstances are combined, there will scarcely be any opportunity for remarking the uncertainty of the signs of death.

Although the weakness of the thread

of life in its early stages, the intemperance of manhood, the power of disease and of accident, exert such destructive effects on the human race, that out of one thousand children born into the world, not more than seventy-eight die as we have now described, without disease; yet on comparing the longevity of man with that of other mammalia, under nearly similar circumstances, we shall be immediately convinced, that, of all the querulous declamations concerning the wretchedness of human life, none is more unjust than the complaint of its shortness.

Putrefaction. As soon as life abandons the organs, they become totally influenced by physical laws; and their component parts have a tendency to separate from each other; which is stronger in proportion to the multiplicity of their elements. The entire cessation of life is necessary to this change, for life and putrefaction are two ideas absolutely contradictory of each other. A mild temperature, humidity, and the presence of air, are necessary to putrefaction. Icy coldness, or great heat, prevent it: the former by condensing the parts, the latter by depriving them of moisture. Air is not essential, as bodies will decay in vacuo.

All animal substances exhale at first a musty or cadaverous odour, soften, increase in size, become heated, change their colour, turn green, blue, and, lastly, a blackish brown. Several gaseous matters are at the same time disengaged, among which the ammoniacal is the principal, both on account of its quantity, and because animal matter begins to furnish it, from the instant its alteration commences to the period of its complete dissolution. Carbonic acid gas is also disengaged, and forms with the ammoniacal air a fixed salt. Hydrogen, united with phosphorus, sulphur, azote, and carbon, and all things that can result from their respective combinations, are likewise produced.

Putrefaction, considered in a philosophical point of view, is only the method employed by nature to return our organs, that are deprived of life, to a more simple composition, in order that their elements may be employed for new creations. (*Circulus æterni motus.*) Nothing is, therefore, better proved than the metempsychosis of matter; whence we may conclude, that this doctrine, like most of the tenets and fabulous conceptions of antiquity, is only a mysterious veil, dextrously interposed between nature and the vulgar by the hand of philosophy.

PHYSSOPHORA, in natural history, a genus of the Vermes Mollusca class and order. Generic character: body gelatinous, pendant from the aerial vesicle, with gelatinous sessile members at the sides, and numerous tentacula beneath. There are three species, viz. the hydrostatica, which is of an oval shape; the rosacea, which is orbicular; and the filiformes, which is lateral, filiform, and pendent.—This genus is nearly allied to the MEDUSA tribe, which see.

PHYTEUMA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Campanaceæ. Campanulaceæ, Jussieu. Essential character: corolla wheel-shaped, with linear segments, five-parted; stigma bifid or trifid; capsule two or three-celled, inferior. There are sixteen species. The European sorts of phyteuma have the flowers in a close terminating head; those from the East have them scattered; in all there is a little bracte to each flower. They are all natives of the South of Europe.

PHYTOLACCA, in botany, a genus of the Decandria Decagynia class and order. Natural order of Miscellaneæ. Atriplices, Jussieu. Essential character: calyx none; petals five, calycine; berry superior, ten-celled, ten-seeded. There are six species.

PHYTOLOGY, a discourse concerning the kinds and virtues of plants.

PHYTOTOMA, the *plant-cutter*, in natural history, a genus of birds of the order Passeres. Generic character: bill conic, straight, and serrated on the edges; nostrils oval; tongue obtuse and short. There are two species.

P. rara, or the plant-cutter of Chili, inhabits that country in great plenty, and is about the size of a quail, and feeds on vegetables. These birds take considerable pains to saw off the vegetable as near as possible to the ground, and are extremely injurious in the cultivated lands of the districts which it frequents, and are consequently particularly disliked by the inhabitants. They build in high trees and sequestered situations. They are distinguished by having four toes, from the following species, which has only three: P. tridactyla, the Abyssinian plant-cutter. This is of the size of a gros-beak, delights in solitude, and abounds in the wilds of Abyssinia, where it subsists much on the kernels of the almond, breaking the shell with particular ease and dexterity.

PICÆ, in natural history, the second

order of the class Aves in the Linnæan system. They are characterized by a sharp-edged bill, convex above; legs short, strong; feet formed for walking, perching, or climbing; body toughish, impure. They feed on various filthy substances. They build their nests in trees; the male feeds the female while she is sitting; they live in pairs. There are twenty-six genera, divided into sections.

A. Feet formed for perching, containing:

Buphaga	Oriolus
Certhia	Paradisea
Coracias	Sitta
Corvus	Trochilus
Glaucopis	Upupa
Gracula	

B. Feet formed for climbing, containing:

Bucco	Psittacus
Crotophaga	Rhamphastos
Cuculus	Scythrops
Galbula	Trogon
Picus	Yunx

C. Feet formed for walking, containing:

Alcedo	Momotus
Buceros	Todus
Merops	

PICKET, PICQUET, or PIQUET, in fortification, a painted staff shod with iron; used in marking out the angles and principal parts of a fortification, when the engineer is tracing out a plan upon the ground. There are, also, larger pickets, or painted stakes, which are driven into the earth, to hold together fascines or faggots, in any work cast up in haste.—Pickets are likewise the stakes driven into the ground near the tents of the horsemen in a camp, to tie their horses to; and before the tents of the foot, where they rest their musquets or picks about them in a ring. The same name is also given to the stakes with notches towards the top, to which are fastened the cordages of tents: thus, to plant the picket is to encamp. When a horseman has committed any considerable offence, he is sometimes sentenced to stand upon the picket, which is to have one hand and the opposite foot tied together, and being drawn up from the ground by the other hand, he is obliged to stand with one foot on the point of a picket or stake, so that he can neither stand nor hang without great pain, nor ease himself by changing feet.

PICQUET, a celebrated game at cards played between two persons, with only thirty-two cards; all the deuces, threes, fours, fives, and sixes, being set aside.

In playing at this game twelve cards are dealt to each, and the rest laid on the table: when, if one of the gamesters find he has not a court card in his hand, he is to declare that he has *carte blanche*, and tell how many cards he will lay out, and desire the other to discard, that he may show his game, and satisfy his antagonist, that the *carte blanche* is real; for which he reckons ten. And here the eldest hand may take in three, four, or five, discarding as many of his own for them, after which the other may take in all the remainder, if he pleases. After discarding, the eldest hand examines what suit he has most cards of; and, reckoning how many points he has in that suit, if the other has not so many in that, or any other suit, he reckons one for every ten in that suit, and he who thus reckons most is said to win the point. It is to be observed, that in thus reckoning the cards, every card goes for the number it bears; as a ten for ten; only all court cards go for ten, and the ace for eleven, and the usual game is one hundred up. The point being over, each examines what sequences he has of the same suit, viz. how many tierces, or sequences of three cards; quartes, or sequences of four cards; quintes, or sequences of five cards, &c. he has. These several sequences are distinguished in dignity by the cards they begin from: thus ace, king, and queen, are stiled tierce major; king, queen, and knave, tierce to a king; knave, ten, nine, tierce to a knave; and the best tierce, quarte, or quinte, prevails, so as to make all the others in that hand good, and to destroy all those in the other hand. In like manner, a quarte in one hand sets aside a tierce in the other.

The sequences over, they proceed to examine how many aces, kings, queens, knaves, and tens, each holds; reckoning for every three of any sort, three; but here, too, as in sequences, he that with the same number of threes or fours, has one that is higher than any the other has, makes his own good, and sets aside all his adversary's; but four of any sort, which is called a quatorze, because fourteen are reckoned for it, always set aside three.

The game in hand being thus reckoned, the eldest proceeds to play, reckoning one for every card he plays above nine, while the other follows him in the suit: but unless a card be won by one above nine, except it be the last trick, nothing is reckoned for it. The cards being played out, he that has most tricks reckons ten for winning the cards: but if they have tricks alike, neither reckons any thing.—If one of them wins all the tricks, instead of ten, which is his right for winning the cards, he reckons forty, and this is called capot.

The deal being finished, each person sets up his game; they then proceed to deal again as before; cutting afresh each time for the deal: if both parties are within a few points of being up, the carte blanche is the first that reckons, then the point, then the sequences, then the quatorzes, then the tierces, and then the tenth cards. He that can reckon thirty in hand by carte blanche, points, quintes, &c without playing, before the other has reckoned any thing, reckons ninety for them, and this is called a repike; and if he reckons above thirty, he reckons so many above ninety. If he can make up thirty, part in hand, and part in play, before the other has told any thing, he reckons for them sixty; and this is called a pique, whence the name of the game. Mr. de. Moivre, in his doctrine of chances, has resolved, among others, the following problems: 1. To find, at picquet, the probability which the dealer has for taking one ace or more in three cards, he having none in his hands. He concludes from his computation, that it is 29 to 28 that the dealer takes one ace, or more. 2. To find at picquet the probability which the eldest has of taking an ace or more in five cards, he having no ace in his hand. Answer; 232 to 91, or 5 to 3, nearly. 3. To find at picquet the probability which the eldest has of taking both an ace and a king in five cards, he having none in his hand. Answer; the odds against the eldest hand taking an ace and a king are 331 to 315, or 21 to 20 nearly. 4. To find at picquet the probability of having twelve cards dealt to, without king, queen, or knave; which case is commonly called cartes blanches. Answer; the odds against cartes blanches are 323 to 578, 956, or 1791 to 1 nearly. 5. To find how many different sets, essentially different from one another, one may have at picquet before taking in. Answer, 28,967,278. This number falls short of the sum of all the distinct combinations, whereby twelve cards may be taken out of 32, this number being 225,792,840; but it ought to be considered, that in that number several sets of the same import, but differing in suit might be taken, which would not introduce an essential difference among the sets.

PICRAMNIA, in botany, a genus of the Dioecia Pentandria class and order. Essential character: calyx three or five-parted; corolla three or five-petalled; berry two-celled. There are two species, *viz.* P. antidesma and P. pentandra, both natives of Jamaica.

PICRIS, in botany, *ox-tongue,* a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx calycled; receptacle naked; seed transversely grooved; down-feathered. There are six species.

PICRUM, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rotaceæ. Gentianæ, Jussieu. Essential character: calyx four or five cleft; corolla one-petalled, four or five cleft; nectary of four or five scales; stigma bilamellate; capsule half two celled, two valved. There are two species, *viz.* P. spicatum and P. ramosum.

PICTS *wall,* in antiquity, a wall begun by the Emperor Adrian, on the northern bounds of England, to prevent the incursions of the Picts and Scots. It was first made only of turf, strengthened with palisadoes, till the Emperor Severus coming in person into Britain built it with solid stone. This wall, part of which still remains, begun at the entrance of Solway Frith in Cumberland, and running N. E. extended to the German ocean.

PICUS, the *wood-pecker,* in natural history, a genus of birds of the order Picæ. Generic character: bill straight, strong, angular, and wedge-formed at the tip nostrils covered with bristly feathers, reflected downwards; tongue long, slender, cylindric, bony, jagged at the end, and missile; tail of ten feathers, stiff and sharp-pointed. These birds live principally upon insects, to obtain which they climb trees, and are perpetually in search of those crevices in which their food is lodged. These insects they transfix with their missile and daggered tongue, which, when it has obtained its purpose, is by an almost invisible motion withdrawn wholly into the mouth. This process is incessantly repeated throughout the day, with inconceivable precision and celerity. Doomed to this perpetual occupation, wood-peckers avoid society, even of their own species, and appear to possess none of the animation of cheerfulness or vigour of courage. They have no notes but such as are expressive of pain and sadness. There are fifty species. P. martius, or the greatest black wood-pecker, abounds in Germany, and builds in ash and poplar trees, which they are said to excavate speedily, so as to expose them to be blown down by winds which would not otherwise have effected them; under the hole made by these birds may be often found several pecks of dust and pieces of wood. They are of the size of a jack-daw.

P. viridis, or the green wood-pecker, is the largest species in Great Britain, and is thirteen inches long. These birds are more frequently seen on the ground than the other species, particularly where ant-hills abound, the population of which they almost extirpate by their incessant efforts. Occasionally this bird is not content with darting its tongue at them single, but by the combined exertion of its bill and feet lays open the whole nest, and commits the most wholesale ravage upon both the ants and their eggs.

P. major, or the witwall, is nine inches long, and strikes with far greater comparative force against the trees than any other of the European species. It creeps with facility over the branches in every direction, and when any person attempts to observe it on one side of a branch passes to the opposite with extreme celerity, repeating this change in correspondence with every renewed effort of the enemy. For the greater spotted wood-pecker, see Aves, Plate XII. fig. 3.

Ten species of this interesting genus have been enumerated as inhabitants of the United States, of which the

P. principalis, or Ivory-billed Woodpecker, is the largest of the whole tribe hitherto discovered, being twenty inches long, and thirty inches in extent. Black, bill ivory white, crest brilliant red, black before; a white line originates near the angles of the mouth on each side, passes down each side of the neck and over the back, terminating near the rump; secondary feathers of the wings white. This disposition of colours gives to the bird a white backed appearance when at rest; neck long; tail long, cuneiform, the feathers of which it is composed are remarkably concave beneath The female is destitute of the brilliant red of the crest, but in this part is wholly black. They feed principally on the larvæ of different species of coleoptera, such as *Passalus cornutus*, &c. This species is very seldom seen north of Carolina, but his range extends, in a southern direction, far beyond the boundaries of the United States. —The skins of several different kinds of birds are worn by some of our tribes of Indians, either to decorate their persons, as symbols of office, or as amulets or charms. By way of ornament the skin of this bird, particularly of the head with its bill and the neck, are worn and highly valued by some of our southern Indians.

P. pileatus, Pileated Woodpecker, Black Wood-cock, or Log-cock, as he is called in different parts of the country, stands next to the preceding species in point of size. Length eighteen inches; width twenty-eight: colour blackish-brown; crest entirely of a brilliant red; a red dash at the angles of the mouth; bill black; chin and feathers of the nostrils white; this colour passes in a stripe down the side of the neck and spreads under the wings; upper half of the wings white, concealed when at rest by the black coverts; tail rather long, tapering; feathers convex above and strong. The female is distinguished from the male by having the front of the head of a light brown colour, and the dash behind the angle of the mouth is dusky.

This noble bird appears to be a general inhabitant of North America, at least as far north as Canada; his residence being in the interior of large forests, he is rarely seen near our large towns on the sea board, around which the forests have been felled or much thinned; makes a loud cackling noise before rain, and then seems to fly about with unusual impatience and restlessness.

P. auratus. Golden winged Woodpecker, Flicker, High-hole, Hittock, &c. is a very common and beautiful species, found in almost all parts of the United States, and ranges very far to the north; he is partially migratory, but may be found in our markets every month in the year. Colour of the back and wings above dark umber, marked regularly and transversely with streaks of black; cheeks, chin and neck, cinnamon colour; head above, and superior part of the neck, iron grey, hind head marked with a sanguineous lunate spot, the angles pointing towards the eyes, an abbreviated stripe on each side of the throat arising near the base of the lower jaw, and a large deep black lunule on the breast, belly and vent white, a little yellowish, and marked with very numerous rounded spots of black; shafts of the feathers golden yellow; rump and tail coverts white, the latter curiously serrated with black; tail beneath yellow, tip and all above black. The female is destitute of the abbreviated stripes of the throat;

length twelve inches, extent twenty inches. They build their nest in the hollow of an old tree, which they have been instrumental in forming. The female lays six white nearly transparent eggs in April. Their food is not confined to the larvæ of insects, but they delight in several kinds of fruits, as cherries, gumberries, grapes, and, perhaps, sometimes a little Indian corn when in its milky or unripe state, but the food on which his principal reliance seems to be placed is the Wood louse (Oniscus. Lin.) and the pupa and young of ants, &c.

P. erythrocephalus, or Red-headed Wood-pecker, is one of the most common of our birds, and is well known by his appearance to almost every individual in the United States, or even in North America, from the conspicuous colours with which he is decorated, as well as by his constant recurrence, wherever there are old trees to attract his attention, for the larvæ of insects they contain, and also from his peculiar note and the loud noise made by the strokes of his beak against the wood, succeeding each other with almost incredible rapidity of succession. Length nine inches and a half, extent seventeeen inches. Head and neck deep scarlet; back, primaries, wing coverts and tail black, with steel blue reflections, rump, secondary feathers, lower parts of the back, breast, abdomen and vent white. The young bird does not receive his full and perfect plumage until the succeeding spring, his head and neck are blackish grey. They form their nest in some old tree, of which the wood is not so hard as to oppose any great obstacle to their labours; though it must be confessed that they sometimes dig out wood of a considerable degree of firmness. The female deposits six white eggs, and the young appear about the middle of June. His food is Indian corn, fruit, &c. but principally the larvæ of insects; these he discovers by some means, unknown to us, under the bark of decaying trees, and arrives at them by perforating it with his bill; it is probabable that, in his search for this favourite food, he is guided by his acute hearing, directed to catch the sound of the gnawing hidden worm. In Pennsylvania they migrate to the southward in October, and return in May.

P. Villosus. Hairy Woodpecker of Catesby, is a very common bird in Pennsylvania, and is one of the several species familiarly known to almost every body under the name of *Sap-Sucker*, derived probably from a notion, that their constant labour in perforating trees is for the purpose of supplying themselves with the sap of the tree as food; but it is well known to every naturalist, that their object is exclusively the acquisition of the larvæ of insects, by destroying which they render essential service to man.—This bird is in length about nine inches, and in extent fifteen; head white, crown and broad line, which includes the eyes, and descends on the hind neck to the back, black; hind head with a large scarlet spot; a line of black spots, from near the base of the lower jaw, terminates in a broad black stripe on the shoulder; back black, divided by a broad lateral stripe of white, of which the feathers are loose, resembling hairs, not being webbed; wings, black spotted with white; the four middle tail feathers black, the others whitish; all beneath pure white; nostrils concealed by very numerous hairs. The female is destitute of the scarlet spot on the hind head.

This bird remains with us all winter; the female deposits her five white eggs in May, and the young are hatched in June.

P. Pubescens. Downy Woodpecker, smallest woodpecker of Catesby. This is the smallest of all our woodpeckers, and is the species to which the term *Sap-Sucker* is most usually applied, being exceeding common in orchards, &c. where the apple and other fruit-trees seem to be his favourite hunting places; in his pursuit of the larvæ of insects, he forms those circular and regular bands of small round holes which are so often seen on apple trees. This species bears a very striking resemblance to the preceding at first view, appearing to differ from it only by its more diminutive stature, but it is, nevertheless, an entirely distinct species. Length six and three quarter inches, extent twelve inches; the same description will serve for this as for the preceding, excepting that the rump, tail, coverts, and four middle feathers of the tail above, are black; the three white feathers of the tail on each side are spotted with black. The female is destitute of the scarlet spot on the hind part of the head.

P. Varius, or the yellow-bellied woodpecker of Catesby, is a companion of the two preceding species, to which also it bears some resemblance, and has in consequence received the same vulgar name of *Sap-Sucker*, from those who do not take the trouble to observe the differences between the objects before them. Length eight and a half, extent fifteen inches; crown of the head and throat deep scarlet bordered with black, sides of the head and neck white, with a black stripe from the eye running down the neck; head slightly crested; back dusky yellowish, sprinkled and waved black; wings black, with a large oblong white spot drawn from the shoulder, the primaries and three inner secondaries variegated with white; rump white with a black border; belly yellow, on each side rather darker and marked with numerous sagittate spots; tail black, the two outer feathers edged with white, inner ones edged on the inside with white. The female is destitute of the scarlet mark on the throat, this part is white; lays about four white eggs the latter end of May. They are found in all parts of the United States, and do not migrate.

P. Carolinus, Red-bellied Woodpecker of Wilson, Jamaica Woodpecker of Edwards. This is another of those of this genus, whose back, wings, &c. are barred or spotted with black and white, and have more or less of red about the head; they generally bear to each other a pretty strong resemblance. The present species is a general inhabitant of the United States, and although less frequent near houses or without the covert of a wood, yet he is well known every where as one of the *Sap-Suckers*. Length ten inches, extent seventeen. Head above, hind neck down to the back to the shoulders, golden red polished; sides of the head and neck pale buff, which on the belly becomes of a yellowish ash colour stained with sanguineous. The back is black, banded with curving lines of white, the wings also black, with white bands of spots; rump white, with a few black spots; the vent and thigh feathers whitish, with cordate and sagittate spots; the feathers of the front of the head are of a dull yellowish red. In the female the black colour is less intense, and about an inch in length of the crown of the head is cinereous. They sometimes, for the purpose of nidification, scoop a cavity out of the solid wood, but more commonly choose some hollow limb, which it requires less labour to adapt to their purposes. The female lays five white eggs in April, and the young appear the beginning of June.

P. querulus, or red-cockaded woodpecker, was discovered by Mr. Wilson in the state of North-Carolina, and was first described by him; it is an inhabitant of the southern states, and has not yet been found as far north as Pennsylvania; it is closely allied to the preceding species, and to the P. villosus; it is however smaller: length seven and a half inches, extent thirteen; head above black, region of the eyes, cheeks and sides of the neck, white; hairs over the nostrils whitish, a black line from the base of the lower mandible passes to the shoulder of the wing, where it disappears in spots on the side of the breast, each side of the head, above the eye, a vermillion line; back black, with about twelve transverse white bands, wings black, with white spots; rump black, varied with white; tail with the four inner feathers black, the others spotted with white; vent white, with black spots. In the female, the red mark is wanting; in other respects she resembles the male; feeds upon Coleopterous insects.

P. torquatus, Lewis's woodpecker, is a bird of remarkable aspect; it was discovered by Lewis and Clark, during their memorable and eventful journey across the continent to the Pacific ocean; and was described by Mr. Wilson, from several skins brought to Philadelphia by those travellers. It was in length eleven and a half inches; back, wings and tail glossed with green; head black, with the front region of the eyes, cheeks and chin, dark red; a broad collar of white round the neck, passes over the breast, with hair-like feathers; belly deep vermillion, and with the same strong hair-like feathers intermixed with silvery ones, vent black. Of its history, we know nothing, neither can we say any thing about the difference of the colouring in the sexes.

PIECE, in commerce, signifies sometimes a whole, and sometimes a part of the whole. In the first sense, we say a piece of cloth or velvet, &c. meaning a certain quantity of yards regulated by custom; being yet entire, and not cut. In the other signification we say a piece of tapestry; meaning a distinct member wrought apart, which, with several others, make one hanging.

Piece, in matters of money, signifies sometimes the same thing with species; and sometimes by adding the value of the pieces, it is used to express such as have no other particular name.

Piece, in heraldry, denotes an ordinary or charge. See Ordinary and Charge. The honourable pieces of the shield are the chief, fesse, bend, pale, bar, cross, saltier, chevron, and in general all those which may take up one-third of the field, when alone, and in what manner soever it be.

Pieces, in the military art, include all sorts of great guns and mortars. Battering pieces are the larger sort of guns used at sieges for making the breaches, such are the twenty-four pounder, and culverin, the one carrying twenty-four, and the other an eighteen pound ball. Field pieces are twelve-pounders, demiculverins, six-pounders, sakers, minions, and three-pounders, which march with the army, and encamp always behind the second line, but in the day of battle are in the front. A soldier's firelock is likewise called his piece.

PIEPOWDER is a court held for the redress of grievances, in remedying and inforcing of contracts at fairs.

PIER, or Peer, in building, denotes a mass of stone, &c. opposed by way of fortress against the force of the sea, or a great river, for the security of ships that lie at harbour in any haven.

PIERCED, or Perce, in heraldry, is when any ordinary is perforated, or struck through, showing, as it were, a hole in it, which must be expressed in blazon, as to its shape: thus if a cross have a square hole, or perforation in the centre, it is blazoned square-pierced, which is more proper than quarterly-pierced, as Leigh expresses it. When the hole or perforation is round, it must be expressed round-pierced; if it be in the shape of a lozenge, it is expressed pierced lozenge-ways. All piercings must be of the colour of the field, and when such figures appear on the centre of a cross, &c. of another colour, the cross is not to be supposed pierced, but that the figure on it is a charge, and must be accordingly blazoned.

PIGEON. See Columba.

Pigeons. By statute 1. James I. c. 27. the shooting at a pigeon is punishable with 20*l.* fine, or commitment for three months.

PIGMENTS, are preparations, in a solid form, chiefly employed by painters, for imitating particular colours, and imparting them to the surface of bodies. They are obtained from animal, vegetable, and mineral substances: the latter are the most durable. See Colours.

PIKE, an offensive weapon, consisting of a shaft of wood, twelve or fourteen feet long, headed with a flat-pointed steel, called the spear. The pike was a long time in use among the infantry, to enable them to sustain the attack of the cavalry; but it is now taken from them, and the bayonet, which fixes on at the end of the carbine, is substituted in its place. Yet the pike still continues the weapon of the serjeants, who fight pike in hand, salute with the pike, &c.

PILASTER, in architecture, a square column, sometimes insulated, but more frequently let within a wall, and only showing a fourth or fifth part of its thickness. See Architecture.

PILCHARD, a species of the Clupea, or Herring genus. The pilchard is less than the herring, but fatter and more abundant in oil. The pilchard appears in vast shoals off the Cornish coasts, (England), about the middle of July. Their approach is known by much the same signs as those that indicate the arrival of the herring. To the inhabitants of Cornwall, the pilchard fishery is a very profitable concern. Thousands of persons are employed, during the season, in catching and curing the fish; and the fishermen and merchants make large gains in sending them to Italy, Spain, &c. Nearly 30,000 hogsheads are exported annually.

PILE, any heap, as a pile of balls, shells, &c.

Pile, in antiquity, a pyramid built of wood, on which the bodies of the deceased were laid in order to be burnt.

Pile, in coinage, denotes a kind o puncheon, which in the old way of coining with the hammer, contained the arms, or other figure and inscription to be struck on the coin. Accordingly we still call the arms side of a piece of money the pile, and the head the cross, because in ancient coin, a cross usually took the place of the head in ours: but some will have it called pile, from the impression of a church built on piles, struck on this side our ancient coins, and others will have it to come from *pile*, the old French word for a ship.

Pile, in heraldry, an ordinary in form of a wedge, contracting from the chief, and terminating in a point towards the bottom of the shield. The pile, like other ordinaries, is borne inverted, ingrailed, &c. and issues indifferently from any point of the verge of an escutcheon.

Pile *engine*. See Engine.

Pile, in military affairs. Piles of shot or shells are generally formed, in the King's magazines, in three different manners: the base is either a triangular square, or a rectangle; and from thence the piles are called triangular, square, and oblong.

Rules for finding the Number of Shot in any Pile.

Pile, *triangular*. Multiply the number in the side of the base by the base +

1, this product by the base + 2, and divide by 6.

PILE, *square.* Multiply the bottom row by the bottom row + 1, and this product by twice the bottom row + 2, and divide by 6.

PILES, *rectangular.* Multiply the breadth of the base by itself + 1, and this product by three times the difference between the length and breadth of the base, added to twice the breadth + 1, and divide by 6.

PILES, *incomplete.* Incomplete piles being only frustrums, wanting a similar small pile on the top, compute first the whole pile as if complete, and also the small pile wanting at top; and then subtract the one number from the other.

PILEUS, in botany, the orbicular horizontal expansion, or upper part of a mushroom, which covers the fructification. This, from its figure, is termed, by botanists, the hat of the mushroom.

PILL. See PHARMACY.

PILLAR, in architecture, a kind of irregular column, round and insulated, but deviating from the proportions of a just column. See ARCHITECTURE.

PILLORY, was anciently a post erected in a cross road, by the Lord of the Manor, with his arms upon it, as a mark of his seignory, and sometimes with a collar to fix criminals to. At present it is a wooden machine, made to confine the head and hands, in order to expose criminals to public view, and to render them publicly infamous.

PILOCARPOS, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: calyx five-leaved; corolla five-petalled; filaments inserted below the germ; pericarpium with from two to five cocculi, united below, elastic. There is only one species, *viz.* P. Racemosus, a native of the West Indies.

PILOT, a person employed to conduct ships over bars and sands, or through intricate channels, into a road or harbour. Pilots are no constant and standing officers aboard our vessels, but are called in occasionally, on coasts or shores unknown to the Master, and having pilotted in the vessel, they return to the shore where they reside.

Every respect and attention are paid to pilots on board his Majesty's ships: they are likewise well accommodated, and when conducting a ship have the sole command of it, and may give orders for steering, setting, trimming, &c. The captain is to see that all the officers and men obey his orders.

PILOT. All pilots must be examined and approved by the Trinity House. 3 Geo. I. c. 13. And for the particular regulations of the pilots of the Trinity House, at Deptford, see the statute 5 Geo. II. c. 30.

PILULARIA, in botany, a genus of the Cryptogamia Miscellaneæ class and order. Natural order of Filices, or Ferns. Generic character: common receptacle globose, with four cells and four valves, lined with numerous anthers, and many globose germs beneath them. There is but one species, *viz.* P. globulifera, pillwort, or pepper-grass.

PIMELEA, in botany, a genus of the Diandria Monogynia class and order. Essential character: calyx none; corolla four-cleft; stamina inserted into the throat; nut covered with a bark, one-celled. There are four species, natives of New Zealand and New South Wales.

PIMELIA, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ filiform; feelers four; thorax plano-convex, margined; head exserted; shells rather rigid; generally without wings. There are between one and two hundred species, divided into sections: A. antennæ, moniliform at the tip. B. antennæ, entirely filiform. The section is subdivided into *a* feelers filiform, and *b* feelers clavate. The section B is likewise subdivided into *a*, fore-feelers, filiform: *b*, fore-feelers, hatchet-shaped; hind ones clavate. The species P. mortisaga, is black; shells mucronate, subpunctured. It is found in many parts of Europe; and in Sweden it is regarded as a presage of death to one of the house in which it is found crawling. It is believed that not a single species of this genus is to be found in America.

PIMPINELLA, in botany, *burnet saxifrage,* a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: petals bent in; stigma subglobular; fruit ovate, oblong. There are nine species, among which we shall notice the P. anisum, anise; it has an annual root, producing a stem a foot and a half in height, dividing into several branches, having narrow leaves on them, cut into three or four narrow segments; umbels large and loose, on long peduncles; flowers small, yellowish white; seeds oblong, swelling, possessing an aromatic scent, and a pleasant warm taste: in distillation with water, three pounds of them yield an ounce of essential oil, which congeals into a butyraceous white concrete, even when the air is not sensibly cold; these seeds also yield an oil, by expression, of a greenish colour and grateful taste, strongly impregnated with the flavour of the seeds. It is a native of Egypt; it is cultivated in Malta and Spain, whence the seeds are annually imported into England.

PIN, in commerce, a little necessary implement made of brass-wire, used chiefly by the women in adjusting their dress. The perfection of pins consists in the stiffness of the wire and its whiteness, in the heads being well turned, and in the fineness of the points. The London pointing and whitening are in most repute, because our pinmakers, in pointing, use two steel mills, the first of which forms the point, and the latter takes off all irregularities, and renders it smooth, and as it were polished; and in whitening, they use block-tin granulated: whereas in other countries they are said to use a mixture of tin, lead, and quicksilver; which not only whitens worse than the former, but is also dangerous, on account of the ill quality of that mixture, which renders a puncture with a pin thus whitened somewhat difficult to be cured. The consumption of pins is incredible, and there is no commodity sold cheaper. The number of hands employed in this manufacture is very great, each pin passing through the hands of six different workmen, between the drawing of the brass wire and the stick-in of the pin in the paper.

Pins are sometimes made of iron wire, rendered black by a varnish of linseed-oil, with lamp-black, which the brass wire would not receive: these are designed for the use of persons in mourning, though not universally approved.

PINCHBECK. See COPPER.

PINE. See PINUS.

PINE *apple*. See ANANAS.

PINEAL GLAND. See ANATOMY.

PINGUICULA, in botany, *butter wort*, a genus of the Diandria Monogynia class and order. Natural order of Corydales. Lysimachiæ, Jussieu. Essential character: corrolla ringent, with a spur; calyx, two-lipped, five-cleft; capsule, one celled. There are five species, natives of many parts of England.

PINION, in mechanics, an arbor, or spindle, in the body whereof are several notches, which catch the teeth of a wheel that serves to turn it round; or it is a lesser wheel which plays in the teeth of a larger. In a watch, &c. the notches of a pinion, which are commonly 4, 5, 6, 8, &c. are called leaves, and not teeth, as in other wheels. For the pinions of a watch, and the leaves, turns, &c. thereof. See CLOCK.

PINION *of report*, is that pinion in a watch, commonly fixed on the arbor of a great wheel; it drives the dial-wheel, and carries about the hand.

PINITE, in mineralogy, is of a blackish grey colour, usually crystallized, in six-sided prisms, with truncated edges and angles. The crystals are of different sizes. Specific gravity almost three. It experiences no alteration before the blow-pipe, either alone or with the addition of borax. With carbonate of soda it forms an opaque globule, and with microcosmic salt, a transparent glass: it is compounded of

Alumina	63.75
Silica	29.50
Oxide of iron	6.75
	100.00

It has been found only in the mine level of Pini in Saxony, hence it derives its name; and is usually accompanied with quartz, felspar and micar.

PINK, a vessel used at sea, masted and rigged like other ships, only that this is built with a round stern; the bends and ribs compassing so as that her ribs bulge out very much. This disposition renders the pinks difficult to be boarded, and also enables them to carry greater burthens than others, whence they are often used for store-ships, and hospital ships in the fleet.

PINK. See DIANTHUS.

PINNA, in natural history, *nacre*, a genus of the Vermes Testacea class and order: animal a limax: shell bivalve, fragile, upright, gaping at one end, and furnished with a beard; hinge without teeth, the valves united into one. There are eighteen species. The inhabitants of these shells produce a large quantity of byssus, which is woven by the Italians into a kind of silk: the shells themselves are generally found standing erect in the smoother waters of the bays, with the larger end a little open: the fish of several of the species affords a rich food. We do not know of any species on the shores of the United States.

PINNACE, a small vessel used at sea, with a square stern, having sails and oars, and carrying three masts, chiefly used as a scout for intelligence, and for landing of men, &c. One of the boats belonging to a great man of war, serving to carry the officers to and from the shore, is also called the pinnace.

PINNACLE, in architecture, the top or roof of an house, terminated in a point. This kind of roof, among the ancients, was appropriated to temples; their ordinary roofs were all flat, or made in the platform way. It was from the pinnacle that the form of the pediment took its rise.

PINNATED *leaves*. See BOTANY.

PINT, a vessel or measure used in estimating the quantity of liquids, and even sometimes of dry things. It is the eighth part of a gallon, both in ale and wine measure; but the gallon being different, the pint must also differ. The wine pint of pure water weighs almost seventeen ounces avoirdupois, and the ale pint contains a little more than twenty ounces. The Scotch pint is equal to three English pints.

PINUS, in botany, *pine tree*, a genus of the Monoecia Monadelphia class and order. Natural order of Coniferæ. Essential character: male, calyx four-leaved; corolla none; stamina very many, with naked anthers: female, calyx strobiles, with a two-flowered scale; corolla none; pistil one; nut with a membranaceous wing. There are twenty-one species; we shall notice some of the most remarkable.

P. cedrus, cedar of Lebanon, has a general striking character of growth so peculiar to itself, that no other tree can be mistaken for it; it is placed by Linnæus along with the larch, in the same genus with the firs and pines; it agrees with the former in its foliation, with the latter in being evergreen; the leaves resemble those of the larch, but are longer and closer set, erect, and perpetually green; the cones are tacked and ranged between the branch leaves, in such order as to give it an artificial and very curious appearance, and at a little distance a beautiful effect: these cones have the bases rounder, or rather thicker, and with blunter points, the whole circumzoned with broad, thick scales, which adhere together in exact series to the summit, where they are smaller; but the entire lorication is smoother couched than those of the firs: within these repositories, under the scale, nestle the small nutting seeds, of a pear shape. Many wonderful properties are ascribed to the wood of this celebrated tree, such as its resisting putrefaction, destroying noxious insects, continuing a thousand or two thousand years sound, yielding an oil famous for preserving books and writings.

The P. sylvestris, wild pine tree, is called in Britain the Scotch fir, from its growing naturally in the mountains of Scotland; it is common in most parts of Europe, particularly the northern; the wood is the red or yellow deal, which is the most durable of any of the kinds yet known; the cones are small, pyramidal, ending in narrow points; they are of a light colour; the seeds are small. In a favourable soil, this tree grows to the height of eighty feet, with a straight trunk; the bark is of a brownish colour, full of crevices; the leaves issue from a white, truncated, little sheath, in pairs; they are linear, acuminate, entire, striated, convex on one side, flat on the other, mucronate, bright green, smooth, from an inch and a half to two inches in length; the scales of the male catkins roll back at top, and are feathered; the inner and upper scales of the cones gradually terminate in a short awn, the lower scales have none. Few trees have been applied to more uses than this; the tallest and straightest afford masts to our navy; the timber is resinous, durable, and applicable to numberless domestic purposes; from the trunk and branches of this and others of the genus, tar and pitch are obtained; by incision, barras, Burgundy pitch, and turpentine, are acquired and prepared; the resinous roots are dug out of the ground in many parts of the Highlands of Scotland. The fishermen make ropes of the inner bark; and hard necessity has taught the Laplanders and Kamschatdales to convert it into bread; to effect this, in spring they strip off the outer bark carefully from the best trees, collecting the soft, white, succulent, interior bark, and drying it in the shade. When they have occasion to use it, they first toast it at the fire, then grind, and after steeping the flower in warm water, to take off the resinous taste, they make it into thin cakes and bake them.

P. strobus, Weymouth pine tree, or white pine, is one of the tallest species, frequently attaining a hundred feet in height, in its native country, North America. The bark is very smooth and delicate, especially when the tree is young; the leaves are long and slender; they are closely placed on the branches; the cones are long, slender, and very loose, opening with the first warmth of the spring.

P. picea, silver fir, is a noble, upright, tree; the branches are not numerous, but the bark is smooth and delicate; the upper surface of the leaves is of a fine strong green, the under has two white lines running lengthwise on each side of the mid-rib, giving the leaves a silvery look, for which reason this fir takes its name; the cones are large, growing erect; when the warm weather comes on they soon shed their seeds; the scales are wide, deltoid, rounded above, below beaked, and appendicled with a membranaceous, spatulate, dorsal ligule, terminated by a recurved dagger-point; nuts rather large, membranaceous, variously angular, dun-coloured. It has been observed in Ireland, that no tree grows so speedily to so large a size as the silver fir; some at forty years' growth, in a wet clay on a rock, measuring twelve feet in circumference at the ground, and seven feet and a half at five feet high; one contained seventy-six feet of solid timber.

P. balsamea, balm of Gilead fir tree, rises with an upright stem; the leaves are dark green on their upper surface, marked with whitish lines underneath; the cones are roundish and small; the buds and leaves are remarkably fragrant; from wounds made in this tree a very fine turpentine is obtained, which is often sold for the true balm of Gilead. This tree makes little progress after eight or ten years' growth; it has very much the habit of the silver fir; but the leaves are wider and blunter, disposed on each side along the branches like the teeth of a comb, but in a double row, the upper one shorter than the under; underneath they are marked with a double, glaucous line, each having eight rows of white dots; they are often cloven at top.

PIONEER, in the art of war, a labourer employed in an army to smooth the roads, pass the artillery along, and dig lines and trenches, mines, and other works.

PIPE, in building, &c. a canal or conduit, for the conveyance of water and other liquids. Pipes for water, water-engines, are usually of lead, iron, earth, or wood: the latter are usually made of oak or elder. Those of iron are cast in forges, their usual length is about two feet and a half; several of these are commonly fastened together by means of four screws at each end, with leather or old hat between them, to stop the water. Those of earth are made by the potters; these are fitted into one another, one end being always made wider than the other. To join them the closer, and prevent their breaking, they are covered with tow and pitch: their length is usually about that of the iron pipes. The wooden pipes are trees bored with large iron augers, of different sizes, beginning with a less, and then proceeding with a larger successively; the first being pointed, the rest being formed like spoons, increasing in diameter from one to six inches, or more: they are fitted into the extremities of each other.

Wooden pipes are bored as follows. (Fig. 1, Plate Pipe-boring,) is a plan of the machine; and fig. 2, an elevation of it. The piece of timber intended to form the pipe is placed upon a frame, *a, a, a, a*, and held down upon it firmly by chains going over it, and round two small windlasses, *b b*, and it is wedged up to prevent its rolling sideways; if the piece is tolerably straight, this will be sufficient, otherwise it must be steadied by iron dogs or hooks, similar to those used by sawyers, drove into the carriage at one end, and into the tree at the other. The frame and tree together run upon small wheels traversing two long beams or ground sills, D D, placed on each side of a pit, dug to receive the chips made by the borer; at one end they are connected by a cross beam, E, bolted upon them; this supports the bearing for a shaft, F, the extremity of which, beyond the bearing, is perforated at the end with a square hole, to receive the end of the borer, *f*. The carriage, *a a*, and piece of timber, are advanced towards the borer by ropes; *g* is one hooked to it, going over a pulley, (not seen) and returning to a windlass, H, above the carriage, round which it is coiled several times, and the end made fast to it; *h* is another rope, hooked to it at the other end, and going over a pulley, and coming to the same windlass, H, it is coiled round the windlass in a contrary direction to *g g*, and then nailed fast; by this means, when the windlass, H, is turned by the handles on its wheel, I, one rope will wind up, while the other gives out, and draws the carriage and piece of timber backwards or forwards, according as the wheel is turned. The weight of the borer is supported by a wheel, *l*, turning between uprights, fixed to a block, L, whose end rests upon the ground sills, D; it is moved forwards by two iron bars, *m m*, pinned to the front cross bar of the carriage, *a a*; the distance between the wheel, 2, and the carriage can be varied, by altering the iron bar and pins, so as to bring the point of support, or wheel, *l*, always as near as convenient to the end of the tree. The shaft, F, may be turned by any first mover, wind, water, steam, or horses, as is most convenient, and a man regulates the wheel, I. When the borer is put in motion, by turning the wheel, I, from *o* to *p*, he draws the tree up to the borer, which pierces it; when a few inches are bored, he withdraws the tree, by turning the wheel back, that the borer may throw out its chips; he then returns the tree, and continues this process until the work is finished; the borer is the shape of a common auger.

Pipe, *tobacco*, a machine used in the smoaking of tobacco, consisting of a long tube, made of earth or clay, having at one end a little case, or furnace, called the bowl, for the reception of the tobacco, the fumes whereof are drawn by the mouth through the other end. Tobacco-pipes are made of various fashions; long, short, plain, worked, white, varnished, unvarnished, and of various colours, &c. The Turks use pipes three or four feet long, made of rushes, or of wood bored, at the end thereof they fix a kind of pot of baked earth, which serves as a bowl, and which they take off after smoking.

Pipe also denotes a vessel or measure for wine, and things measured by wine-measure. It is usually reckoned two hogsheads, or 126 gallons: this is the measure found in books, but in actual life it is very different.

	Gallons.
The pipe of Port is	138
——— Madeira	110
——— Vidonia	120
——— Sherry	130
——— Lisbon, and Bucellas	140

The pipe of port is seldom accurately 138 gallons, and it is customary in trade to charge what the cask actually contains, be it more or less than the estimated quantity.

Pipe, in music, any tube formed of a reed, or of wood, metal, &c. which being inflated at one end, produces a musical sound, acute or grave, soft or loud, according to the material, its form, and dimensions. The pipe, which was originally no more than a simple oaten straw, formed one of the first instruments by which melodious sounds were attempted.

Pipes *of Pan*, or *mouth organ*, a wind instrument, consisting of a range of pipes bound together side by side, and gradually lessening, with respect to each other, in length and diameter. The longest is about six inches, and the shortest only two in length. In performing upon this instrument, it is held in the hand, and the pipes are blown into by the mouth at the upper end.

Pipe, in law, a roll in the exchequer, otherwise called the Great *roll*, whence there is an office called the pipe office, where they take cognizance of estreats and forfeitures to the king.

PIPER, in botany, *pepper*, a genus of the Diandria Trigynia class and order. Natural order of Piperitæ. Urticæ, Jussieu. Essential character: calyx none; corolla none; berry one-seeded. There are sixty species. Most of the peppers are perennial, with herbaceous or frutescent stems, sometimes scandent and dichotomous, the branches as it were jointed. The numerous species of this genus are natives of the East and West Indies, a few of the islands in the South Seas, and two or three of the Cape of Good Hope. P. nigrum, black pepper, grows spontaneously in the East Indies and Cochin China; it is cultivated with such success in Malacca, Java, and especially in Sumatra, that it is thence exported to every part of the world, where a regular commerce has been established. White pepper was formerly thought to be a different species from the black; but it is nothing more than the ripe berries deprived of their skin, by steeping them about a fortnight in water; after which they are dried in the sun. P. betle, betel, has the stems smooth and even, striated, angular; leaves acuminate, a little oblique at the base; peduncle longer than the petiole, and opposite to it; spike cylindrical, frequently, together with the peduncle, pendulous; petiole channeled at the base. It is the leaf of this species of pepper plant, which is called betle, or betel, which serves to enclose a few slices or bits of the areca; these, together with a little chunam, or shell lime, are what the southern Asiatics universally chew to sweeten the breath and strengthen the stomach; the lower people there use it as ours do tobacco in Europe, to keep off the calls of hunger: it is there deemed the height of unpoliteness to speak to a superior without some of it in the mouth. The women of Canara on the Malabar coast, stain their teeth black with antimony, thus preserving them good to old age; the men, on the contrary, ruin theirs by the betel and chunam, or lime, which they take with it.

Piperitiæ, in botany, from the word piper, pepper, the name of the second order in Linnæus's "Fragments of a Natural Method;" consisting as the name imports, of pepper, and a few genera which agree with it in habit, structure, and sensible qualities. These plants are mostly herbaceous and perennial. The stalks of some of them creep along rocks and trees, into which they strike root at certain distances. None of them rise above fifteen feet high, and but few exceed three or four feet. The flesh roots of many of these plants, particularly those of several species of arum, are extremely acrid when fresh. They lose this pungent quality, however, by being dried, and become of a soapy nature. The pepper plant of Senegal bears a round berry, about the size of hemp seed, which, when ripe, is of a beautiful red colour, and of a sweetish taste. It contains a seed of the shape and bigness of a grain of cabbage, but very hard, and possessing an agreeable poignancy. The berries grow in small bunches on a shrub that is about four feet high, and has thin supple branches, furnished with oval leaves, that are pointed at the ends, not very unlike those of the privet.

PIPRA, the *manakin*, in natural history, a genus of birds of the order Passeres.—Generic character: bill short, strong, hard, nearly triangular at the base, and slightly incurvated at the tip; nostrils naked; tail short. These birds are very similar to the genus of Titmice, and are almost all peculiar to South America.—There are thirty-one species noticed by Gmelin. Latham enumerates only twenty-five. The following are most deserving of attention. P. rupicola, or the rock manakin, is as large as a pigeon, and is a very beautiful species, inhabiting Cayenne and Guiana, and building in the holes and clefts of the rocks, in the most obscure recesses. They are very timid; but are frequently tamed, so as to accompany the domestic poultry. The female, after laying her eggs for a few years, assumes, in some instances, the distinctive plumage of the male, and may be mistaken for him; a circumstance, however, not peculiar to this genus of birds. The black-crowned manakin is frequent in Guiana, avoiding the open plains, and haunting the skirts of woods in small flocks. These birds are found in the neighbourhood of ants' nests, from which they are seen to spring up frequently as if stung by these insects, uttering at the moment a cry somewhat similar to the cracking of a nut.

PIRATE, one who maintains himself by pillage and robbing at sea. By statute 28 Henry VIII. c. 15, all felonies committed upon the sea, or any place where the admiral has jurisdiction, shall be tried wherever the king shall appoint by his special commission, as if the offence had been at common law. And by statute 6 George I. if any subject or denizens of this kingdom, commit any hostility against others of the king's subjects upon the sea, under colour of any commission from any prince or other authority, he shall be deemed a pirate, and suffer accordingly.

By statute 18 George II. c. 30, persons committing hostilities, or aiding enemies at sea, may be tried as pirates. Piracies at sea are excepted out of the general pardon, by 20 George II. c. 52.

PISCES, in natural history, is the fourth class in the Linnæan system, consisting of five orders, viz.

Abdominales	Jugulares
Apodes	Thoracici
Cartilaginii	

The class is described as having incumbent jaws; eggs without white; organs of sense; for covering, imbricate scales; fins for supporters; they swim in water, and smack. The several orders and other matters relative to fishes, have been treated of in the article Ichthyology, and in the several parts of the Dictionary, in the alphabetical order of the genera, &c. To this article we have referred, intending to give under it a brief account of the functions of the several fishes. Of these the most important is respiration, which is performed by means of gills, which supply the place of lungs. Air is equally necessary to the existence of fish, as it is to other animals. In general, a fish first receives a quantity of water by the mouth, from which it is driven to the gills; these close, and prevent the water from returning by the mouth, at the same time that their bony covering prevents it from passing through them, until the proper quantity of air has been extracted from it.—The covers then open, and give it a free passage; by which means the gills are again opened, and admit a fresh body of water. This process, in fishes, as breathing in the human subject, is carried on during sleep, and is repeated about twenty-five times in a minute; and the necessity of it is evinced from the circumstance of fish being certainly killed in water, from which air is taken away by means of the air-pump, or excluded by very severe frost. Should the free play of the gills be even suspended, or their covers kept from moving, by a string tied round them, the fish would fall into convulsions, and die in a few minutes. It is said, likewise, that though the branchial apparatus be comprized in a small compass, its surface, when fully extended, would occupy many square feet; a fact, that may convince the most sceptical, of the numberless convolutions and ramifications in which the included water is elaborated and attenuated, in the course of giving out its air in the respiratory process.

Fishes have the organs of sense, some of them probably in a very high degree, and others imperfectly; of the latter kind are the senses of touch and of taste: but the sense of hearing has now been completely ascertained, which was long doubted, and by some physiologists denied: the organ is contained in the cavity of the head; it was discovered by Professor Camper, who remarks, that "fish perceive sound, but sound peculiar to the watery element." This organ has been observed and described by Mr. Hunter, in the Philosophical Transactions, who has likewise ascertained that its structure varies in different species. And Dr. Shaw, in his "Introduction to the Natural History of Fishes," Vol. IV. Part I. observes, that "Fishes, particularly of the skate kind, have a bag at some distance behind the eyes, which contains a fluid, and a soft cretaceous substance, and supplies the place of the vestibule and cochlea: there is a nerve distributed upon it similar to the portio mollis in man: they have semicircular canals, which are filled with a fluid, and communicate with the bag; they have likewise a meatus externus, which leads to the internal ear. The cod-fish, and others of the same shape, have an organ of hearing somewhat similar to the former, but instead of a soft substance contained in the bag, there is a hard cretaceous stone." From the same work we shall transcribe the observations on the sense of smelling and that of sight.

"The organ of smelling is large, and the animals have a power of contracting and dilating the entry to it as they have occasion. It seems to be mostly by their acute smell that they discover their food, for their tongue seems not to have been designed for a very nice sensation, being of a pretty firm cartilaginous substance; and common experience evinces that their sight is not of so much use to them as their smell in searching for their nourishment. If you throw a fresh worm into the water, a fish shall distinguish it at a considerable distance; and that this is not done by the eye, is plain from observing, that after the same worm has been a considerable time in the water, and lost its smell, no fishes will come near it; but if you take out the bait, and make several little incisions into it, so as to let out more of the odoriferous effluvia, it shall have the same effect as formerly. Now it is certain, that had the animals discovered this bait with their eyes, they would have come equally to it in both cases. In consequence of their smell being the principal means they have of discovering their food, we may frequently observe them allowing themselves to be carried down with the stream, that they may ascend again leisurely against the current of the water: thus the odoriferous particles swimming in that medium, being applied more forcibly to their organs of smell, produce a stronger sensation.

"The optic nerves in fishes are not confounded with one another in their middle progress between their origin and the orbit, but the one passes over the other without any communication; so that the nerve which comes from the left side of the brain goes distinctly to the right eye, and *vice versa*. Indeed it should seem not to be necessary for the optic nerves of fishes to have the same kind of connection with each other as those of man have; for their eyes are not placed in the fore-part, but in the sides of the head; and, consequently, cannot look so conveniently at any object with both eyes at the same time. The crystalline lens in fishes is a complete sphere, and more dense than in terrestrial animals, that the rays of light coming from the water might be sufficiently refracted. As fishes are continually exposed to injuries in the uncertain element in which they reside, and as they are in perpetual danger of becoming a prey to the larger ones, it was necessary that their eyes should never be shut; and as the cornea is sufficiently washed by the element they live in, they are not provided with palpebræ; but, as in the current itself the eye must be exposed to several injuries, there was a necessity that it should be sufficiently defended; which, in effect, it is, by a firm pellucid membrane, seeming to be a continuation of the cuticula stretched over it: the epidermis is very proper for this purpose, as being insensible, and destitute of vessels, and consequently not liable to obstructions, and thus becoming opaque. In the eye of the skate tribe there is a digitated curtain, which hangs over the pupil, and which may shut out the light when the animal rests, being somewhst similar to the tunica adnata of other animals."

We now proceed to notice the motion of fishes, for the celerity of which their shape is admirably adapted: hence, vessels designed to be navigated in water are made to imitate, in some degree or other, the shape of fish; but the rapidity of a ship in sailing before the wind is not to be compared to the velocity of a fish. The largest fishes are known to overtake a ship in full sail with the greatest ease, to play round it without effort, and to surpass it at pleasure. Every part of the body seems formed for dispatch: the fins, the tail, and the motion of the whole back-bone assist in the business; and it is to that flexibility of body which mocks the effort of art, that fishes owe the great velocity of their motions. The chief instruments in a fish's motion are its fins, air-bladder and tail; with two pair, and three single fins, it will migrate a thousand leagues in a season, and without indicating any visible symptoms of languor or fatigue. The fins serve not only to assist the animal in progression, but in rising and sinking, in turning, and even in leaping out of the water. The pectoral fins serve to push the animal forward, and to balance the head when it is too large for the body, and prevent it from tumbling to the bottom, which it infallibly would if the fins were cut off. The ventral fins, which always lie flat in the water, serve rather to raise or depress. the body, than to assist its progressive motion. The dorsal fin acts as a poiser, in preserving the animal's equilibrium, while it aids the forward movement; and the anal fin is designed to maintain the vertical position of the body. By means of the air bladder, fishes can increase or diminish the specific gravity of their body. When they contract it, and press out the air, the bulk of the body is diminished, and the fish sinks as far as it pleases: on relaxing the operation, the bladder acquires its natural size, the body becomes specifically lighter, and the fish is enabled to swim near the surface. The tail, in the last place, may be regarded as the rudder, directing the motions of the fish, to which the fins are only subservient.

With respect to the nourishment of fishes: they are mostly carnivorous, though they seize upon almost any thing that falls in their way, and not uncommonly devour their own offspring: they seem, indeed, to manifest a particular predilection for whatever they can swallow possessed of life. They often meet with each other in fierce opposition, and the victor, without scruple, devours his antagonist. Thus are they irritated by the continual desire of satisfying their hunger; and the life of a fish, from the smallest to the greatest, is but one scene of hostility and violence. The smaller species, which stand no chance in the unequal combat, resort to those shallows where the larger are unable to approach. There they become invaders in their turn, and live on the spawn of large fishes, and on small insects and worms, which they find floating on the water. Fishes can, however, notwithstanding their natural voracity, live long, apparently, without food; but they, perhaps, in vases and other ornamental vessels, feed on insects too small for the human eye to see; or, it has been thought, they may have the power of chemically decomposing water. We now proceed to the subject of reproduction.

In most, if not in all fishes, there is a difference in sex, though Bloch and others make mention of individuals, which seemed to unite the two sexes, and to be real hermaphrodites. The number of males, it has been remarked, is about double that of females; and were it not for this wise provision of nature, a large proportion of the extruded eggs would remain unfecundated. A few species, indeed, as the eel, blenny, &c. are viviparous; but by far the greater number are produced from eggs. These last compose the roe, ovaries of the females, which lie along within the abdomen. The milt of the males is disposed along the back-bone, in one or two bags, and consists of a whitish glandular substance, which secretes the spermatic fluid. Though the history of the generation of fishes be still involved in considerable obscurity, it seems to be ascertained, that no sexual union takes place among the oviparous kinds, and that the eggs are fructified after exclusion. They are of a spherical form, and consist of a yolk, a white part, and a bright crescent-like spot, or germ. The yolk, which is usually surrounded by the white, is round, and not placed in the middle, but towards one of the sides; and the clear spot, or embryo, is situated between the yolk and the white.

In this spot there is observable, on the day after fecundation, a moveable point, of a somewhat dull appearance. On the third day, it assumes the appearance of a thickish mass, detached on one side, and on the other strongly adhering to the yolk, and presenting the contour of the heart, which at this period receives an increase of motion, while the disengaged extremity, which forms the rudiments of the tail, is perceived to move at intervals. On the fourth day, the pulsations of the heart, and the movements of the whole body occur in quicker succession. On the fifth, the circulation of the humours in the vessels may be discerned, when the fish is in a particular position. On the sixth, the back-bone may be distinctly recognised. On the seventh, two black points, which are the eyes, and the whole form of the animal, are visible to the naked eye. Although the yolk gradually diminishes as the embryo enlarges, the included animal cannot yet stretch itself at length, but makes a curve with its tail. Its motions are then so brisk, that when it turns its body, the yolk turns with it; and these motions become more and more frequent, as the moment of birth, which happens between the seventh and ninth day, approaches. By repeated strokes of the tail, the covering of the egg at length gives way, and the fish comes forth, first by the tail, redoubling its efforts, till it detach its head; and then it moves nimbly, and at liberty in its new element.

Fishes have different seasons for depositing their spawn. Some, which live in the depths of the ocean, are said to choose the winter months; but, in general, those with which we are acquainted choose the hottest months in summer, and prefer such water as is somewhat tepified by the beams of the sun. They then leave the deepest parts of the ocean, which are the coldest, and shoal round the coast, or swim up the fresh-water rivers, which are warm as they are comparatively shallow, depositing their eggs where the sun's influence can most easily reach them, and seeming to take no farther charge of their future progeny. Of the eggs thus deposited scarcely one in a hundred brings forth an animal, as they are devoured by all the lesser fry which frequent the shores, by aquatic birds near the margin, and by the larger fish in deep water. Still, however, the sea is amply supplied with inhabitants: and notwithstanding their own rapacity, and that of various tribes of fowls, the numbers that escape are sufficient to relieve the wants of a considerable portion of mankind. Indeed, when we consider the fecundity of a single fish, the amount will seem astonishing. If we should be told, for example, that a single being could in one season, produce as many of its kind as there are inhabitants in England, it would strike us with surprise: yet the cod annually spawns, according to Lewenhoeck, above nine million of eggs contained in a single roe. The flounder is commonly known to produce above one million; and the mackarel above five hundred thousand; a herring of a moderate size will yield at least ten thousand; a carp, of fourteen inches in length, contained, according to Petit, two hundred and sixty-two thousand two hundred and twenty-four; and another, sixteen inches long, contained three hundred and forty-two thousand one hundred and forty-four; a perch deposited three hundred and eighty thousand six hundred and forty; and a female sturgeon, seven million six hundred and fifty-three thousand two hundred. The viviparous species are by no means so fruitful; yet the blenny brings forth two or three hundred at a time, all alive, and playing round the parent together.

PISCES, in astronomy, the twelfth sign or constellation of the zodiac. The stars in Pisces, in Ptolemy's catalogue, are thirty-eight; in Tycho's thirty-three; and in the Britannic catalogue one hundred and nine.

PISCIDA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: stigma acute; legume winged four ways. There are two species, *viz.* P. erythrina, Jamaica dogwood tree, and P. carthaginensis, both natives of the West Indies.

PISCIS *australis*, the southern fish, is a constellation in the southern hemisphere, being one of the forty-eight constellations mentioned by the ancients. The star tomahaut, of the first magnitude, is in the mouth of this fish. Piscis volans, the flying fish, is a small constellation of the southern hemisphere, added by the moderns; it contains eight stars, but is not visible in our latitude.

PISONIA, in botany, so named in honour of William Piso, a physician, a genus of the Polygamia Dioecia class and order. Natural order of Nyctagines, Jussieu. Essential character: calyx scarcely any: corolla bell shaped, five-cleft; stamina five or six; pistil one; capsule superior, one-celled, valveless: male and female on the same or on different plants. There are five species.

PISTIACIA, in botany, a genus of the

Dioecia Pentandria class and order. Natural order of Amentaceæ. Terebintaceæ, Jussieu. Essential character: male an ament; calyx five-cleft; corolla none; female distinct; calyx trifid; corolla none: styles two; drupe one-seeded. There are six species, among which we shall notice the P. lentiscus, mastick tree: it is about eighteen or twenty feet in height, the trunk is covered with a greyish bark, the branches are numerous, the leaves have three or four pairs of small leaflets, of a lucid green on their upper, but pale on their under side; the male flowers come out in loose clusters from the sides of the branches, of an herbaceous colour, appearing in May, and soon falling off; they are generally on different plants from the fruits, which also grow in clusters, and are small berries of a black colour when ripe.

PISTAZITE, in mineralogy, is of pistachio green, passing sometimes into olive green, and blackish green. It occurs massive and crystallized. Internally it is shining; fracture sometimes foliated, sometimes narrow, parallel and stellular, diverging radiated. It is hard, easily frangible, and not very heavy It occurs in beds in primitive mountains in Norway, Germany, and France.

PISTIA, in botany, a genus of the Monadelphia Octandria class and order. Natural order of Miscellaneæ. Hydrocharides, Jussieu. Essential character: calyx none; corolla one-petalled, tongue-shaped, entire; anthers six or eight, placed on the filament; style one; capsule one-celled at the bottom of the corolla. There is but one species, *viz.* P. stratiotes, a native of Asia, Africa, and South America, in stagnant waters.

PISTILLA, in botany. See BOTANY.

PISTOLE, a gold coin struck in Spain, and in several parts of Italy, Switzerland, &c. equal to about ten shillings and sixpence of our money.

PISTON, in pump-work, is a short cylinder of metal, or other solid substance, fitted exactly to the cavity of the barrel or body of the pump. There are two kinds of pistons used in pumps, the one with a valve, and the other without a valve, called a forcer.

PISUM, in botany, *pea*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: style triangular, above keeled, pubescent; calyx has the two upper segments shorter. There are three species, of which we shall mention P. sativum, the common pea. Many varieties of this are cultivated in England; the Hot spurs and Hastings have their names from their coming to bear early in the season; new varieties of these are raised almost every year, which, because they differ in some slight particular, are sold at an advanced price, having frequently the names of the persons who raised them, or the place where they first grew. These varieties are not permanent, and, without the greatest care, will soon degenerate.

PITCAIRNIA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Bromeliæ, Jussieu. Essential character: calyx three-leaved or three-parted, half superior; corolla three-petalled, with a scale at the base of each petal; stigmas three, contorted; capsule three, opening inwards; seeds winged. There are three species, natives of the West Indies.

PITCH, a tenacious oily substance, drawn chiefly from pines and furs, and used in shipping, medicine, and various other arts: or it is more properly tar, inspissated by boiling it over a slow fire. The method of procuring the tar is, by cleaving the trees into small billets, which are laid in a furnace that has two apertures, through one of which the fire is put, and through the other the pitch is gathered, which, oozing from the wood, runs along the bottom of the furnace into places made to receive it; when the smoke, which is here very thick, gives it its blackness; this is called tar, which, on being boiled, to consume more of its moisture, becomes pitch. There is another method of drawing pitch, used in the Levant: a pit is dug in the ground, two ells in diameter at the top, but contracting as it grows deeper; this is filled with branches of pine, cloven into shivers; the wood at the top of the pit is then set on fire, and burning downwards, the tar runs from it, out of a hole made in the bottom; and this is boiled, as above, to give it the consistence of pitch. See TURPENTINE.

PITCH, in music, the acuteness or gravity of any particular sound, or of the tuning of any instrument. A sound less acute than some other sound with which it is compared, is said to be of a lower pitch than that other sound; and *vice versa*.

PITCHING, in naval affairs, is the vertical vibration which the length of a ship makes about her centre of gravity, or the motion by which she plunges her head and after part alternately into the hollow of the sea. This motion may proceed from the waves that agitate the vessel, or the wind acting upon the sails, which makes her stoop at every blast.

PITCH *pipe*, in music, an instrument used by vocal practitioners to ascertain the pitch of the key in which they are about to sing. It is blown at one end like a common flute, and being shortened or lengthened by a scale, is capable of producing, with great exactness, all the semitones within its compass.

PITCH *stone*, in mineralogy, is of various colours, as grey, green, yellow, and red, in their several shades, but generally of the paler cast. It occurs in mass. Internally it is shining, with a greasy lustre. Its fracture is conchoidal, passing into splintery, it approaches to hornstone. Its fragments are angular and sharp-edged. Sometimes it occurs in smooth granular distinct concretions. It is hard, brittle, and easily frangible, and the specific gravity is 2.3. It is fusible, by means of the blow-pipe, into a porous enamel. It is composed of

Silica	64.58
Alumina	15.41
Oxide of Iron	5
	84.99
Loss	15.01
	100

This mineral occurs in mountain masses, and constitutes entire mountains. It forms the base of a particular kind of porphyry, and abounds in many parts of Germany and Siberia.

PITTOSPORUM, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx deciduous; petals five, converging into a tube; capsule two to five valved, two to five celled; seeds covered with a pulp. There are three species.

PIVOT, a foot or shoe of iron, or other metal, usually conical, or terminating in a point, whereby a body, intended to turn round, bears on another fixed at rest, and performs its circumvolutions. The pivot usually bears or turns round in a sole, or piece of iron or brass, hollowed to receive it.

PLACARD, or PLACART, among foreigners, signifies a leaf or sheet of paper, stretched out and applied on a wall or post, containing edicts, regulations, &c.

PLACE, in law, where a fact was committed, is to be alleged in appeals of death, indictments, &c.

PLACE, in philosophy, a mode of space, or that part of immoveable space which any body possesses. Place is to space or expansion, says Mr. Locke, as time is to duration. Our idea of place is nothing but the relative position of any thing with reference to its distance from some fixed and certain points. Whence we say, that a thing has or has not changed place, when its distance either is or is not altered with respect to those bodies with which we have occasion to compare it. That this is so, continues that great philosopher, we may easily gather from hence, that we have no idea of the place of the universe, though we can of all its parts. To say that the world is somewhere, means no more than it does exist; however, the word place is sometimes taken to signify that space which any body takes up; and in this sense, according to the same author, the universe may be conceived in a place; but he thinks that this portion of infinite space possessed by the material world, might more properly be called extension.

PLACE, in war, a general name for all kinds of fortresses where a party may defend themselves: thus, 1. A strong or fortified place, is one flanked and covered with bastions. 2. A regular place, one whose angles, sides, bastions and other parts, are equal: and this is usually denominated from the number of its angles, as a pentagon, hexagon, &c. 3. Irregular place, is one whose sides and angles are unequal. 4. Place of arms, is a strong city or town, pitched upon for the chief magazine of an army; or, in a city or garrison, it is a large open spot of ground, usually near the centre of the place where the grand guard is commonly kept, and the garrison holds its rendezvous at reviews; and in cases of alarm to receive orders from the governor. 5. Place of arms of an attack, in a siege, is a spacious place covered from the enemy by a parapet or epaulement, where the soldiers are posted ready to sustain those at work in the trenches against the soldiers of the garrison. 6. Place of arms particular, in a garrison, a place near every bastion, where the soldiers sent from the grand place to the quarters assigned them relieve those that are either upon the guard or in sight. 7. Place of arms without, is a place allowed to the covert way for the planting of cannon, to oblige those who advance in their approaches to retire. 8. Place of arms in a camp, a large place at the head of the camp for the army to be ranged in and drawn up in battalia. There is also a place for each particular body, troop, or company to assemble in.

PLACENTA. See MIDWIFERY.

PLAGIANTHUS, in botany, a genus of the Monadelphia Dodecandria class and order. Essential character: calyx five cleft; petals five, two approximating, remote from the other three; berry.—There is but one species, *viz.* P. divaricatus, a native of New-Zealand.

PLAGIARY, in philology, the purloining another person's works, and putting them off for a man's own.

PLAGUE. Any infectious distemper in foreign countries may be declared the plague, by the King's proclamation.—And there are several very salutary regulations by our statute law for the performance of quarantine, in order to prevent the extending of infection.

PLAIN *table*, in surveying, a very simple instrument, whereby the draught of a field is taken on the spot, without any future protraction. It is generally of an oblong rectangular figure, and supported by a fulcrum, so as to turn every way by means of a ball and socket. It has a moveable frame, which serves to hold fast a clean paper; and the sides of this frame, facing the paper, are divided into equal parts every way. It has also a box with a magnetical needle, and a large index with two sights; and, lastly, on the edge of the frame, are marked degrees and minutes. See SURVEYING

PLAIN *number*, is a number that may be produced by the multiplication of two numbers into one another: thus 20 is a plain number produced by the multiplication of 5 and 4.

PLAIN *problem*, in mathematics, is such a problem as cannot be solved geometrically, but by the intersection either of a right line and a circle, or of the circumferences of two circles: as given the greatest side, and the sum of the other two sides of a right-angled triangle, to find the triangle, as also to describe a trapezium that shall make a given area of four given lines. Such problems can only have two solutions, because a right line can only cut a circle, or one circle cut another in two points.

PLAIN, in heraldry, sometimes denotes the point of the shield, when couped square; a part remaining under the square, of a different colour or metal from the shield. This has been sometimes used as a mark of bastardy, and called champaigne: for, when the legitimate descendants of bastards have taken away the bar, fillet, or traverse borne by their fathers, they are to cut the point of the shield with a different colour called plain.

PLAISE. See PLEURONECTES.

PLAN, in general, denotes the representation of something drawn on a plane: such are maps, charts, ichnographies, &c. See MAP, CHART, &c.

The term plan, however, is particularly used for a draught of a building, such as it appears, or is intended to appear, on the ground; shewing the extent, division, and distribution of its area, or ground-plot, into apartments, rooms, passages, &c. A geometrical plan is that, wherein the solid and vacant parts are represented in their natural proportions. The raised plan of a building, is the same with what is otherwise called an elevation, or orthography. A perspective plan, is that exhibited by degradations, or diminutions, according to the rules of perspective.

PLANARIA, in natural history, a genus of the Vermes Intestina class and order. Generic character: body gelatinous, flattish, with a double ventral pore; mouth terminal. There are about fifty species, divided into six sections, distinguished by the number of their eyes: A without eyes: B with a single eye: C with two eyes: D with three eyes: E with four eyes: and F with numerous eyes. Of the first division we may notice, P. quadrangularis; body pale, ovate, very sharp-pointed before, and winged with small curled longitudinal membranes.—It is found in Europe in ditches among duck-weed; very soft, pellucid, of a changeable form, and moves like a slug, leaving a slime on the bodies it passes over; when it meets another animal it draws itself in like a snail.

Of the third division we have a species which is very common in Pennsylvania, inhabiting running waters, large creeks, &c. It may be found by turning up the stones which lie in the water, and looking attentively on their under surface. We have named this species P. triangularis; body pale, linear, rounded behind, head triangular, angle in front acute, lateral acute angles extending rather beyond the line of the body, eyes round, black, conspicuous, placed about the middle of the head, and partly surrounded each with a whitish mark or lunule; this, however, is sometimes obsolete. It trails along with a slow but regular gait, over the stones, plants, &c. in the water, and never ventures out of it. Length about three-tenths of an inch.

PLANE, in geometry, denotes a plain surface, or one that lies evenly between its bounding lines: and as a right line is the shortest extension from one point to another, so a plain surface is the shortest extension from one line to another. In astronomy, conics, &c. the term plane, is frequently used for an imaginary surface, supposed to cut and pass through solid bodies; and on this foundation is the whole doctrine of conic sections built. See CONIC *sections*.

In perspective, we meet with the perspective plane, which is supposed to be pellucid, and perpendicular to the horizon; the horizontal plane, supposed to pass through the spectator's eye, parallel to the horizon; the geometrical plane, likewise parallel to the horizon, whereon the object to be represented is supposed to be placed, &c. See PERSPECTIVE.

The plane of projection, in the stereographic projection of the sphere, is that on which the projection is made; corresponding to the perspective plane.

PLANE, in joinery, an edged tool, or instrument for paring and shaving of wood smooth. It consists of a piece of wood, very smooth at bottom, as a stock or shaft; in the middle of which is an aperture, through which a steel-edge, or chisel, placed obliquely, passes; this being very sharp, takes off the inequalities of the wood it is slid along. Planes have various names, according to their various forms, sizes, and uses: as, 1. The fore-plane, which is a very long one, and is usually that which is first used: the edge of its iron or chisel is not ground straight, but rises with a convex arch in the middle; its use is to take off the greater irregularities of the stuff, and to prepare it for the smoothing-plane. 2. The smoothing-plane is short and small, its chisel being finer: its use is to take off the greater irregularities left by the fore-plane, and to prepare the wood for the jointer. 3. The jointer is the longest of all; its edge is very fine, and does not stand out above an hair's breadth; it is chiefly used for shooting the edge of a board perfectly straight, for jointing tables, &c. 4. The strike-block, which is like the jointer, but shorter: its use is to shoot short joints. 5. The rabbit-plane, which is used in cutting the upper edge of a board, straight or square, down into the stuff, so that the edge of another cut after the same manner, may join in with it, on the square; it is also used in striking facias on mouldings; the iron or chisel of this plane is as broad as its stock, that the angle may cut straight, and it delivers its shavings at the sides, and not at the top, like the others. 6. The plough, which is a narrow-rabbit plane, with the addition of two staves, on which are shoulders: its use is to plough a narrow square groove on the edge of a board. 7. Moulding-planes, which are of various kinds, accommodated to the various forms and profiles of the moulding; as the round-plane, the hollow-plane, the ogee, the snipe's bill, &c. which are all of several sizes, from half an inch to an inch and a half.

PLANE *tree*. See PLATANUS.

PLANET, a celestial body, revolving round the Sun as a centre, and continually changing its position, with respect to the fixed stars; whence the name planet, which is a Greek word signifying wanderer.

The planets are usually distinguished into primary and secondary. The primary ones, called by way of eminence, planets, are those which revolve round the Sun as a centre; and the secondary planets, more usually called satellites, or moons, are those which revolve round a primary planet as a centre, and constantly attend it in its revolution round the Sun. See ASTRONOMY.

The primary planets are again distinguished into superior and inferior. The superior planets are those further from the Sun than our Earth; as Mars, Jupiter, Saturn, and the Herschel: and the inferior planets are those nearer the Sun than our Earth; as Venus and Mercury: for the astronomy, and other peculiarities, of which, see JUPITER, MARS, &c.

PLANETS, *nature of the*. That the planets are opaque bodies, like our Earth, appears evident for the following reasons: 1. Since in Venus, Mercury, and Mars, only that part of the disc illuminated by the Sun is found to shine; and again, Venus and Mercury, when between the Earth and the Sun, appear like dark spots, or maculæ, on the Sun's disc; it is evident that Mars, Venus, and Mercury, are opaque bodies, illuminated with the borrowed light of the Sun. And the same appears of Jupiter, from its being void of light in that part to which the shadow of the satellites reaches, as well as in that part turned from the Sun; and that his satellites are opaque, and reflect the Sun's light, is abundantly shown. Wherefore, since Saturn, with his ring and satellites, only yield a faint light, fainter considerably than that of the fixed stars, though these be vastly more remote, and than that of the rest of the planets, it is past doubt, he too, with his attendants, are opaque bodies. 2. Since the Sun's light is not transmitted through Mercury and Venus, when placed against him, it is plain they are dense opaque bodies; which is likewise evident of Jupiter, from his hiding the satellites in his shadow; and therefore, by analogy, the same may be concluded by Saturn. 3. From the variable spots in Venus, Mars, and Jupiter, it is evident these planets have a changeable atmosphere; which changeable atmosphere may, by a like argument, be inferred of the satellites of Jupiter, and therefore by similitude the same may be concluded of the other planets. 4. In like manner, from the mountains observed in Venus, the same may be supposed in the other planets. 5. Since, then, Saturn, Jupiter, both their satellites, Mars, Venus, and Mercury, are opaque bodies, shining with the Sun's borrowed light, are furnished with mountains, and encompassed with a changeable atmosphere; they have, of consequence, waters, seas, &c. as well as dry land, and are bodies like the Moon, and therefore like the Earth. And hence it seems highly probable, that the other planets have their animal inhabitants, as well as our Earth.

Planets, *masses of.* It would appear, at first view, impossible to ascertain the respective masses of the Sun and planets, and to calculate the velocity with which heavy bodies fall towards each when at a given distance from their centres; yet these points may be determined from the theory of gravitation without much difficulty. It follows, however, from certain theorems relative to centrifugal forces, that the gravitation of a satellite towards its planet is to the gravitation of he Earth towards the Sun, as the mean distance of the satellite from its primary, divided by the square of the time of its sidereal revolution, or the mean distance of the Earth from the Sun divided by the square of a sidereal year. To bring these gravitations to the same distance from the bodies which produce them, we must multiply them respectively by the squares of the radii of the orbits which are described: and, as at equal distances the masses are proportional to the attractions, the mass of the Earth is to that of the Sun as the cube of the mean radius of the orbit of the satellite, divided by the square of the time of its sidereal motion, is to the cube of the mean distance of the Earth from the Sun, divided by the square of the sidereal year. Let us apply this result to Jupiter. The mean distance of his fourth satellite subtends an angle of 1530″.86 decimal seconds. Seen at the mean distance of the Earth from the Sun, it would appear under an angle of 7964″.75 decimal seconds. The radius of the circle contains 636,619″.8 decimal seconds. Therefore the mean radii of the orbit of Jupiter's fourth satellite, and of the Earth's orbit, are to each other as these two numbers. The time of the sidereal revolution of the fourth satellite is 16.6890 days; the sidereal year is 365.2564 days. These data give us $\frac{1}{1066.08}$ for the mass of Jupiter, that of the Sun being represented by I. It is necessary to add unity to the denomination of this fraction, because the force which retains Jupiter in his orbit is the sum of the attractions of Jupiter and the Sun. The mass of Jupiter is then $\frac{1}{1067.08}$. The mass of Saturn and Herschel may be calculated in the same manner. That of the Earth is best determined by the following method: If we take the mean distance of the Earth from the Sun for unity, the arch described by the Earth in a second of time will be the ratio of the circumference to the radius divided by the number of seconds in a sidereal year. If we divide the square of that arch by the diameter, we obtain $\frac{1479565}{10^{20}}$ for its versed sine, which is the deflection of the Earth towards the Sun in a second. But on that parallel of the Earth's surface, the square of the sine of whose latitude is $\frac{1}{3}$, a body falls in a second $16\frac{1}{8}$ feet. To reduce this attraction to the mean distance of the Earth from the Sun, we must divide the number by the feet contained in that distance; but the radius of the Earth at the abovementioned parallel is 19,614,648 French feet. If we divide this number by the tangent of the solar parallax, we obtain the mean radius of the Earth's orbit expressed in feet. The effect of the attraction of the Earth, at a distance equal to the mean radius of its orbit, is equal to

$\frac{16\frac{1}{8}}{19614648}$ multiplied by the cube of the tangent of the solar parallax $= \frac{1479560.5}{10^{20}}$. Hence the masses of the Sun and Earth are to each other as the numbers 1479560.5 and 4.486113; therefore the mass of the Earth is $\frac{1}{329809}$, that of the Sun being unity. M. de la Place calculated the masses of Mars and Venus from the secular diminution of the obliquity of the ecliptic, and from the mean acceleration of the Moon's motion. The mass of Mercury he obtained from its volume, supposing the densities of that planet and of the Earth reciprocally as their mean distance from the Sun, a rule which holds with respect to the Earth, Jupiter, and Saturn. The following table exhibits the masses of the different planets, that of the Sun being unity:

Mercury	$\frac{1}{2025810}$
Venus	$\frac{1}{383137}$
Earth	$\frac{1}{329809}$
Mars	$\frac{1}{1846082}$
Jupiter	$\frac{1}{1067.09}$
Saturn	$\frac{1}{3359.40}$
Herschel	$\frac{1}{19304}$

The densities of bodies are proportional to their masses divided by their bulks; and when bodies are nearly spherical, their bulks are as the cubes of their semi-diameters, of course the densities in that case are as the masses divided by the cubes of the semi-diameters.

Planets, *motion of the.* Each of the primary planets bend their course about the centre of the Sun, and are accelerated in their motions as they approach to him, and retarded as they recede from him; so that a ray, drawn from any one of them to the Sun, always describes equal spaces, or areas, in equal times: whence it follows that the power which bends their way into a curve line, must be directed to the Sun. This power is no other than that of gravitation, which we have already proved to increase, as the square of the planet's distance from the Sun decreases. See Gravitation, &c. But the universality of this law still further appears, by comparing the motions of the different planets: for the power which acts on a planet near the Sun is manifestly greater than that which acts on a planet more remote; both because it moves with greater velocity, and because it moves in a lesser orbit, which has more curvature, and separates further from its tangent, in arcs of the same length, than in a greater orbit. By comparing the motion of the planets, the velocity of a nearer planet is found to be greater than that of one more remote, in the proportion of the square root of the number which expresses the greater distance, to the square root of that which expresses the lesser distance; so that if one planet was four times further from the Sun than another, the velocity of the first would be half the velocity of the latter; and the nearer planet would describe an arc in one minute, equal to the arc described by the other planet in two minutes; and though the curvature of the orbits were the same, the nearer planet would describe, by its gravity, four times as much space as the other would describe in the same time; so that the gravity of the nearer planet would appear to be quadruple, from the consideration of its greater velocity only. But besides this, as the radius of the lesser orbit is supposed to be four times less than the radius of the other, the lesser orbit must be four times more curved; and the extremity of a small arc of the same length, will be four times further below the tangent, drawn at the other extremity, in the lesser orbit than in the greater; so that, though the velocities were equal, the gravity of the nearer planet would, on this account only, be found to be quadruple. Hence, on both these accounts together, the greater velocity of the nearer planet, and the greater curvature of its orbit, its gravity towards the Sun must be supposed sixteen times greater, though its distance from the Sun is only four times less than that of the other; that is, when the distances are as 1 to 4, the gravities are reciprocally as the squares of these numbers, or as 16 to 1. And in the same manner as this principle governs the motions of the primary planets of the great solar system, acts at their surfaces, and keeps their parts together; so it governs also the motions of the satellites, or secondary planets, in the lesser systems of which the greater is composed, and is extended around them, decreasing in the same manner as the squares of the distances increase. The comets are evidently governed by the same law, since they descend with an accelerated motion, as they approach towards the Sun, and ascend again with a retarded motion, bending their way about the Sun, and describing equal areas in equal times, by rays drawn from them to his centre. See ASTRONOMY.

PLANETARIUM, an astronomical machine, contrived to represent the motions, orbits, &c. of the planets, as they really are in nature, or according to the Copernican system. A very remarkable machine of this sort was invented by Huygens, which is still preserved among the curiosities of the University at Leyden. In this planetarium, the five primary planets perform their revolutions about the Sun, and the moon performs her revolution about the Earth, in the same time that they are really performed in the heavens. Also the orbits of the Moon and planets are represented with their true proportions, excentricity, position, and declination from the ecliptic, or orbit of the Earth. So that, by this machine, the situation of the planets, with the conjunctions, oppositions, &c. may be known, not only for the present time, but for any other time, either past or yet to come, as in a perpetual ephemeris. There was exhibited in London, *viz.* in the year 1791, a still much more complete planetarium of this sort, called "a planetarium, or astronomical machine, which exhibits the most remarkable phenomena, motions, and revolutions of the universe; invented, and partly executed, by the celebrated M. Hahn, member of the academy of sciences at Erfurt; but finished and completed by M. A. de Mylius." This is a most stupendous and elaborate machine, consisting of the solar system in general, with all the orbits and planets in their due proportions and positions; as also the several particular planetary systems of such as have satellites, as of the Earth, Jupiter, &c.; the whole kept, in continual motion by a chronometer, or grand eight-day clock; by which all these systems are made perpetually to perform all their motions exactly as in nature, exhibiting at all times the true and real motions, positions, aspects, phenomena, &c. of all the celestial bodies, even to the very diurnal rotation of the planets, and the unequal motions in their elliptic orbits. A description was published of this most superb machine, and it was purchased and sent as one of the presents to the Emperor of China, in the embassy of Lord Macartney.

We shall now give a description of one of these machines in common use.

Fig, 1, Plate Planetarium, is an elevation of the mechanism of a planetarium; and fig. 2, a plan of the same. A, (fig. 1,) is a ball of brass representing the sun, supported by a wire screwed to a bridge, *b*, fixed beneath the board, B B, which supports the whole instrument; *a* is the section of an endless screw, which has a small handle on the end of its spindle to turn it by; it gives motion to a worm-wheel, 60, of sixty teeth, the arbor of this wheel is a tube, and goes over the central wire sustaining the Sun, to its upper end is fixed the frame, E E, containing the wheel-work, and carrying the Earth, ⊕, and Moon, ☾. The plan (fig. 2) is this frame of wheels, the upper plate of the frame being removed, *d* is the first wheel of sixty-four teeth, fixed fast to the central wire of the sun, and having no motion, it works with another of sixty-four, on the same arbor, *h h*, with several others to be hereafter described; it turns another, *f*, of sixty-four, on whose arbor, *g*, the Earth is fixed; as *d* is fixed, and the next wheel, with its frame, E E, rolls round it, and is thereby turned upon its own axis; the wheel, *f*, which is on the other side, will have no motion on its axis, and the axis of the Earth, fixed to it, will remain parallel to itself, while it describes an orbit round the Sun, by the motion of the frame, E E. The next wheel, 60, upon the arbor, *h*, turns a pinion, 14, of fourteen teeth, (not seen in the plan) by the intervention of a wheel, 64, which does not alter its velocity; the arbor of the pinion is a tube, and fitted upon the central wire; at its upper end it supports the planet, Mercury, ☿. The third wheel from the bottom, on the arbor, *h*, has forty teeth, and by the wheel, 56, communicates motion to a small wheel of twenty-four, which has the planet, Venus, ♀, fixed to its tubular arbor. The upper wheel of the arbor, *h*, has seventy-four teeth, and turns a pinion of six, on a tube, concentric with *g*, and with it the moon. There is a small wheel of fourteen teeth between the wheel and pinion, but it does not alter the velocity: *k*, (fig. 1), is a thin brass ring seen edgeways, which has a wire diametrically across it, on which it turns a san axis, to set it at any given obliquity to the axis, *g*, supporting the Earth, the wire is fixed into a short tube, which turns stiffly in a hole made in the upper plate of the frame, E E, and thus the circle can be turned round, while its plane continues oblique to the axis, *g*, this ring represents the plane of the Moon's orbit, and is engraved with the different phases of the Moon. The Moon is not fixed to the arm which turns it, but its stem slides up and down in a short tube fixed to the arm, and rests upon the ring, so as to describe a parallel plane to it. On the end of the frame, E E, a pillar is erected, to support a small semi-circular piece of brass, *m*, inclosing the Earth, and showing the line of light and darkness. *N* is a tube screwed fast to the board, B B, by a flanch at the lower end; it fits the outside of the tube of the wheel, 60, beneath the board, and thus steadies the whole frame as it turns round; upon this tube long arms are fitted, carrying Mars, Jupiter, and the other superior planets; but as there is no wheel-work to turn these, they are omitted in the plate. This instrument is defective in not having the diurnal motion of the Earth upon its axis shown, and the rotation of the Moon's nodes; there have been instruments made, which show all these motions, and those of the superior planets with their satellites; but they are so complicated, that it would far exceed the limits of our plates to describe them.

The numbers of the teeth of the wheels of this planetarium are not correctly calculated to produce true revolutions of the planets introduced in it, as the fixed wheel, 64, and the wheel 64, on the axis, *h*, are equal; the latter, and all the wheels on *h h*, revolve once in a tropical year; the wheels which turn Mercury are 60, upon *h*, turning 14, that is $\frac{14}{60}$ of a tropical year, or 85.223185 days; this period, which is intended to be the tropical revolution of Mercury, *viz.* 87*d.* 23*h.* 14*m.* 35*s.* is made the synodical revolution by the mechanism, by reason of the wheel-work being carried round the Sun again in a year, by the frame, E, representing the Earth's radius vector; so that the planet Mercury goes from conjunction with the Earth to conjunction again, instead of going through the ecliptic only in this period, and the imperfection of the wheel-work is rendered still more imperfect by its position, which ought to have been on a stationary bar, to have produced the true calculated effect; this error causes it to make just one revolution in a year more than intended. The tropical period of Venus is also turned into a synodic one, by the same fault in the position of the wheel-work; besides, the period itself being erroneous, *viz.* $\frac{24}{40}$ of a year, according to the original intention, which time is only 219*d.* 3*h.* 29*m.* 19.8*s.*, instead of 224*d.* 16*h.* 41*m.* 30*s.*, which is the true tropical period.

The Moon-wheels, $\frac{6}{74}$, making $12\frac{1}{3}$ lunations, or synodic revolutions, give one lunation at 29*d.* 14*h.* 44*m.* 29.8*s.*, which is greatly too long; the true period being 29*d.* 12*h.* 44*m.* 3*s.*; but $\frac{8}{99}$, making $12\frac{3}{8}$ lunations, or one in 29*d.* 12*h.* 20*m.* 54*s.*, would be much more accurate, and equally well made. Thus the instrument before us is so very inaccurate, in all respects, that it ought to have its numbers rectified, which may be done in this manner.

For Mercury, instead of $\frac{14}{60}$, (or $\frac{14}{59}$), put $\frac{20}{63}$, in which case the wheel, 63, will produce $3\frac{3}{20}$ revolutions; and the Earth's arm will carry the 20 round oval in a year, making together, 4.15 revolutions of Mercury for one of the Earth's, which is very near the truth, producing one tropical revolution in 88*d.* 0*h.* 14*m.* 38*s.*

For Venus, instead of $\frac{24}{40}$, put $\frac{32}{20}$, and one revolution per annum will be produced by the motion of the Earth's arm, and $\frac{20}{32}$ of another by the wheels, making, together, 1.625 in each year, or one tropical revolution in 224*d.* 18*h.* 21*m.* 27*s.*

The true synodic periods are:—of Mercury, 115.877*d.*, and of Venus, 583.923*d.*; therefore the said periods, by the present wheel-work, are too short by more than thirty days in Mercury, and in Venus, by 364*d.*, and upwards.

PLANIMETRY, that part of geometry which considers lines and plain figures, without considering their height or depth. See SURVEYING, &c.

PLANISPHERE, signifies a projection of the sphere, and its various circles on a plane; in which sense maps, wherein are exhibited the meridians, and other circles of the sphere, are planispheres. See MAP, SPHERE, &c.

PLANISPHERE, is more particularly used for an astronomical instrument used in observing the motions of the heavenly bodies. It consists of a projection of the celestial sphere upon a plane, representing the stars, constellations, &c. in their proper order; some being projected on the meridian, and others on the equator.

The use of the planisphere is to represent the face of the heavens for any day and hour: find, on the lesser moveable plate, the month and day proposed, and turn the plate till the given day of the month stand against the hour and minute required; and the plate will then represent the face of the heavens, by showing what stars are then rising in the meridian, or what setting. 2. To know at what hour and minute any star rises or sets, &c. Turn the moveable plate till the given star reaches the horizon east or west, and against the given day, on the moveable plate, is the hour and minute on the exterior or immoveable one: and in the same manner may most of the problems, usually resolved by the celestial globe, be determined.

PLANT, in botany, an organic vegetable body, consisting of roots and other parts. Whether capable either of sensation, or of spontaneous motion, is not yet fully ascertained. It attaches itself to other bodies, in such a manner as to derive nourishment from them, and to propagate itself by seeds. The constituent parts of plants are the roots, stems, branches, rind, or bark, leaves, flowers, and seeds; which greatly vary, both in figure and size, according to the nature of particular trees, shrubs, &c. Their various appearances have induced botanists to divide the vegetable kingdom into orders, classes, genera, species, and varieties; for an account of which see Botany.

According to the Linnæan system, plants take their denominations from the sex of their flowers, in the following manner:—1. Hermaphrodite plants, are such as upon the same root bear flowers that are all hermaphrodite, as in most genera. 2. Androgynous, male and female, such as upon the same root bear both male and female flowers, as in the class Monœcia. 3. Male, such as upon the same root bear male flowers only, as in the class Diœcia. 4. Female, such as upon the same root bear female flowers only, as in the class Diœcia. 5. Polygamous, such as, either in the same individual plant, or in different individual plants of the same species, have hermaphrodite flowers, and flowers of either or both sexes, as in the class Polygamia. All plants, however minute, are propagated by seed; and so easy is their cultivation, that in many instances they may be reared by parting their roots, or depositing layers, cuttings, &c. of the parent stock, in such soils as are most congenial to their nature. Hence some botanists consider them as somewhat analogous to animals; a conjecture that is strongly corroborated by the regular circulation of the sap throughout all their parts; and by the sleep of plants, or the faculty which some possess of assuming at night a position different from that in which they appear during the day. In the second volume of the Manchester Transactions, we find some speculations on the perceptive power of vegetables, by Dr. Percival, who attempts to show, by the several analogies of organization, life, instinct, spontaneity, and self-motion, that plants, like animals, are endued both with the powers of perception and enjoyment. The attempt, though ingeniously supported, however, fails to convince. That there is an analogy between animals and vegetables is certain; but we cannot from thence conclude, that they either perceive or enjoy. Botanists have, it is true, derived from anatomy and physiology almost all the terms employed in the description of plants. But we cannot from thence conclude, that their organization, though it bears an analogy to that of animals, is the sign of a living principle, if to this principle we annex the idea of perception. Yet so fully is our author convinced of the truth of it, that he does not think it extravagant to suppose, that, in some future period, perception may be discovered to extend even beyond the limits now assigned to vegetable life.

Mr. Good, the learned author of the translation of Lucretius, delivered in the spring of the present year, before the Medical Society of London, a discourse "On the general Structure and Physiology of Plants compared with those of Animals, and the mutual Convertibility of their Organic Elements," which contained much interesting matter, and many curious and ingenious speculations. He began by assuming, what indeed is the basis of the sexual system, that every thing that has life is produced from an egg; that the egg of the plant is its seed. The seed is sometimes naked, and sometimes covered with a pericarp, which is of various forms and structures: the seed itself consists internally of a corculum, or little heart, and externally of a parenchymatous substance, called a cotyledon, which is necessary for the germination and future growth of the seed, and may be denominated its lungs or placentule. The corculum is the "punctum saliens" of vegetable life, and to this the cotyledon is subservient. The corcle consists of an ascending and descending part: the former is called its plumule, which gives birth to the trunk and branches; from the latter spring the root and radicles. The position of the corcle in the seed, which is always in the vicinity of the eye, is a cicatrix, or umbilicus, remaining after the separation of the funis from the pericarp, to which the seed has been attached. The first radicle elongates, and pushes into the earth, before the plumule evinces any change: like the cotyledon, the radicles consist chiefly of lymphatics and air-vessels, which serve to separate the water from the soil, in order that the oxygen may be separated from the water. Hence originates the root, the most important part of the plant. The solid parts of the trunk of the plant are the cortex, or outer bark; the liber, or inner bark; the alburnum, or soft wood; lignum, or hard wood; and medulla, or pith. These lie in concentric circles; and the trunk enlarges, by the formation of a new liber, or inner bark, every year; the whole of the liber, excepting indeed its outermost layer, which is transformed into cortex, becoming the alburnum of the next, and the alburnum becoming the lignum. Hence a mark of any sort, as the initials of a name, which has penetrated through the outer into the inner bark, must in a long process of years be transferred to the central parts of the trunk. Independently of these more solid parts of the trunk, we generally meet with some portion of parenchyma and cellular substance: the vessels contained in this may be compared to arteries and veins, air vessels, and lymphatics. The lymphatics lie immediately under the cuticle, and in the cuticle, and by branching different ways are enabled to perform the alternating economy of inhalation and exhalation: below these lie the arteries, which rise immediately from the root, and communicate nutriment in a perpendicular direction: interior to these lie the reducent vessels, or veins, which are softer and more numerous, and in young shoots run down through the cellular texture and the pith. Between the arteries and veins are situated the air-vessels.

"The lymphatics of a plant may be often seen with great ease by merely stripping off the cuticle with a delicate hand, and then subjecting it to a microscope; and in the course of the examination, we are also frequently able to trace the existence of a great multitude of valves, by the action of which the apertures of the lymphatics are commonly found closed. Whether the other systems of vegetable vessels possess the same mechanism, we have not been able to determine decisively: the following experiment, however, should induce us to conclude that they do. If we take the stem of a common balsamine, or of various other plants, and cut it horizontally at its lower end, and plunge it, so cut, into a decoction of Brazil wood or any other coloured fluid, we shall perceive that the arteries, or adducent vessels, as also the air vessels, will become filled or injected by an absorption of the coloured liquor, but that the veins, or reducent vessels, will not become filled; of course evincing an obstacle in this direction to the ascent of the coloured fluid. But if we invert the stem, and in like manner cut horizontally the extremity which till now was uppermost, and plunge it so cut into the same fluid, we shall then perceive that the veins will become injected, or suffer the fluid to ascend; but that the arteries will not: proving clearly the same kind of obstacle in the course of the arteries in this direction, which was proved to exist in the veins in the opposite direction; and which reverse obstacles we can scarcely ascribe to any other cause than the existence of valves.

"By this double set of vessels, moreover, possessed of an opposite power, and acting in an opposite direction, the one to convey the sap or vegetable blood forwards, and the other to bring it backwards, we are able very sufficiently to establish the phenomenon of a circulatory system."

The author admits that no experiments, nor observations, have been able to detect the existence of muscular or nervous fibres in vegetables; but notwithstanding this, in answer to those who maintain the necessity of a regular and alternate contraction and dilatation for the production of a circulatory system, both in animals and vegetables, he says, "still must we admit the competency of other powers to produce the same result, while we reflect on the facility with which the human cutis or skin, an organ destitute of all muscular fibres whatever, contracts and relaxes generally on the application of a variety of other powers; powers different in their nature, and in their effect palpable to the external senses: whilst we recal to mind that it is contracted by austere, and relaxed by oleaginous preparations; constringed by cold, and dilated by warmth: and that the opposite passions of the mind have a still more powerful influence on the same organ, since fear, apprehension, horror, will not only freeze and corrugate the skin, but in the language of the poet, which is also the language of nature, freeze the blood itself, making

'——each particular hair to stand on end
Like quills upon the fretful porcupine:'

while hope, pleasure, agreeable expectation, smooth, soften, and expand it to an equal degree, and, figuratively, perhaps literally, lubricate it with the oil of joy. More especially must we come to this conclusion, while in conjunction herewith, we survey, in various species of the vegetable kingdom, as strong a contractility and irritability as are to be met with in the most contractile and irritable muscles of the most sentient animals.

"Yet, could it even be proved that the vessels of plants are incapable of being made to contract by any power whatever, still should we have no great difficulty in conceiving a perfect circulatory system in animals or vegetables without any such cause, whilst we reflect that one half of the circulation of the blood in man himself is accomplished without such a contrivance; and this, too, the more difficult half; as every one knows that the veins have, for the most part, to oppose the attraction of gravitation, instead of being able to take advantage of it.

"To argue, therefore, against the existence of a circulation of blood, or sap, in plants, from the single circumstance that we are not able to prove demonstrably their possession either of muscular fibres, or of a regular systole and diastole, is merely to argue *ex ignorantiâ,* and in defiance of facts and experiments, which, if not absolutely decisive, are perhaps as decisive as the nature of the case will allow."

Having established this point, the author proceeds to point out some striking resemblances in plants to the economy and habits of animals. To these we can but briefly allude.

Plants, like animals, are propagated by sexual connection: "although among vegetables we meet with a few instances of propagation by other means, as, for instance, by slips and offsets, or by buds and bulbs, the parallelism, instead of being hereby diminished, is only drawn the closer; for we meet with just as many instances of the same varieties of propagation among animals. Thus the hydra, or polype, as it is more generally called, the asterias, and several species of the leech, as the hirudo viridis, for example, are uniformly propagated by lateral sections, or instinctive slips or offsets; while almost every genus of zoophytic worms is only capable of increase by buds, bulbs, or knobs.

"The blood of plants, like that of animals, instead of being simple, is compound, and consists of a great multitude of compacter corpuscles, globules for the most part, but not always globules, floating in a looser and almost diaphanous fluid. From this common current of vitality, plants, like animals, secrete a variety of substances of different, and frequently of opposite powers and qualities, —substances nutritive, medicinal or destructive. And as in animal life, so also in vegetable, it is often observed that the very same tribe, or even individual, that in some of its organs secretes a wholesome aliment, in other organs secretes a deadly poison. As the viper pours into the reservoir situated at the bottom of his hollow tusk a fluid fatal to other animals, while in the general substance of his body he offers us not only a healthful nutriment, but in some sort, an antidote for the venom of his jaw: so the jatropha manihot, or Indian cassava, secretes a juice extremely poisonous in its root, while its leaves are regarded as a common esculent in the country, and are eaten like spinach-leaves among ourselves.

"Animals, as we all know, are liable to a great variety of diseases; so, too, are vegetables; to diseases as numerous, as varied, and as fatal; to diseases epidemic, endemic, sporadic; to scabies, pernio ulcer, gangrene; to polysarca, atrophy, and, above all, to invermination. Whatever, in fine, be the system of nosology to which we are attached, it is impossible for us to put our hand upon any one class or order of diseases which they describe, without putting our hand, at the same time, upon some disease to which plants are subject in common with animals.

"There are some tribes of animals that exfoliate their cuticle annually; such are grass hoppers, spiders, several species of crabs, and serpents. Among vegetables we meet with a similar variation from the common rule, in the shrubby cinquefoil, indigenous to Yorkshire, and the plane-tree of the West Indies. Animals are occasionally divided into the two classes of locomotive or migratory, and fixed or permanent; vegetables may partake of a similar classification. Unquestionably the greater number of animals are of the former section, yet in every order of worms we meet with some instances that naturally appertain to the latter, while almost every genus and species of the zoophytes can only be included under it. Plants, on the contrary, are for the most part stationary, yet there are many that are fairly entitled to be regarded as locomotive or migratory. The strawberry may be selected as a familiar example."

Plants, like animals, have a wonderful power of maintaining their common temperature, whatever be the temperature of the atmosphere that surrounds them, and like animals, they are found to exist in astonishing degrees of heat and cold. Of these, Mr. Good has given many curious instances. Animals are often divided into the three classes of terrestrial, aquatic, and aerial. Plants are capable of a similar division. Among animals, it is probable that the largest number is of the first class, but among vegetables, it should seem, from the almost countless species of fuci, &c. that the largest number belongs to the submarine class Many animals are amphibious, or capable of preserving life in either element; the vegetable world is not without instances of a similar power. Animals of various kinds are aerial: all the most succulent plants of hot climates are of this description: these will only grow in soils or sands from which no moisture can be extracted: they are even destroyed by a full supply of wet by a rainy season: hence it has been supposed, that they derive the whole of their nourishment from the surrounding atmosphere, and that the only advantage which they acquire from thrusting their roots into such strata, is that of obtaining an erect position. Some quadrupeds seem to derive nutriment in the same manner. The bradypus, or sloth, never drinks, and trembles at the feeling of rain. Among plants, possessing the same properties, is the aerial epidendrum, a native of the East Indies, where it is no uncommon thing for the inhabitants to pluck it up, on account of the elegance of its leaves, the beauty of its flower, and the exquisite odour it diffuses, and to suspend it by a silken cord from the ceiling of their rooms, where, from year to year, it continues to put forth new leaves, new blossoms, a new fragrance, excited alone to new life and action by the stimulus of the surrounding atmosphere. "That stimulus is oxygen; ammonia is a good stimulus, but oxygen possesses far superior powers, and hence, without some portion of oxygen, no plant can ever be made to germinate: hence, to the use of cow-dung, and other animal recrements, which consists of muriatic acid and ammonia, while in fat oil and other fluids, that contain little or no oxygen, and consist altogether, or nearly so, of hydrogen and carbon, seeds may be confined for ages without exhibiting any germination whatever. And hence, again, and the fact deserves to be extensively known, however torpid a seed may be, and destitute of all power to vegetate in any other substance, if steeped in a diluted solution of oxygenated muriatic acid, at a temperature of about 46° or 48° of Fahrenheit, provided it still possess its principle of vitality, it will germinate in a few hours; and if, after this, it be planted, as it ought to be, in its appropriate soil, will grow with as much speed and vigour as if it had evinced no torpidity whatever."

The author next proceeds to enquire into the mode by which vegetable matter is capable of being converted into animal substance, so as not only to be perfectly assimilated to it, but to become the basis of animal nutriment and increase. "Now, to be able to reply succinctly and directly to this question, it is necessary first of all to inquire into the chief feature in which animal and vegetable substances agree, and the chief feature in which they disagree.

"Animals and vegetables, then, agree in their equal necessity of extracting a certain sweet and saccharine fluid, as the basis of their support, from whatever substances may, for this purpose, be applied to their respective organs of digestion.—Animal chyle and vegetable sap have a very close approximation to each other, in their constituent principles, as well as in their external appearance. In this respect plants and animals agree. They disagree, inasmuch as animal substances possess a very large proportion of azote, with a very small proportion of carbon; while vegetable substances, on the contrary, possess a very large proportion of carbon, with a very small proportion of azote. And it is hence obvious, that vegetable matter can only be assimilated to animal, by parting with its excess of carbon, and filling up its deficiency of azote.

"Vegetable substances, then, part first of all with a considerable portion of their excess of carbon, in the stomach and intestinal canal, during the process of digestion; a certain quantity of the carbon detaching a certain quantity of the oxygen, existing in these organs, as an elementary part of the air or water they contain, in consequence of its closer affinity to oxygen, and producing carbonic acid gas; a fact which has been clearly ascertained, by a variety of experiments by M. Jurine, of Geneva. A very large surplus of carbon, however, still enters the animal system, through the medium of the lacteals, and continues to circulate with the chyle, or the blood, till it reaches the lungs. Here, again, a considerable portion of carbon is perpetually parted with upon every expiration, in the same form of carbonic gas, in consequence of its union with a part of the oxygen introduced into the lungs with every returning inspiration; as is sufficiently established by the experiments of Mr. Davy, and other celebrated chemists; while the excess, that yet remains, is carried off by the skin, in consequence of its contact with atmospheric air: a fact put beyond all doubt by the experiments and observations of M. Jurine, although, on a superficial view, opposed by a few experiments of M. Ingenhouz; and obvious to every one, from the well-known circumstance, that the purest linen, upon the purest skin, in the purest atmosphere, soon becomes discoloured. In this way, then, and by this triple co-operation of the stomach, the lungs, and the skin, vegetable matter, in its conversion into animal, parts with the whole of its excess of carbon.—Its deficiency of azote becomes supplied in a twofold method. First, at the lungs; also, by the process of respiration; for we uniformly find, and the experiments of Dr. Priestley and Mr. Davy are fully conclusive upon this subject, that a larger portion of azote is inhaled upon every inspiration, than is returned by every succeeding expiration; in consequence of which, the portion retained in the lungs must enter into the system, in the same manner as the retained oxygen, and perhaps in conjunction with it; while, in unison with this action of the lungs, the skin also absorbs a considerable quantity of azote, and thus completes the supply that is necessary for the animalization of vegetable food; evincing, hereby, a double consent of action in these two organs, and giving us some insight into the mode by which insects and worms, which are totally destitute of lungs, are capable of employing the skin as a substitute for lungs, by breathing through certain spiracles, introduced into the skin for this purpose, or merely through the common pores of the skin, without any such additional mechanism. It is by this mode, also, that respiration takes place through the whole vegetable world, offering us another instance of resemblance to many parts of the animal; in consequence of which, insects, worms, and the leaves of vegetables, equally perish, by being smeared over with oil, or any other viscous fluid, that obstructs their cutaneous orifices.

"But to complete the great circle of universal action, and to preserve the important balance of nature in a state of equipoise, it is necessary, also, to inquire by what means animal matter is reconverted into vegetable; so as to afford to plants the same basis of nutriment which plants have previously afforded to animals."

The process of putrefaction is shown to be that principle, which is to be regarded as a most important link in the great chain of universal life and harmony. See Good's Oration.

Corallines, madrepores, millepores, and sponges, were formerly considered as fossil bodies; but the experiments of Count Marsigli evinced, that they are endued with life, and led him to class them with the maritime plants. And the observations of Ellis, Jussieu, and Peysonel, have since raised them to the rank of animals. The detection of error in long established opinions, concerning one branch of natural knowledge, justifies the suspicion of its existence in others, which are nearly allied to it. And it will appear, from the prosecution of an enquiry into the instincts, spontaneity, and self-moving power of vegetables, that the suspicion is not without foundation.

PLANTAGO, in botany, *plantain*, a genus of the Tetrandria Monogynia class and order. Natural order of Plantagines, Jussieu. Essential character: calyx four-cleft; corolla four-cleft, with the border reflex; stamina very long; capsule two-celled, cut transversely. There are thirty-eight species. These plants, having little beauty, are rarely cultivated, except in botanic gardens.

PLASHING *of quickset hedges*, an operation very necessary, to promote the growth and continuance of old hedges. It is performed in this manner: the old stubs must be cut off, &c. within two or three inches of the ground, and the best and longest of the middle sized shoots must be left to lay down. Some of the strongest of these must also be left to answer the purpose of stakes. These are to be cut off to the height at which the hedge is intended to be left; and they are to stand at ten feet distance one from another: when there are not proper shoots for these at the due distances, their places must be supplied with common stakes of dead wood. The hedge is to be first thinned, by cutting away all but those shoots which are intended to be used either as stakes, or the other work of the plashing; the ditch is to be cleaned out with the spade: and it must be now dug, as at first, with sloping sides each way; and when there is any cavity on the bank, on which the hedge grows, or the earth has been washed away from the roots of the shrubs, it is to be made good by facing it, as they express it, with the mould dug from the upper part of the ditch: all the rest of the earth dug out of the ditch is to be laid upon the top of the bank.

In plashing the quick, two extremes are to be avoided; these are, the laying it too low, and the laying it too thick: this makes the sap run all into the shoots, and leaves the plashes without sufficient nourishment; which, with the thickness of the hedge, finally kills them. The other extreme of laying them too high, is equally to be avoided; for this carries up all the nourishment into the plashes, and so makes the shoots small and weak at the bottom, and, consequently, the hedge thin.

PLASMA, in mineralogy. The colour of this mineral is intermediate between grass and leek green, and of different degrees of intensity. It is marked with ochre yellow dots, and whitish spots. It occurs in angular pieces; internally it is glistening; fracture perfectly flat conchoidal. It is hard, brittle, easily frangible; not very heavy. It has been found in Italy, Germany, and Turkey, but chiefly among the ruins of Rome. It is said that it was formerly worn by the Romans as a part of ornamental dress.

PLASTER, in pharmacy, is defined to be an external application, of a harder consistence than our ointments; these are to be spread according to the different circumstances of the wound, place, or patient, either upon linen or leather. See Pharmacy.

Plaster, among builders, &c. The plaster of Paris is a preparation of several species of gypsums, dug near Mont Maitre, a village in the neighbourhood of Paris; whence the name. See Mortar.

PLATANUS, in botany, *plane tree*, a genus of the Monoecia Polyandria class and order. Natural order of Amentaceæ. Essential character: male, calyx ament globular; corolla scarcely apparent; anthers growing round the filament: female, calyx ament globular; corolla many-petalled; stigma recurved: seeds roundish, mucronate with the style, pappose at the base. There are two species, *viz.* P. orientalis, oriental plane tree, and P. occidentalis, American plane tree; these are very large, handsome, and lofty trees. The first sort, or eastern plane tree, grows naturally in Asia; the stem is tall, erect, and covered with a smooth bark, which annually falls off; it sends out many side branches, and are generally a little crooked at their joints; the leaves are placed alternate, on foot-stalks an inch and a half long; the flowers come out upon long peduncles, hanging downward, each sustaining five or six round balls of flowers; the upper, which are the largest, are more than four inches in circumference: these sit very close to the peduncle; the bristly down surrounding the seeds helps to transport them to a great distance.

PLATALEA, the *spoonbill*, in natural history, a genus of birds of the order Grallæ. Generic character: bill long, broad, flat, and thin, the end widening into a roundish form; nostrils small at the base of the bill; tongue short and pointed; feet four-toed and semi-palmated. There are three species.

P. leucerodia, or the white spoon-bill, inhabits Europe, Asia, and Africa, and subsists on frogs and fishes, snakes and grass. It is of the size of a heron; it frequents the sea coasts, near which it builds in the highest trees, and in the breeding season, is nearly as clamorous as the rook. These birds are migratory, and withdraw to warm regions on the approach of winter. Their flesh has a strong resemblance in taste to that of a goose. See Aves, Plate XII. fig. 4.

P. ajaja, is somewhat less than the above, and its plumage is nearly throughout of an exquisite rose colour. It is seldom found further north than Georgia, feeds on small crabs, fish and moluscous animals, in pursuit of which it wades and occasionally dives.

The scarlet spoonbill, a variety, or more probably the young of the last, is of the colour from which it is named, which, however, it does not attain till its third year. It is of the same size as the last, and found in Jamaica and Mexico.

The dwarf spoonbill is of the size of a sparrow, and inhabits South America.

PLATE, in heraldry, is a round flat piece of silver, without any impression; but, as it were, formed ready to receive it.

Plate is also a term used by our sportsmen, to express the reward given to the best horse at our races.

Plates, in gunnery. The prize plates

are two plates of iron on the cheeks of a gun carriage, from the cape square to the centre, through which the prize-bolts go, and on which the handspike rests when it poises up the breech of the piece. Breast-plates are the two plates on the face of the carriage, one on each cheek. Train-plates are the two plates on the cheeks, at the train of the carriage. Dulidge-plates are the six plates on the wheel of a gun-carriage, where the felloes are joined together, and serve to strengthen the dulidges.

PLATFORM, in the military art, an elevation of earth, on which cannon is placed, to fire on the enemy; such are the mounts in the middle of curtins. On the rampart there is always a platform, where the cannon are mounted. It is made by the heaping up of earth on the rampart, or by an arrangement of madriers, rising insensibly, for the cannon to roll on, either in a casemate, or on attack in the out-works.

All practitioners are agreed, that no shot can be depended on, unless the piece can be placed on a solid platform; for if the platform shakes with the first impulse of the powder, the piece must likewise shake, which will alter its direction, and render the shot uncertain.

Platform, in architecture, is a row of beams, which support the timber-work of a roof, and lie on the top of the wall, where the entablature ought to be raised. This term is also used for a kind of terrace, or broad, smooth, open walk at the top of a building, from whence a fair prospect may be taken of the adjacent country. Hence an edifice is said to be covered with a platform, when it is flat at top, and has no ridge. Most of the oriental buildings are thus covered, as were all those of the ancients.

PLATINA, or Platinum, a metal, which in most of its properties is equal to gold, but in others it is very superior. It was first ascertained to be a distinct metal by Scheffer, a Swedish chemist, in the year 1752. By him it was named white gold, because it resembled this metal in many of its properties. It immediately became subject to the experiments of all the chemists in Europe, and obtained, from its colour, the name of platina, signifying little silver, from the word plata, which is Spanish for silver. Platina has been found among the gold ores of South America, and more particularly in the mine of Santa Fe near Carthagena, and in the district of Choco in Peru. Platina, in the state in which it reaches this country, is contaminated by the presence of several other metals, as iridium, osmium, rhodium, and palladium, and, in fact, it is merely an ore of platina. It is in the form of small grains or scales, of a whiter colour than iron, and extremely heavy. Various processes have been contrived for its purification; but the one, which is the most simple and practicable, is described in the ninth volume of Nicholson's Journal. Platina has the following properties. It is a white metal, resembling silver in colour, but greatly exceeding it, and indeed all other metals, in specific gravity, being, when it is hammered, twenty-three or twenty-four times heavier than water. It is not oxydized by the long continued and concurrent action of heat and air. It has the property of welding, which belongs to no other metal but this and iron. It is not acted on by any other acid than the nitro-muriatic and oxygenized muriatic. The former is best adapted to effect this solution. Sixteen parts of the compound acid are to be poured on one of the laminated metal, and exposed to heat in a glass vessel; nitrous gas is disengaged, and a reddish coloured solution is obtained, which gives a brown stain to the skin. The muriate of platina has the characteristic property of being precipitated by a solution of muriate of ammonia. By this character, platina is distinguished from all other metals, and may be separated when mingled with them in solution. The precipitate, thus obtained, is decomposed by a strong heat, and leaves pure platina. When pure potash is poured into the muriatic solution, a precipitate ensues, which is not an oxide of platina, but a triple compound of that oxide with the alkali and acid. With soda, also, it forms a triple combination.

Platina is acted upon by fusion with nitrate of potash, and also with pure fixed alkalies. The most delicate test of the presence of platina is muriate of tin. A solution of platina, so dilute as to be scarcely distinguishable from water, assumes a bright red colour, on the addition of a single drop of the recent solution of tin.

Platina has been discovered by Dr. Wollaston to be a remarkably slow conductor of caloric. When equal pieces of silver, copper, and platina, were covered with wax, and heated at one end, the wax was melted 3¼ inches on the silver; 2½ on the copper; and one inch only on the platina. Its expansion by heat is considerably less than that of steel; which, between the temperatures of 32° and 212° is expanded about 12 parts in 10,000, while the expansion of platina is only about 10.

Platina combines with many of the metals, and forms with them alloys, some of which are of considerable importance in the working of this metal. Platina forms an alloy with arsenic, which is brittle and very fusible. It is in this state of alloy that platina is susceptible of being formed into different utensils and instruments for which it is peculiarly fitted. It is first fused with this metal, and then cast into moulds, at first in the form of square plates. It is then exposed to a red heat, and hammered into bars. By the heating and hammering, the arsenic is driven off, and the metal is purified and becomes infusible, but retains its ductility, so that it may be wrought like iron. It has been found extremely difficult to combine platina and mercury. Guyton had observed that the adhesive force of platina and mercury is greater than that of metals which do not combine with it; and that it is not inferior even to those which readily form alloys; from which he conjectured that the alloy of platina and mercury might be effected by the following process. He placed a very thin plate of pure platina at the bottom of a matrass containing a quantity of mercury. The matrass was put upon a sand bath, and heat applied, till the mercury boiled and the matrass became red-hot. When the platina was taken out, it was found to have acquired additional weight, and to have become very brittle. But this combination is different from the other combinations of mercury with the metals, for the platina did not lose its solid form. M. Chenevix, in the course of experiments and researches respecting a supposed new metal called palladium, succeeded in forming an amalgam with platina and mercury. He heated purified platina in the form of fine powder, with ten times its weight of mercury, and rubbed them together for a long time. The result was an amalgam of platina, which being exposed to a violent heat, lost all the mercury it contained, and the original weight of the platina remained. Platina combines with copper by means of fusion, and gives it hardness. When the proportion of copper is three or four times greater than that of platina, the alloy is ductile, susceptible of a fine polish, and is not altered by exposure to the air. This alloy has been employed in the fabrication of mirrors for telescopes. Gold combines readily with platina, but it requires a very powerful heat for the fusion of these two metals. Platina diminishes the colour of gold, unless it be in very small quantity. When the proportion of platina is above $\frac{1}{17}$, the colour of the gold begins to be altered. There is no perceptible change in the specific gravity or the ductility of gold from this alloy.

Platina, on account of its peculiar properties, its infusibility, density and indestructibility, could it be obtained in sufficient quantity, and at a moderate price, would undoubtedly prove one of the most useful and most important of the metals yet known. The importance and utility of platina, on account of its scarcity, have been hitherto limited to chemical purposes; and for different chemical instruments and utensils, it has been found peculiarly appropriate, as there are few chemical agents whose effects it cannot resist. There is indeed little doubt but it might be employed with equal advantage in the construction of instruments and utenils, in various arts and manufactures.

PLATING, is the art of covering baser metals with a thin plate of silver, either for use or for ornament. It is said to have been invented by a spur-maker, not for show, but for real utility. Till then the more elegant spurs in common use were made of solid silver; and from the flexibility of that metal, they were liable to be bent into inconvenient forms by the slightest accident. To remedy this defect, a workman at Birmingham contrived to make the branches of a pair of spurs hollow, and to fill that hollow with a slender rod of steel or iron. Finding this a great improvement, and being desirous to add cheapness to utility, he continued to make the hollow larger, and of course the iron thicker and thicker, till at last he discovered the means of coating an iron spur with silver in such a manner, as to make it equally elegant with those which were made wholly of that metal. The invention was quickly applied to other purposes; and to numberless utensils, which were formerly made of brass or iron, are now given the strength of these metals, and the elegance of silver, for a small additional expense. The silver plate was formerly made to adhere to the baser metal by means of solder; which is of two kinds, the soft and the hard, or the tin and silver solders. The former of these consists of tin alone, the latter generally of three parts of silver and one of brass. When a buckle, for instance, is to be plated by means of the soft solder, the ring, before it is bent, is first tinned, and then the silver-plate is gently hammered upon it, the hammer employed being always covered with a piece of cloth. The silver now forms, as it were, a mould to the ring, and whatever of it is not intended to be used is cut off. This mould is fastened to the ring of the buckle by two or three cramps of iron-wire; after which the buckle, with the plated side undermost, is laid upon a plate of iron sufficiently hot to melt the tin, but not the silver. The buckle is then covered with powdered resin, or anointed with turpentine; and, lest there should be a deficiency of tin, a small portion of rolled tin is likewise melted on it. The buckle is now taken off with tongs, and commonly laid on a bed of sand; where the plate and the ring, while the solder is yet in a state of fusion, are more closely compressed by a smart stroke with a block of wood. The buckle is afterwards bent and finished.

The mode of plating at present is, to fasten plates of silver upon thicker plates of copper, and then rolling them together into thin plates. The copper is twelve times thicker than the silver, and one ounce of silver is rolled to a surface of three feet or more. The plates being thus made, they are then stamped by a single stroke into the size and form of buckles, buttons, spoons, &c.

PLATONIC *year*, or the Great *year*, is a period of time determined by the revolution of the equinoxes, or the space wherein the stars and constellations return to their former places, in respect of the equinoxes. The platonic year, according to Tycho Brahe, is 25,816, according to Ricciolus 25,920, and according to Cassini 24,800 years. This period once accomplished, it was an opinion among the ancients, that the world was to begin anew, and the same series of things to turn over again.

Platonic *philosophy*. See Academics.

PLATOON, in the military art, a small square body of forty or fifty men, drawn out of a batallion of foot, and placed between the squadrons of horse, to sustain them; or in ambuscades, straits, and defiles, where there is not room for whole battalions or regiments. Platoons are also used, when they form the hollow square, to strengthen the angles. The grenadiers are generally posted in platoons.

PLATYLOBYUM, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx bell-shaped, five-cleft; the two upper segments very large and obtuse; legume pedicelled, compressed, winged at the back. There is but one species, *viz.* P. formosum, orange flat pea, a native of New South Wales, where it flowers all the year round.

PLATYPUS, in natural history, a genus of Mammalia of the order Bruta. Generic character: mouth shaped like the bill of a duck; webbed feet. The P. anatinus, or duck-billed platypus, is a native of South Wales, and constitutes a new and most curious genus of quadrupeds. See Ornithorhynchus.

PLEA, in law, that which either party alleges for himself in court. These are divided into pleas of the crown and common pleas. Pleas of the crown, are all suits in the King's name, against offences committed against his crown and dignity, or against his crown and peace. Common Pleas, are those that are held between common persons. Common Pleas, are either dilatory or pleas to the action. Pleas dilatory, are such as tend merely to delay, or put off the suit, by questioning the propriety of the remedy, rather than by denying the injury. Pleas to the action, are such as dispute the very cause of suit. Dilatory pleas must not be confounded with sham pleas, which are used for the purpose of delay, but which, if true, would go to the merits of the action, and which, however they may be abused, can never be avoided in practice.

PLEADINGS. Pleadings, in general, signify the allegations of parties to suits when they are put into a proper and legal form; and are distinguished in respect to the parties who plead them, by the names of bars, replications, rejoinders, sur-rejoinders, rebutters, &c.; and though the matter in the declaration or count does not properly come under the name of pleading, yet, being often comprehended in the extended sense of the word, it is generally considered under this head. This is the technical sense of the word pleading, which is vulgarly applied to the public speaking of the advocates in the courts. The necessity of reducing the proceedings into writing gives rise to a great deal of business amongst barristers, which is called special pleading, and those who are skilled in this are distinguished particularly as pleaders. Of late years persons under the degree of barristers have drawn pleadings, which are afterwards signed by barristers. These persons take very low fees, but when called to the bar engross a great share of business. Their habits bring them closely connected with attornies.

PLEASURE and Pain, says Mr Locke, are simple ideas, which we receive both from sensation and reflection; there being thoughts of the mind, as well as sensations, accompanied with pleasure or pain.

PLECTRANTHUS, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx upper segment larger; corolla resupine, gibbous or spurred at the base; filaments simple. There are five species, natives of Africa and Arabia Felix.

PLECTRONIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Rhamni, Jussieu. Essential character: petals five, inserted into the throat of the calyx; berry two-seeded, inferior. There is but one species, viz. P. ventosa, a native of the Cape of Good Hope.

PLEIADES, in astronomy, an assemblage of seven stars in the neck of the constellation Taurus, the bull; although there are now only six of them visible to the naked eye. The largest is of the third magnitude, called "lucido pleiadum."

PLENUM, in physics, denotes, according to the Cartesians, that state of things wherein every part of space is supposed to be full of matter; in opposition to a vacuum.

PLENUS *flos*, in botany, *a full flower*; a term expressive of the highest degree of luxuriance in flowers. The petals in full flowers are so multiplied as to exclude all the stamina, and frequently to choak up the female organ, so that such flowers, though delightful to the eye, are vegetable monsters. Flowers with more than one petal, are most liable to this; such are the ranunculus, anemony, poppy, myrtle, &c. &c. Flowers with one petal only are but seldom subject to this fulness; these, however, are not totally exempt, as may be seen in the double polyanthus, hyacinth, crocus, &c. In flowers with one petal, the mode of luxuriance, or impletion, is by a multiplication of the divisions of the limb, or upper part. In flowers with more than one petal, by a multiplication of the petals of nectarium.

PLEURISY, in medicine, a violent pain in the side, attended with an acute fever, a cough, and a difficulty of breathing.

PLEURONECTES, the *flounder*, in natural history, a genus of fishes of the order Thoracici. Generic character: the eyes spherical, and both on the same side of the head; mouth arched; body compressed, one side representing the back, and the other the abdomen. In this genus are comprehended all that are commonly denominated flat fish. They swim obliquely, and are observed generally at the bottom of the water, being destitute of the air bladder. They often ingulph themselves in sands as far as the head, and thus elude the attacks of many enemies. The eyes of some of this genus are towards the right when the fish presents its abdomen to the spectator, and those of others towards the left. This difference constitutes the principal division of this genus.

P. hippoglossus, or the holibut, is one of the largest of fishes, being sometimes found of four hundred pounds weight.—It subsists on smaller fishes, and on various kinds of crabs and shell fish It is considered as rather coarse for the table, when particularly large, and the part nearest the fins is thought by far preferable to any other. It is found in the European and North American seas.

The P. platessa, or plaise, is distinguishable from the other species, by being marked on the body and fins by numerous orange coloured spots. This fish inhabits the same seas as the former, and is sometimes taken of the weight of fifteen pounds, though one of eight is considered in England as very large. They are in considerable estimation, and are thought preferable when of a moderate size. They subsist on the same food as the former.

The P. limanda, or dab, inhabits the same seas, but is far less common. It is much smaller than the last, but thought far more delicate for the table. It is in the greatest perfection in the spring months.

P. flesus, or the flounder, is formed much like the plaise, but is smaller, and destitute of the orange spots; it inhabits the same seas, and abounds on the British coasts, and frequently ascends the rivers to a considerable height.

P. solea, or the sole, is found in the European and American seas, and is sometimes two feet long, and eight pounds in weight; but, in general, very considerably smaller. Its scales may be distinguished by the microscope for their peculiar elegance of structure. Soles are fond of lying at the bottom of the waters which they frequent, and are caught by trawl nets. Their flesh is extremely firm and rich, and is preferred to that of any other species but the turbot. They are taken in the greatest abundance near Brixham, in Devonshire.

P. tuberculatus, or P. maximus, the turbot, is broader and squarer than the above species, has a skin apparently wrinkled, and covered with numerous obtuse, unequal, spinous tubercles. It occasionally attains the weight of thirty pounds, and though called by Linnæus the largest of the genus, is extremely inferior in size to the holibut. Its flesh, however, is more valued than that of any other species, and is considered as a high and luxurious delicacy. It is found in the same seas, and subsists on the same food, as the species above-mentioned. On the coast of Holland, these fishes are caught in great abundance by baits of herrings, haddocks, and particularly of lampreys, which are exported from Mortlake, in this country, for that purpose, to the number of nearly half a million per annum, and the value of seven or eight hundred pounds. In England, Scarborough is the principal station of the turbot fishery, which is conducted in vessels of a ton burden, in which three men carry each three distinct lines, hooked and baited, which, altogether, when let down into the water, fixed at both extremities with stones, as anchors, extend sometimes to the length of three miles, always across the tide, and contain between two and three thousand hooks. At every turn of the tide they are drawn up. This fishery is attended with great danger, notwithstanding the admirable construction of the boats, or cobles, as storms come on with extreme celerity, and scarcely admitting the opportunity of escaping to the shore, from a sea which exhibits suddenly the most mountainous and overwhelming billows. This, and all the above species, have their eyes on the right side. Seven species are enumerated as inhabitants of the United States.

PLINIA, in botany, a genus of the Icosandria Monogynia class and order. Natural order of Rosaceæ, Jussieu. Essential character: calyx five or four-parted; petals five or four; drupe superior, grooved. There are two species, viz. P. crocea, saffron fruited plinia, and P. pedunculata, red fruited plinia.

PLINTH, in architecture, a flat square member, in the form of a brick. It is used as the foundation of columns, being that flat square table, under the moulding of the base and pedestal at the bottom of the whole order. It seems to have been originally intended to keep the bottom of the original wooden pillars from rotting.

Plinth *of a statue*, &c. is a base, either flat, round, or square, that serves to support it.

Plinth *of a wall*, denotes two or three rows of bricks advancing out from a wall; or, in general, any flat high moulding, that serves in a front wall to mark the floors, to sustain the eaves of a wall, or the larmier of a chimney.

PLOCAMA, in botany, a genus of the Pentandria Monogynia class and order.—Essential character: calyx five-toothed, superior; corolla bell-shaped, five-cleft; berry three-celled; cells one-seeded.—There is but one species, viz. P. pendula, pendulous plocama, a native of the Canary Islands.

PLOT, in dramatic poetry, is sometimes used for the fable of a tragedy or comedy, but more particularly the knot or intrigue, which makes the embarras of any piece. The unravelling puts an end to the plot.

Plot, in surveying, the plan or draught of any field, farm, or manor, surveyed with an instrument, and laid down in the proper figure and dimensions.

PLOTTING, among surveyors, is the art of laying down on paper, &c. the several angles and lines of a tract of ground surveyed by a theodolite, &c. and a chain. In surveying with the plain table, the plotting is saved; the several angles and distances being laid down on the spot, as fast as they are taken. See Plain-table. But, in working with the theodolite, semicircle, or circumferentor, the angles are taken in degrees; and the distances in chains and links, so that there remains an after-operation, to reduce these members into lines, and so to form a draught, plan, or map; this operation is called plotting. Plotting, then, is performed by means of two instruments, the protractor and plotting scale. By the first, the several angles observed in the field with a theodolite, or the like, and entered down in degrees in the field book, are protracted on paper in their just quantity. By the latter, the several distances measured with the chain, and entered down in the like manner in the field book, are laid down in their just proportion.—See Surveying.

Plotting-*scale*, a mathematical instrument, usually of wood, sometimes of brass, or other matter; and either a foot or half a foot long. On one side of the instrument are seven several scales, or lines, divided into equal parts. The first division of the first scale is subdivided into ten equal parts, to which is prefixed the number 10, signifying that ten of these subdivisions make an inch; or that the divisions of that scale are decimals of inches. The first division of the second scale is likewise subdivided into 10, to which is prefixed the number 16, denoting that sixteen of these subdivisions make an inch. The first division of the third scale is subdivided in like manner into 10, to which is prefixed the number 20; to that of the fourth scale is prefixed the number 24; to that of the fifth, 32; that of the sixth, 40; that of the seventh, 48; denoting the number of subdivisions equal to an inch, in each, respectively. The two last scales are broken off to make room for two lines of chords. There is, also, on the back side of the instrument a diagonal scale.

As to the use of plotting, if we were required to lay down any distance upon paper, suppose 6 chains 50 links: draw an indefinite line; then setting one foot of the compasses at figure 6 on the scale, *e. gr.* the scale of 20 in an inch, extend the other to five of the subdivisions, for 50 links: this distance, being transferred to the line, will exhibit the 6 chains 50 links required.

If it be desired to have 6 chains 50 links take up more or less space, take them off from a greater or lesser scale, *i. e.* from a scale that has more or fewer divisions in an inch.

To find the chains and links contained in a right line, *e. gr.* that is just drawn, according to any scale, *e. gr.* that of 20 in an inch. Take the length of the line in the compasses, and applying it to the given scale, you will find it extend from the number 6 of the great divisions to 5 of the small ones: hence the given line contains 6 chains 50 links.

PLOTUS, the *darter*, in natural history, a genus of birds of the order Anseres. Generic character: bill strait, pointed toothed; nostrils, a slit near the base; face and chin without feathers; legs short; toes four, and all webbed. There are three species. P. anhinga, or the white bellied darter, is of the size of a mallard, but measures nearly three feet in length. It is found in Brazil; builds in trees and roosts in them at night, though living chiefly on fishes. In catching these its manner resembles that of serpents. Drawing up its neck, it darts on its prey with its bill, and catches it in its claws. It is rarely seen on the ground, and, when not on the water in the pursuit of its food, it is to be seen on the most elevated trees, where it sits with its head drawn in between the shoulders. Its flesh is rank and oily. The black bellied anhinga is found in Ceylon and Java, and darting its long neck through the low shrubs immediately over the water, is, on the first view, mistaken frequently for some venomous reptile, and excites corresponding agitation and terror. The Surinam darter is of the size of a teal, and feeds on flies as well as fishes and water insects; and in every attempt at destroying a fly by the dart of its bill it has been observed to succeed for a long continued time. It is often domesticated, and is called the sun-bird, from the circumstance, probably, of its often developing at once its tail and wings, and thus exhibiting a circular appearance of plumage, which, however, is certainly by no means glowing and ardent.

PLOUGH, in agriculture, a machine for turning up the soil, contrived to save the time, labour, and expence, that without this instrument must have been employed in digging land, to prepare it for the sowing of all kinds of grain. See Agriculture.

Plough, among book-binders, is a machine for cutting the edges of the leaves of books smooth.

PLUKENETIA, in botany, so named from Leonard Plukenet, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoccæ Euphorbiæ, Jussieu. Essential character; calyx none; petals four; male, stamens eight: nectaries four, bearded: female, style very long, with a peltate, four-lobed stigma; capsule four-grained. There is but one species; *viz.* P. volubilis, a native of both Indies.

PLUM-*tree*. See Prunus.

PLUMB-*line*, among artificers, denotes a perpendicular to the horizon; so called as being commonly erected by means of a plummet.

PLUMBAGO, in botany, *lead-wort*, a genus of the Pentandria Monogynia class and order. Natural order of Plumbagines, Jussieu. Essential character: corolla funnel-form; stamens inserted into scales inclosing the base of the corolla; stigma five-cleft; seed one, oblong, tunicated. There are seven species.

Plumbago, in chemistry, a carburet of iron. See Iron.

PLUMBERY, the art of casting and working lead, and using it in buildings, &c. As this metal melts very readily, it is easy to cast it into figures of any kind, by running it into moulds of brass, clay, plaster, &c. But the chief articles in plumbery are sheets and pipes of lead; and as these make the basis of the plumber's work, we shall here give the process of making them. In casting sheet-lead, a table or mould is made use of, which consists of large pieces of wood well jointed, and bound with bars of iron at the ends, on the sides of which runs a frame, consisting of a ledge, or border of wood, two or three inches thick, and two or three inches high from the mould, called the sharps: the ordinary width of the mould, within these sharps, is from three to four feet: and its length is sixteen, seventeen, or eighteen feet. This should be something longer than the sheets are intended to be, in order that the end where the metal runs off from the mould may be cut off, because it is commonly thin, or uneven, or ragged at the end.—It must stand very even or level in breadth, and something falling from the end in which the metal is poured in, *viz.* about an inch, or an inch and a half, in the length of sixteen or seventeen inches. At the upper end of the mould stands the pan, which is a concave triangular prism, composed of two planks nailed together at right angles, and two triangular pieces fitted in between them at the ends. The length of this pan is the whole breadth of the mould in which the sheets are cast; it stands with its bottom, which is a sharp edge, on a form at the end of the mould, leaning with one side against it, and on the opposite side is a handle to lift it up by, to pour out the melted lead; and on that side of the pan next the mould are two iron hooks to take hold of the mould and prevent the pan from slipping, while the melted lead is pouring out of it into the mould. This pan is lined on the inside with moistened sand, to prevent it from being fired by the hot metal. The mould is also spread over about two thirds of an inch thick, with sand sifted and moistened, which is rendered perfectly level by moving over it a piece of wood called a strike, by trampling upon it with the feet, and smoothing it over with a smoothing plane, which is a thick plate of polished brass, about nine inches square, turned up on all the four edges, and with a handle fitted on the upper or concave side. The sand being thus smoothed, it is fit for casting sheets of lead; but if they would cast a cistern, they measure out the bigness of the four sides, and having taken the dimensions of the front, or fore-part, make mouldings, by pressing long slips of wood, which contain the same mouldings, into the level sand, and form the figures of birds, beasts, &c. by pressing in the same manner leaden figures upon it, and then taking them off, and at the same time smoothing the surface where any of the sand is raised up, by making these impressions upon it.

The rest of the operation is the same in casting either cisterns or plain sheets of lead; but before we proceed to mention the manner in which that is performed, it will be necessary to give a more particular description of the strike. The strike, then, is a piece of board about five inches broad, and something longer than the breadth of the mould on the inside; and at each end is cut a notch about two inches deep, so that when it is used it rides upon the sharps with those notches. Before they begin to cast, the strike is made ready by tacking on two pieces of an old hat on the notches, or by slipping a case of leather over each end, in order to raise the under side about one-eighth of an inch, or something more, above the sand, according as they would have the sheet to be in thickness; then they tallow the under edge of the strike, and lay it across the mould. The lead being melted, it is ladled into the pan, in which, when there is a sufficient quantity for the present purpose, the scum of the metal is swept off with a piece of board to the edge of the pan, letting it settle on the sand, which is by this means prevented from falling into the mould at the pouring out of the metal. When the lead is cool enough, which is known by its beginning to stand with a shell or wall on the sand round the pan; two men take the pan by the handle, or else one of them lifts it up by a bar and chain fixed to a beam in the ceiling, and pour it into the mould, while another man stands ready with the strike, and, as soon as they have done pouring in the metal, puts on the mould, sweeps the lead forward, and draws the overplus into a trough prepared to receive it. The sheets being thus cast, nothing remains but to planish the edges, in order to render them smooth and straight; but if it be a cistern, it is bent into four sides, so that the two ends may join the back, where they are soldered together, after which the bottom is soldered up.

The Method of casting thin sheets of Lead. Instead of sand, they cover the mould with a piece of woollen stuff nailed down at the two ends to keep it tight, and over this lay a very fine linen cloth. In this process great regard is had to the just degree of heat, so as that the lead may run well, and yet not burn the linen.—This they judge of by a piece of paper, for it takes fire in the liquid lead if it is too hot, and if it be not shrunk and scorched a little, it is not hot enough.

The Method of casting Pipes without soldering. To make these pipes they have a kind of little mill, with arms or levers to turn it withal. The moulds are of brass, and consist of two pieces, which open and shut by means of hooks and hinges, their inward calibre, or diameter, being according to the size of the pipe to be made, and their length is usually two feet and a half. In the middle is placed a core, or round piece of brass or iron, somewhat longer than the mould, and of the thickness of the inward diameter of the pipe. This core is passed through two copper-rundles, one at each end of the mould, which they serve to close; and to these is joined a little copper-tube, about two inches long, and of the thickness the leaden pipe is intended to be of. By means of these tubes the core is retained in the middle of the cavity of the mould. The core being in the mould, with the rundles at its two ends, and the lead melted in the furnace, they take it up in a ladle, and pour it into the mould by a little aperture at one end, made in the form of a funnel. When the mould is full, they pass a hook into the end of the core, and, turning the mill, draw it out; and then, opening the mould, take out the pipe. If they desire to have the pipe lengthened, they put one end of it in the lower end of the mould, and pass the end of the core into it; then shut the mould again, and apply its rundle and tube as before, the pipe just cast serving for rundle, &c. at the other end. Things being thus replaced, they pour in fresh metal, and repeat the operation till they have got a pipe of the length required. For making pipes of sheet-lead, the plumbers have wooden cylinders, of the length and thickness required, and on these they form their pipes, by wrapping the sheet around them, and soldering up the edges all along them.

PLUME, a set or bunch of ostrich feathers, pulled out of the tail and wings, and made up to serve for ornaments in funerals, &c. Among sportsmen, plume is the general colour or mixture of the feathers of a hawk, which shows her constitution.

PLUMERIA, in botany, so named in honour of Charles Plumier; a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; follicles two, reflex; seeds inserted into their proper membrane. There are four species.

PLUMMET, Plumb-rule, or Plumb-line, an instrument used by carpenters, masons, &c. in order to judge whether walls, &c. be upright planes, horizontal, or the like. It is thus called from a piece of lead, "plumbum," fastened to the end of a cord, which usually constitutes this instrument. Sometimes the string descends along a wooden ruler, &c. raised perpendicularly on another; in which case it becomes a level. See Level.

PLUMMING, among miners, is the method of using a mine-dial, in order to know the exact place of the work where to sink down an air-shaft, or to bring an adit to the work, or to know which way the load inclines when any flexure happens in it. It is performed in this manner: a skilful person, with an assistant, and with pen, ink, and paper, and a long line, and a sun-dial, after his guess of the place above ground, descends into the adit or work, and there fastens one end of the line to some fixed thing in it, then the incited needle is let to rest, and the exact point where it rests is marked with a pen: he then goes on further in the line, still fastened, and at the next flexure of the adit he makes a mark on the line by a knot or otherwise; and then letting down the dial again, he there likewise notes down that point at which the needle stands in this second position. In this manner he proceeds from turning to turning, marking down the points, and marking the line, till he comes to the intended place; this done, he ascends and begins to work on the surface of the earth what he did in the adit, bringing the first knot in the line to such a place where the mark of the place of the needle will again answer its pointing, and continues this till he comes to the desired place above ground, which is certain to be perpendicularly over the part of the mine into which the air-shaft is to be sunk.

PLUMULA, in botany, a little feather, the scaly part of the corculum, or embryo plant within the seed, which ascends and becomes the stem or trunk. It extends itself into the cavity of the lobes, and is terminated by a small branch resembling a feather, from which it derives its name.

PLUNGER, in mechanics, a solid brass cylinder, used as a forcer in forcing pumps.

PLURAL, in grammar, an epithet applied to that number of nouns and verbs which is used when we speak of more than one thing; or that which expresses a plurality or number of things. See Grammar.

PLURALITY. In ecclesiastical matters, no person having one benefice, with cure of souls, of 8*l*. a year, in the King's books, shall accept another; but the former benefice shall be void, unless the person has a dispensation from the Archbishop of Canterbury, who has power to grant dispensations to chaplains of noblemen and others, under proper qualifications, to hold two livings, provided they are not more than thirty miles distant from each other; and provided that he reside in each, for a reasonable time, every year; and that the parson keep a sufficient curate in that in which he does not ordinarily reside.

PLUS, in algebra, a character marked thus +, used for the sign of addition.

PLUSH, in commerce, &c. a kind of stuff having a sort of velvet knap, or shag, on one side, composed regularly of a woof of a single woollen thread and a double warp, the one wool, of two threads twisted, the other goat's or camel's hair; though there are some plushes entirely of worsted, and others composed wholly of hair. Plush is manufactured, like velvet, on a loom with three treadles; two of these separate and depress the woollen warp, and the third raises the hair warp, upon which the workman throwing the shuttle passes the woof between the woollen and hair warp; and afterwards laying a brass broach, or needle, under that of the hair, he cuts it thereon with a knife destined for that use; conducting the knife on the broach, which is made a little hollow all its length, and thus gives the surface of the plush an appearance of velvet. See Velvet.

PLUVIAMETER. See Rain *gauge*.

PNEUMATICS, is that branch of natural philosophy which treats of the weight, pressure, and elasticity of the air, with the effects arising from them.

Galileo, whose name is presented as of itself, whenever the enquiry relates to the first researches concerning gravity, had verified that of the air, which was denied almost universally before him, though it had been discovered by some few philosophers of antiquity. This celebrated philosopher having injected air into a glass vessel, so that it there remained compressed, found that the vessel weighed more than when the contained air was in its natural state. He inquired also, by another experiment, into the heaviness of this fluid compared with that of water; but he found it only in the ratio of 1 to 400, which is much too small, as we shall soon see. The pneumatic machine, or air-pump, was not then known. It is to Otto Guericke, a burgomaster of Magdeburg, that we are indebted for the invention of this elegant machine, which is not, like many others, confined to one part of experimental philosophy, for almost all branches derive aid from it. This machine, which will be presently described, when reduced to its greatest simplicity, is composed of a vertical cylinder of brass, in which a piston is moved; its upper base carries a cock, above which is soldered a circular brass plate situated horizontally. On this plate the receiver is placed, from which we would exhaust the air, which is executed by making the piston descend and ascend alternately. By the use of this instrument, the gravity of the air has been verified, by first weighing a ball or bladder full of air, and then weighing it, after the ball or bladder has been exhausted of the air; a sensible diminution will be perceived in the weight of the ball. Philosophers have attempted likewise to determine, with precision, the specific gravity of the air.

According to the results of Deluc, the ratio between the weight of common air and distilled water, at the temperature of thawing ice, and under a medium pressure of 29.9 English inches of mercury, is that of 1 to 760; and from the experiments of Lavoisier, it follows that a cubic inch of air, taken at 10 degrees of Reaumur, weighs 0.46005 grains, and that the weight of a cubic foot of the same fluid is one ounce, three drams, and three grains. but by some very accurate experiments of Mr. Cavendish, it was ascertained that the weight of water is to that of air as 800 to 1: this was the case when the barometer stood at 29¾ inches, and the thermometer at 50°. Sir George Shuckburgh found it to be as 836 to 1, when the barometer was 29.37, and the thermometer at 51°. The medium of many experiments by the gentlemen already mentioned, and by Mr. Hauksbee, Dr. Halley, Mr. Cotes, and other philosophers equally zealous in the improvements of natural science, is about 832 to 1, when the barometer is 30°, and the thermometer 55°: this ratio must vary in proportion to the changes in the height of the barometer, and it varies also $\frac{1}{440}$th part for every degree of the thermometer above or below temperature: hence the cubic foot of air, of water, and of quicksilver, may be taken as $1\frac{1}{5}$ ounce, 1000 ounces, and 13,600 ounces.

The gravity of the air being once known, it should seem that it could not be difficult to infer that the ascent of water, in the body of a pump, must be occasioned by the pressure of that fluid. This, however, was not the case: Galileo had no notion of it.

Some Italian conduit-makers being asked if they would construct sucking-pumps, whose tubes should be more than 33 feet in height, remarked, with surprise, that the water refused to rise above that limit. They requested of Galileo the explication of this singular fact; and it is affirmed that the philosopher, being taken unawares, replied, that nature did not entertain the horror of a vacuum beyond 33 feet. Torricelli, a disciple of Galileo, having meditated upon this phenomenon, conjectured that water is elevated in pumps by the pressure of the exterior air; and that this pressure has only the degree of force necessary to counterbalance the weight of a column of water of 33 feet. He verified this conjecture by an experiment, for which natural philosophy owes him a double obligation, since it serves to render evident an important discovery, while it has procured us the barometer. Torricelli saw the mercury stand 29 or 30 inches in a glass tube, sealed at its upper part, and situated vertically; and the height thus under consideration being to that of 33 feet in the inverse ratio of the densities of water and of mercury; he concluded that the phenomenon belonged to statics, and that it was really, as he had conjectured, the pressure of the air which caused water or mercury to rise until an equilibrium was produced: this occurred in 1643. The year following, the news of Torricelli's experiment was disseminated in France by a letter written from Italy to Father Mersenne. The experiment was performed again in 1646, by Mersenne and Pascal; and the latter devised, in 1647, a method of rendering it still more decisive, by making it at different altitudes. He invited, in consequence, his friend Perrier to repeat the experiment upon the mountain Puy-de-Dome, and to observe whether the column of mercury would descend in the tube in proportion as it became more elevated. We may see from the letter of Pascal to Perrier, where he seems to avoid the name of Torricelli, that he had not yet entirely renounced the chimera of the horror at a vacuum which was attributed to nature, and that by admitting that this horror was not invincible, he was not bold enough to assert that it never obtained. The success of the experiment completely removed the delusion. Yet this experiment was only a confirmation of that by Torricelli, and therefore yielded an additional ray to the stream of light which issued from it. The pressure of the atmosphere, upon a given surface, being nearly the same as would be exerted upon that surface by a column of water of 33 feet high; from this datum has been computed the effect of the pressure under consideration, with respect to a man of medium magnitude, and it has been found that it is equivalent to a weight of about 33,600 pounds. Considerable as this weight is, its pressure is exerted unknown to us, because it is continually balanced by the re-action of the elastic fluids comprised in the interior cavities of our bodies; and though the air is subject to continual variations, which augment or diminish its density, in consequence of changes of temperature, and of the action of different natural causes, yet as these variations are generally confined within narrow limits, and succeed each other with comparative tardiness, they do not affect us commonly, except in a manner scarcely perceptible. But if there happen a sudden change, as when a man is raised to great heights, the rupture of the equilibrium which ensues, has a very marked influence upon the animal economy. He then experiences an extreme fatigue, and absolute inability to continue his progress; a drowsiness under which he sinks in spite of himself; the respiration becomes thick and difficult; the pulsations take an accelerated motion. To explain these effects, it must be considered that the state of well-being, in all that depends upon respiration, requires that a determinate quantity of air should pass through the lungs in a given time. If, therefore, the air that we respire becomes much more rare, the inspirations must of necessity be proportionally more frequent; which will render the respiration more difficult, and will occasion the various symptoms to which we have referred. With regard to the inconveniences that would result from an air too condensed, man is not exposed to them by the action of natural causes; and it appears that, in general, they are less than those which are caused by the rarefaction of the air.

We need only cite here, as a proof of the small magnitude of these inconveniences, that which happens to divers, when they have been shut up within a bell which descended vertically in the water, and in which the air, pressed by the weight of the surrounding columns, contracts itself more and more, in proportion as the vessel is found at a greater depth. The accidents which have occurred to those who have continued for a certain time under the bell, have arisen in great part from the alteration produced in the air by respiration, and that which was most dangerous in this fluid was the defect of renewing it. See Diving *bell*, Barometer, &c.

The elasticity of the air is verified by several well-known experiments. One of the most ordinary is that in which we employ the machine called the artificial fountain. It consists of a metallic vessel of a rounded form, its summit being pierced with an orifice, through which the vessel may be filled with water to about two-thirds of its capacity. In this aperture a tube is then fixed, which descends into the vessel until it is within a little distance of the bottom, while its upper part, which projects from the orifice, is furnished with a cock. To this same part a forcing pump is adapted, and the cock being opened, a great quantity of air is injected into the vessel: this air, being lighter than water, rises above it, and its elasticity augments with its density, in proportion as new strokes are given to the piston. Then, after closing the cock, the pump is removed, and a kind of little hollow cone is substituted for it, open at its summit, which is turned upwards; as soon as the cock is again opened, the condensed air exerts its force upon the surface of the water, and drives it through the canal that is immersed into that liquid, whence it is seen to shoot out, under the form of a jet of more than twenty or thirty feet in height. An analogous effect may be obtained, solely by diminishing the natural elasticity of the air, by placing under the receiver of an air pump a little vessel, in which all is similar to what the artificial fountain presents at the moment when the cock is opened to give a free passage to the water, except that the air situated above this liquid is in its ordinary state.

While the exhaustion is going on, the air included in the vessel, and whose pressure upon the water is no longer balanced by that of the exterior air, dilates itself, and gives birth to a jet which rises under the receiver. (See fig. 5.) But the most interesting experiment relative to this object is that of Boyle, and of Mariotte, to show that the air contracts itself nearly in the ratio of the weights with which it is pressed. These kinds of experiments merit the preference, since they are not confined to merely proving the existence of a phenomenon, but make known also how it exists, by determining the law to which it is subject. Take a glass tube *a b* (Plate Pneumatics, fig. 1), bent into two branches, the shortest of which is about twelve inches high; it must be equally thick throughout, and hermetically sealed at its extremity *b*. The other branch, which is open at *a*, should be at least five feet, but if it were eight feet in height, so much the better. The whole is fixed upon a plate which carries divisions adapted to the two tubes. First, let there be poured into the bent part a little mercury, to obtain a line of level, *x z*, that we may estimate the number of degrees comprised between that line and the superior extremity of the shortest branch. In this state of things the air which occupies that branch maintains an equilibrium, by its elasticity, with the pressure of the column of atmosperic air gravitating in the other branch, and whose pressure is transmitted by means of the mercury comprised in the inferior curvature. This pressure, as we have seen in the article Barometer, is equal to that of a mercurial column of about twenty-nine or thirty inches in height. Afterwards, let mercury be poured into the longest branch, and at the same time the air in the other branch will be condensed; by the excess of the resulting pressure the mercury will rise in the shorter branch until an equilibrium is again produced. Then measure, on one part, the length of that column of compressed air, and on the other the excess of the column of mercury contained in the longest branch, above that which occupies the shortest. We will suppose, for more simplicity, that this excess is equal to thirty inches; in that case, we shall find that the column of compressed air is reduced to the half of the height which it occupied previously to the introduction of the fresh mercury. But that column is charged with a weight double of the former, since a pressure of thirty inches of mercury is added to an equal pressure exerted by the atmospheric air, and which is not considered as being diminished; for we may neglect the small difference which results from this, that the thirty inches which terminate the atmospheric column at bottom are actually occupied by the mercury. In general, if we take the ratio between the first pressure from the column of the atmosphere, and any other pressure whatever exerted by that same column, and by the mercury superadded, the corresponding spaces, occupied by the compressed air, will be respectively in the inverse ratio of the pressures; whence it is obvious, that the air contracts itself, as we have stated, in proportion to the weights compressing it. If we afterwards take out the mercury at several distinct times, the air will expand by reason of its elasticity, and the spaces which it will successively occupy in a contrary order will still conform to the inverse ratio of the pressures.

Having given this brief account of the general properties of air, we shall refer to a few experiments, and the instruments which are commonly used in performing these experiments; beginning with the air-pump, which has been already described in a general way. Fig. 2, is an air pump, much in use. A A are two brass barrels, each containing a piston, with a valve opening upwards. They are worked by means of the winch, B, which has a pinion that fits into the teeth of the racks, C C, which are made upon the ends of the pistons, and by this means moves them up and down alternately. On the square wooden frame, D E, there is placed a brass plate, G, ground perfectly flat, and also a brass tube, let into the wood communicating with the two cylinders and the cock, I, and opening into the centre of the brass plate at *a*. The glass vessel, K, to be emptied or exhausted of air, has its rim ground quite flat, and rubbed with a little pomatum, or hog's-lard, to make it fit more closely upon the brass plate of the pump. Sometimes thin slips of moistened leather are used for this purpose. These vessels are called receivers. Having shut the cock, I, the pistons are worked by the winch, and the air being suffered to escape when the piston is forced down, because the valve opens upwards, but prevented from returning into the vessel, for the same reason the receiver is gradually exhausted, and will then be fixed fast upon the pump-plate. By opening the cock, I, the air rushes again into the receiver.

To the air pump is attached the guage, *z*, or instrument for measuring the degree of rarefaction, or exhaustion, produced in the receiver, and which is a necessary appendage to the air-pump. If a barometer be included beneath the receiver, the mercury will stand at the same height as in the open air, but when the receiver begins to be exhausted, the mercury will descend, and rest at a height, which is, in proportion to its former height, as the spring of the air remaining in the receiver is to its spring before exhaustion. Thus, if the height of the mercury, after exhaustion, is the thousandth part of what it was before, we say that the air in the receiver rarefied is a thousand times. On account of the inconvenience of including a barometer in a receiver, a tube, of six or eight inches in length, is filled with mercury, and inverted in the same manner as the barometer. This being included, answers the same purpose, with no other difference, than that the mercury does not begin to descend till after about three-fourths of the air is exhausted: it is called the short barometer guage. This is generally placed detached, but communicating with the receiver by a tube concealed in the frame, as is represented in the figure; another and better guage was invented by Mr. Smeaton, and called, from its form, the pear-guage. It consists of a glass vessel, in the form of a pear (fig. 3.) and sufficient to hold about half a pound of mercury: it is open at one end, and at the other end is a tube, hermetically closed at top. The tube is graduated, so as to represent proportionate parts of the whole capacity. This guage, during the exhaustion of the receiver, is suspended in it by a slip wire, over a cistern of mercury, placed also in the receiver. When the pump is worked as much as is thought necessary, the guage is let down into the mercury, and the air re-admitted. The mercury will immediately rise in the guage; but if any air remained in the receiver, a certain portion of it would be in the guage; and as it would occupy the top of the tube above the mercury, it would shew by its size the degree of exhaustion; for the bubble of air would be to the whole contents of the guage, as the quantity of air in the exhausted receiver would to an equal volume of the common atmospheric air. If the receiver contained any elastic vapour generated during the rarefaction, it would be condensed upon the re-admission of the atmospheric air, as it cannot subsist in the usual pressure. The pear-guage, therefore, shows the true quantity of atmospheric air left in the receiver. Hence it will sometimes indicate that all the permanent air is exhausted from the receiver, except about $\frac{1}{100000}$ part, when the other guages do not shew a degree of exhaustion of more than two hundred times, and sometimes much less.

When the receiver is placed upon the plate of the air-pump without exhausting it, it may be removed again with the utmost facility, because there is a mass of air under it, that resists, by its elasticity, the pressure on the outside; but exhaust the receiver, thus removing the counter pressure, and it will be held down to the plate by the weight of the air upon it. What the pressure of the air amounts to, is exactly determined in the following manner: when the surface of a fluid is exposed to the air, it is pressed by the weight of the atmosphere equally on every part, and consequently remains at rest. But if the pressure be removed from any particular part, the fluid must yield in that part, and be forced out of its situation.

Into the receiver A, (fig. 4), put a small vessel with quicksilver, or any other fluid, and through the collar of leathers at B, suspend a glass tube, hermetrically sealed, over the small vessel. Having exhausted the receiver, let down the tube into the quicksilver, which will not rise into the tube as long as the receiver continues empty. But re-admit the air, and the quicksilver will immediately ascend. The reason of this is, that upon exhausting the receiver, the tube is likewise emptied of air; and therefore, when it is immersed in the quicksilver, and the air re-admitted into the receiver, all the surface of the quicksilver is pressed upon by the air, except that portion which lies above the orifice of the tube: consequently, it muss rise in the tube, and continue so to do, until the weight of the elevated quicksilver press as forcibly on that portion which lies beneath the tube, as the weight of the air does on every other equal portion without the tube.

Take a common syringe of any kind, and having pushed the piston to the furthest end, immerse it into water; then draw up the piston, and the water will follow it. This is owing to the same cause as the last: when the piston is pulled up, the air is drawn out of the syringe with it, and the pressure of the atmosphere is removed from the part of the water immediately under it; consequently, the water is obliged to yield in that part to the pressure on the surface. It is upon this principle that all those pumps called sucking pumps act: the piston fitting tightly the inside of the barrel, by being raised up, removes the pressure of the atmosphere from that part, and consequently the water is drawn up by the pressure upon the surface. See Hydraulics, and Pump.

The effects arising from the weight and pressure of the atmosphere have been absurdly attributed to suction; a word which ought to be exploded, as it conveys a false notion of the cause of these and similar phenomena. To prove that an exhausted receiver is held down by the pressure of the atmosphere, take one, open at top, and ground quite flat, as A, (fig. 6), and covered with a brass plate, B, which has a brass rod passing through it, working in a collar of leather, so as to be air tight; to this rod suspend a small receiver within the large one, a little way from the bottom; place the receiver, A, upon the pump-plate, and exhaust it: it will now be fixed fast down; but the small receiver may be pulled up or down with perfect ease, as it is itself exhausted, and all the air which surrounded it removed, consequently it cannot be exposed to any pressure; let, then, the small one down upon the plate, but not over the hole by which the air is extracted, and re-admit the air into the large receiver, which may then be removed; it will be found, that the small one being itself exhausted, is held down fast by the air, which is now admitted round the outside. If the large receiver be again put over it and exhausted, the small one will be at liberty, and so on, as often as the experiment is repeated. This effect cannot be accounted for upon any other principle than the pressure of the air; as the common idea of suction can have nothing to do in the case of the small receiver, which is fixed down merely by letting in the air round it. We ought, therefore, to attribute all those effects which are vulgarly ascribed to suction, such as the raising of water by pumps, &c. to the weight and pressure of the atmosphere.

A square column of quicksilver, $29\frac{1}{2}$ inches high, and an inch thick, weighs just 15 pounds, consequently the air presses with a weight equal to 15 pounds, upon every square inch of the Earth's surface; and 144 times as much, or 2,160 pounds, upon every square foot. The Earth's surface contains in round numbers, 200,000,000 square miles; and as every square mile contains 27,876,400 square feet, there must be 5,575,080,000,000,000 square feet on the Earth's surface; which number, multiplied by 2,160 pounds (the pressure on each square foot), gives 12,043,468,800,000,000,000 pounds for the pressure, or whole weight of the atmosphere

If the top of a small receiver be covered by a piece of flat, thin glass, upon exhausting it, the glass will be broke to pieces by the incumbent weight; and this would happen to the large receiver itself, but for the arched top, that resists the weight much more than a flat surface.

This experiment may be varied, by tying a piece of wet bladder over the open mouth of the receiver, and leaving it to dry till it becomes as tight as a drum. Upon exhausting the receiver, you will perceive the bladder rendered concave, and it will yield more and more, until it break with a loud report, which is occasioned by the air striking forcibly against the inside of the receiver, upon being re-admitted. Air, as we have seen, is one of the most elastic bodies in nature; that is, it is easily compressed into less compass, and when the pressure is removed it immediately regains its former bulk

As all the parts of the atmosphere gravitate, or press upon each other, it is easy to conceive, that the air next the surface of the earth is more compressed and denser than what is at some height above it; in the same manner as if wool were thrown into a deep pit until it reached the top. The wool at the bottom having all the weight of what was above it, would be squeezed into a less compass; the layer, or stratum above it, would not be pressed quite so much; the one above that still less, and so on, till the upper one, having no weight over it, would be in its natural state. This is the case with the air, or atmosphere, that surrounds our earth, and accompanies it in its motion round the sun. On the tops of lofty buildings, but still more on those of mountains, the air is found to be considerably less dense than at the level of the sea. The height of the atmosphere has never yet been exactly ascertained; indeed, on account of its great elasticity, it may extend to an immense distance, becoming, however, rarer, in proportion to its distance from the earth. It is observed, that at a greater height than forty-five miles it does not refract the rays of light from the sun; and this is usually considered as the limit of the atmosphere. In a rarer state, however, it may extend much further. And this is by some thought to be the case, from the appearance of certain meteors which have been reckoned to be seventy or eighty miles distant, and whose light is thought to depend upon their coming through our atmosphere. Dr. Cotes has demonstrated, that if altitudes in the air be taken in arithmetical proportion, the rarity of the air will be in geometrical proportion. And hence it is easy to prove by calculation, that a cubic inch of such air as we breathe, would be so much rarefied at the altitude of 500 miles, that it would fill a sphere equal in diameter to the orbit of Saturn.

The elastic power of the air is always equivalent to the force which compresses it; for if it were less, it would yield to the pressure, and be more compressed; were it greater, it would not be so much reduced; for action and re-action are always equal, so that the elastic force of any small portion of the air we breathe, is equal to the weight of the incumbent part of the atmosphere; that weight being the force which confines it to the dimensions it possesses.

To prove this by an experiment, pour some quicksilver into the small bottle, A, (fig. 7), and screw the brass collar, C, of the tube, B C, into the brass neck of the bottle, and the lower end of the tube will be immersed into the quicksilver, so that the air above the quicksilver in the bottle will be confined there. This tube is open at top, and is covered by the receiver, G, and large tube, EF; which tube is fixed by brass collars to the receiver, and is closed at top. This preparation being made, exhaust the air out of the receiver, G, and its tube, by putting it upon the plate of the air pump, and the air will, by the same means, be exhausted out of the inner tube, B C, through its open top at C. As the receiver and tubes are exhausting, the air that is confined in the glass bottle, A, will press so by its spring, as to raise the quicksilver in the inner tube to the same height as it stands in the barometer.

There is a little machine, consisting of two vanes of equal weights, independent of each other, and turn equally free on their axles in the frame. Each vane has four thin arms or sails fixed into the axis: those of the one have their planes at right angles to its axis, and those of the other have their planes parallel to it. Therefore, as the former turns round in common air, it is but little resisted thereby, because its sails cut the air with their thin edges; but the latter is much resisted, because the broad side of its sails move against the air when it turns round. In each axle is a fine pin near the middle of the frame, which goes quite through the axle, and stands out a little on each side of it: under these pins a slider may be made to bear, and so hinder the vanes from going, when a strong spring is set or bent against the opposite ends of the pins.

Having set this machine upon the pump-plate, draw up a slider, and set the spring at bend on the opposite ends of the pins: then push down the slider, and the spring, acting equally strong upon each mill, will set them both a-going with equal forces and velocities; but the first will run much longer than the last, because the air makes much less resistance against the edges of its sails than against the sides of the other.

Draw up the slider again, and set the spring upon the pins as before; then cover the machine with the receiver upon the pump-plate; and having exhausted the receiver of air, push down the wire (through the collar of leathers in the neck) upon the slider; which will disengage it from the pins, and allow the vanes to turn round by the impulse of the spring: and as there is no air in the receiver to make any sensible resistance against them, they will both move a considerable time longer than they did in the open air; and the moment that one stops, the other will do so too. This shows that air resists bodies in motion, and that equal bodies meet with different degrees of resistance, according as they present greater or less surfaces to the air.

Take a tall receiver, covered at top by a brass plate, through which works a rod in a collar of leathers, and to the bottom of which there is a particular contrivance for supporting a guinea and a feather, and for letting them drop at the same instant. If they are let fall while the receiver is full of air, the guinea will fall much quicker than the feather; but if the receiver be first exhausted, it will be found that they both arrive at the bottom at the same instant, which proves that all bodies would fall to the ground with the same velocity, if it were not for the resistance of the air, which impedes most the motion of those bodies that have the least momentum. In this experiment the observers ought not to look at the top, but at the bottom of the receiver, otherwise, on account of the quickness of their motion, they will not be able to see whether the guinea and feather fall at the same instant.

Take a receiver, having a brass cap fitted to the top with a hole in it; fit one end of a dry hazel branch, about an inch long, tight into the hole, and the other end tight into a hole quite through the bottom of a small wooden cup; then pour some quicksilver into the cup, and exhaust the receiver of air, and the pressure of the outward air on the surface of the quicksilver will force it through the pores of the hazel, from whence it will descend in a beautiful shower, into a glass cup placed under the receiver to catch it.

Join the two brass hemispherical cups, A and B, together, (fig. 8) with a wet leather between them, having a hole in the middle of it; then having screwed off the handle at C, screw both the hemispheres put together into the pump-plate, and turn the cock E, so that the pipe may be open all the way into the cavity of the hemispheres; then exhaust the air out of them, and turn the cock; unscrew the hemispheres from the pump, and having put on the handle C, let two strong men try to pull the hemispheres asunder by the rings, which they will find hard to do; for if the diameter of the hemispheres be four inches, they will be pressed together by the external air with a force equal to 190 pounds; and to show that it is the pressure of the air that keeps them together, hang them by either of the rings upon the hook of a wire in the receiver of the air-pump, and, upon exhausting the air out of the receiver, they will fall asunder of themselves.

Set a square phial upon the pump-plate, and having covered it with a wire cage, put a close receiver over it, and exhaust the air out of the receiver; in doing which, the air will also make its way out of the phial, through a small valve in its neck. When the air is exhausted, turn the cock below the plate to re-admit the air into the receiver; and as it cannot get into the phial again, because of the valve, the phial will be broken into some thousands of pieces by the pressure of the air upon it. Had the phial been of a round form, it would have sustained this pressure, like an arch, without breaking; but as its sides are flat, it cannot.

Let a large piece of cork be suspended by a thread at one end of a balance, and counterpoised by a leaden weight, suspended in the same manner, at the other. Let this balance be hung to the inside of the top of a large receiver; which being set on the pump, and the air exhausted, the cork will preponderate, and show itself to be heavier than the lead; but upon letting in the air again, the equilibrium will be restored. The reason of this is, that since the air is a fluid, and all bodies lose as much of their absolute weight in it as is equal to the weight of their bulk of the fluid, the cork, being the larger body, loses more of its real weight than the lead does; and therefore must in fact be heavier, to balance it under the disadvantage of losing some of its weight, which disadvantage being taken off by removing the air, the bodies then gravitate according to their real quantities of matter, and the cork which balanced the lead in air, shews itself to be heavier when in vacuo.

Set a lighted candle upon the pump, and cover it with a tall receiver. If the receiver holds a gallon, the candle will burn a minute; and then, having gradually decayed from the first instant, it will go out; which shows, that a constant supply of fresh air is as necessary to feed flame, as animal life.

The moment when the candle goes out, the smoke will be seen to ascend to the top of the receiver, and there it will form a sort of cloud; but upon exhausting the air, the smoke will fall down to the bottom of the receiver, and leave it as clear at the top as it was before it was set upon the pump. This shows, that smoke does not ascend on account of its being positively light, but because it is lighter than air; and its falling to the bottom, when the air is taken away, shows that it is not destitute of weight. So most sorts of wood ascend or swim in water; and yet there are none who doubt of the wood's having gravity or weight.

Set a receiver, which is open at top, on the air-pump, and cover it with a brass plate and wet leather; and having exhausted it of air, let the air in again at top through an iron pipe, making it pass through a charcoal flame at the end of the pipe; and when the receiver is full of that air, lift up the cover, and let down a mouse or bird into the receiver, and the burnt air will immediately kill it. If a candle be let down into that air, it will go out directly; but by letting it down gently, it will drive out the impure air, and good air will get in.

Set a bell on the pump-plate, having a contrivance so as to ring it at pleasure, and cover it with a receiver; then make the clapper strike against the bell, and the sound will be very well heard; but, exhaust the receiver of air, and then, if the clapper be made to strike ever so hard against the bell, it will make no sound; which shows, that air is absolutely necessary for the propagation of sound.

It has been shown, that air can be rarefied, or made to expand; we now proceed to show, that it can also be condensed, or pressed into less space than what it generally occupies. The instrument used for this purpose is called a condenser: (fig. 9) represents a machine of this kind; it consists of a brass barrel, containing a piston, which has a valve opening downwards; so that as the piston is raised, the air passes through the valve; but as the piston is pushed down the air cannot return, and is, therefore, forced through a valve at the bottom of the barrel, that allows it to pass through into the receiver, B, but prevents it from returning. Thus, at every stroke of the piston, more air is thrown into the receiver, which is of very thick and strong glass. The receiver is held down upon the plate, C, by the cross piece, D, and the screws, EF. The air is let out of the receiver by the cock, G, which communicates with it.

The sound of a bell is much louder in condensed than in common air. A phial that would bear the pressure of the common atmosphere, when the air is exhausted from the inside, will be broken by condensing the air round it. These experiments may be made under the receiver B.

A very beautiful fountain may be made by condensed air. Procure a strong copper vessel, (fig. 10) having a tube that screws into the neck of it, so as to be airtight, and long enough to reach near to the bottom. Having poured a quantity of water into the vessel, but not enough to fill it, and screwed in the tube, adapt to it a condensing syringe, and condense the air in the vessel; shut the stop-cock, and unscrew the syringe, then, on opening the stop-cock, the air acting upon the water in the vessel, will force it out into a jet of very great height. A number of different kinds of jets may be screwed on the tube, such as stars, wheels, &c. forming a very pleasing appearance.

The air-gun is a pneumatical instrument, of an ingenious contrivance, which will drive a bullet with great violence, by means of condensed air, forced into an iron ball by a condenser. Fig. 11, represents the condenser for forcing the air into the ball. At the end of this instrument is a male screw, on which the hollow ball, *b*, is screwed, in order to be filled with condensed air. In the inside of this ball is a valve, to hinder the air, after it is injected, from making its escape, until it be forced open by a pin, against which the hammer of the lock strikes; which then lets out as much air as will drive a ball with considerable force to a great distance.

When you condense the air in the ball, place your feet on the iron cross, *h h*, to which the piston-rod, *d*, is fixed; then lift off the barrel, *e a*, by the handles, *i i*, until the end of the piston is brought between *e* and *c*; the barrel, *a c*, will then be filled with air through the hole, *e*. Then thrust down the barrel, *a c*, by the handles, *i i*, until the piston, *e*, join with the neck of the iron ball at *a*; the air being thus condensed between *e* and *a*, will force open the valve in the ball, and when the handles are lifted up again, the valve will close and keep in the air, in this manner the ball will presently be filled; after which, unscrew the ball off the condenser, and screw it upon another male screw, which is connected with the barrel, and goes through the stock of the gun, as represented, (fig. 12) The whole will be better understood by (fig. 13.) which is a section of the gun. The inside, *k*, is that from which the bullets are shot, and, C D S R, is a larger barrel. In the stock of the gun, M, which forces the air through the valve E P, into the cavity between the two barrels, there is a valve at S L, which being opened by the trigger, O, permits the air to rush suddenly behind the bullet, so as to drive it out with great force. If the valve is suddenly opened and closed, one charge of condensed air may make several discharges of bullets.

PNEUMORA, in natural history, a genus of insects of the order Hemiptera.— Body ovate, inflated, diaphanous; head inflected, armed with jaws; thorax convex, carinate beneath; wing-cases deflected, membranaceous; legs formed for running. There are only three species, viz. 1. P. immaculata: green spotted with white; wing-cases immaculate. 2. P. maculata: wing-cases green, with square white spots. And, 3. P. guttata: wing-cases green, with two white spots; abdomen with three white spots on each side. They are all found at the Cape of Good Hope. The insects of this genus appear to consist of a mere hollow inflated membrane: by rubbing together their serrate, or toothed legs, they make a shrill kind of noise morning and evening, and follow a light; and they are so nearly allied to the cricket tribe, that they have been enumerated by some naturalists under the genus Gryllus.

POA, in botany, *meadow-grass*, a genus of the Triandria Digynia class and order. Natural order of Gramina, or Grasses.— Essential character: calyx two-valved, many-flowered: spikelet ovate; valves scariose at the edge, and sharpish. There are seventy one species.

POCKET, in the woollen trade, a word used to denote a large sort of bag, in which wool is packed up to be sent from one part of the kingdom to an another. The pocket contains usually twenty-five hundred weight of wool.

PODOPHYLLUM, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Rhœadeæ. Ranunculaceæ, Jussieu. Essential character: calyx three-leaved; corolla nine-petalled; berry one-celled, crowned with the stigma. There are two species, viz. P. peltatum, duck's-foot, or May-apple; and P. diphyllum.

PODURA, in natural history, *spring tail*, a genus of insects of the order Aptera. Generic character: lip bifid; four feelers, subclavate; two eyes, composed of eight facets; antennæ filiform; body scaly; tail forked, bent under the body, and acting as a spring, hence its name; six legs, formed for running. There are thirty-one species. They feed on leaves of various plants: the larva and pupa are six-footed, nimble, and resemble the perfect insect. P. aquatica is black, and, as its name imports, aquatic; they assemble in troops early in the morning, on the banks of pools and fish-ponds. P. ambulans is white, with a bifid extended tail, and is found principally among moss.

POETICAL *rising and setting of the stars.* The three kinds of rising and setting, viz. the cosmical, acronical, and heliacal, were made by the ancient poets, referring the rising, &c. of the stars to that of the sun.

POETRY. Dr. Blackwall, in his "Essay on the Life and Writings of Homer," says, on the subject of poetry, that "it is of a nature so delicate, as not to admit of a direct definition; for if ever the *je ne scais quoi* was rightly applied, it is to the powers of poetry, and the faculty that produces it. To go about to describe it would be like attempting to define inspiration, or that glow of fancy, or effusion of soul, which a poet feels while in his fit; a sensation so strong, that they express it only by adjurings, exclamations, and rapture." To the same purpose, but in less inflated language, Dr. Blair has observed, that it is not so easy as might at first be imagined, to ascertain, with minute precision, wherein poetry differs from prose. In point of fact, every reflecting reader must be sensible, that as it is difficult to determine the precise line where different shades of colour terminate, or even the boundaries of animal and vegetable nature, so it is a matter of no small nicety to fix the point where composition rises from the scale of prose to that of poetry.

By a small addition to the ideas of Aristotle, poetry may, however, be defined an imitative and creative art, whose energies are exerted by means of words metrically arranged, the end and design of which art is to amuse the fancy, and powerfully to excite the feelings.

It is the favourite expression of Aristotle, that poety is a mimetic or imitative art; and in most particulars it may be justly so defined. The subjects of the poet's imitation are the scenes of nature, and the transactions of human life. This we shall find to be the case, if we particularly examine the productions of those to whom the concurrent voice of ages has given the title of poet. When we open the Iliad of Homer, we behold a lively representation of the actions and speeches of heroes and chiefs. The dramas of Æschylus, of Sophocles, of Aristophanes, and of their numerous tribes of successors, are nothing more than imitations of human manners. And when the lover displays his passion in song, what does he but exhibit to view the tablet of his heart, where we may trace his feelings, and view him agitated by doubt or exulting in hope. The chief interest of didactic poetry consists in the vivid and picturesque descriptions, the imitations or representations of nature, which relieve the insipidity of unornamented precept. This is manifest, when it is recollected, that the pleasure excited by the Georgic of Virgil is not occasioned by his agricultural instructions, but by his descriptions of the various phenomena, which in the course of rural occupations arrest the attention of the lover of nature.

The word poet, in its original import, signifies creator. And as names are not unfrequently significant of the nature of the ideas which they represent, the name itself of poetry will direct us to one of its most distinguishing characteristics. It is indeed one of the noblest qualities of poetry, that it opens to the mind a new creation.

"The poet's eye, in a fine frenzy rolling,
Doth glance from heaven to earth, from earth to heaven;
And as imagination bodies forth
The form of things unknown, the poet's pen
Turns them to shapes, and gives to airy nothing
A local habitation and a name."

The poet enjoys the privilege of ranging through the boundless field of possibilities, and of selecting his objects according to the impulse of his fancy, as controuled and corrected by the discretion of his judgment. What is striking and interesting he may make prominent in his picture; what is offensive, deformed, or gross, he is at liberty to conceal or to soften. In the realities of life a thousand circumstances intervene to check the enthusiastic interest which our hearts are disposed to take in any specific occurrence. These circumstances the poet has a prescriptive right to exclude from his representations. As all ideas of men are primitively derived from objects of sense, he cannot go beyond the materials which the station and the powers of man supply. But he can, by an endless combination of these materials, produce ideal beings and fancied situations, which interest us the more, the better the powers of fiction to which they owe their birth are concealed from us. Like the favoured statuary of Greece, he is surrounded by naked beauties, from each of which he selects its peculiar excellency, and produces a whole, which, though strictly natural, surpasses the realities of nature.

The mathematician, in his investigation of truth, is confined to the narrow path of reason. The same may be said of the philosopher. The slightest deviation into the fields of imagination frustrates their pursuit, and disappoints their hopes of fame. The historian must found his reputation upon a patient investigation of facts, and beware of giving the loosened rein to his inventive talents. The orator, indeed, calls fancy to the aid of reason; but she ought to be strictly an auxiliary. If his edifice be not founded on the solid basis of reason, it will fall, together with its embellishments, to the ground. In oratory, fancy embellishes the operations of judgment; but so far as poetry is a creative art, imagination is its primary cause, and judgment a secondary agent, employed to prune the luxuriant shoots of fancy.

It is the grand source of the excellence of poetic imitation, that this imitation is effected by words. Aristotle has defined words as "sounds significant:" they are significant of ideas. Men that adopt the same language, by a tacit compact, agree that certain sounds shall be the representatives of certain ideas. But ideas represent their archetypes. When, therefore, we use words, we revive in the minds of those who understand our language the pictures of the objects of which we speak. The poetic imitation then being carried on by means of words, evidently embraces all objects of which mankind have ever formed ideas. Its energies are not crippled. It expatiates in the universe, and even passes

—"the flaming bounds of space and time."

This circumstance is justly noted by the ingenious Mr. Harris, as bestowing upon poetry a decisive superiority over the art of painting. The energies of painting are confined to those objects that can be represented by colour and figure. Poetry can also express these objects, though, it must be confessed, with a far inferior degree of exquisiteness; but this deficiency is amply compensated by the extensive range of the poet's excursions. He dives into the human heart, developes the windings of the heart, pourtrays in all their circumstances the workings of the passions, gives form and body to the most abstract ideas, and by the language which he puts into the mouths of his characters he unlocks the secrets of their mind. There is another grand advantage which the poet possesses over the painter, namely, that the latter is confined to the transactions that happen in a moment of time; while the former presents to our view a long series of consecutive events. An interesting picture might no doubt be drawn of the pious agony with which Æneas witnessed the obstinacy of his father, in refusing to save himself from the sword of the Greeks by quitting his ancient and long-loved abode. But what a varied pleasure do we experience in reading of the circumstances that preceded and that followed this event, in tracing the steps of the duteous son from the palace of Priam to his father's mansion, and in beholding him at length bearing his parent beyond the reach of the foe. Aristotle's doctrine, that a finished composition should have a beginning, a middle, and an end, is founded on reason; and the mind feels a superior degree of satisfaction, when the rise, the circumstances, and the consequences of events, are displayed before it in artful order.

But the poetic imitation or representation is effected, not merely by words, but by words metrically, or at least melodiously arranged.

Melody is naturally pleasing to the human ear; and it is not surprizing, that the cultivators of an art, whose province it is to delight, should be careful in bringing as nearly as possible to perfection the melody of their numbers. It is astonishing with what accuracy the Greeks and Romans attended to this particular; how minutely they weighed the value of almost every syllable; how strictly their bards were obliged to conform to the established standard. In modern times, and in our own language, greater latitude is allowed; yet almost every reader of poetry is aware of the charms of melodious composition. What a sensible difference do we perceive between the careless couplets of Churchill and the polished numbers of Pope. How much more pleasing to the ear are the measured sentences of M'Pherson, than a host of lines which we sometimes find printed in the form of verses.

But though melodious and metrical arrangement of words be one of the characteristics, and, as Dr. Blair denominates it, "the exterior distinction" of poetry, it is necessary to observe, that too many writers seem to assign to this characteristic a place of eminence to which it is by no means entitled. In consequence of this error, vast multitudes of compositions are obtruded upon the world under the name of poems, which possess no other merit than that of regularity of versification and smoothness of numbers. Against these wearisome productions Horace has long ago protested, in his memorable declaration, that the quality of mediocrity is denied to poets, and that poetry includes something more in its definition than the measuring of syllables and the tagging of a verse. If the heart does not glow with the flame of genius, the mechanism of art will be of no avail. No one can excite strong feelings in others, who is not himself strongly excited; no one can raise vivid images in the mind of his reader who is not himself illumined by the sportive light of fancy. Verses strictly and legitimately measured out, with due attention to pause and cadence, but devoid of the animating spirit which characterizes true poetry, are, like the human body when deprived of the principle of life, cold, cheerless, and offensive.

He who aspires after the title of poet should never, indeed, forget, that the end of poetry is to amuse the fancy and powerfully to excite the feelings, and that this is effected by impressing the mind with the most vivid pictures. In the course of her operations, poetry hurries us beyond the reach of sober judgment, and captivates by rousing the energy of passion. Here then we see the cause of the power of verse, nor wonder at the efficaciousness which has, more especially in early times, been ascribed to the muses. For how easily are mankind guided by those who possess the art of awakening or of allaying their feelings. Though all unconscious of being under the guidance of another, they turn obedient to the rein. They are roused to insurrection, or moderated to peace, by him who can touch with a skilful hand the master springs that regulate the motions of their minds. "The primary aim of a poet," says Dr. Blair, "is to please and to move; and therefore it is to the imagination and the passions that he speaks. He may, and he ought to have it in his view, to instruct and to reform; but it is indirectly, and by pleasing and moving, that he accomplishes this end. His mind is supposed to be animated by some interesting object, which fires his imagination, or engages his passions; and which of course communicates to his style a peculiar elevation, suited to his ideas, very different from that mode of expression which is natural to the mind in its calm ordinary state."

As then it appears to be the leading end of poetry to make a lively impression on the feelings, we may judge as it were *à priori* of the amazing intenseness of its powers, and we shall find our judgment verified when we come to inquire into the fact. In consequence of the efficacy of poetry upon the human feelings, the maxims of early wisdom, the first records of history, the solemn offices of religion, nay even the dictates of law, were delivered in the poetic dress. In the infancy of states, poetry is a method equally captivating and powerful of forming the dispositions of the people, and kindling in their hearts that love of glory which is their country's safeguard in the day of peril. Whether we look to the cold regions of Scandinavia, or the delicious clime of Greece; whether we contemplate the North American Indian, or the wild Arab of the desert; we find, that when mankind have made a certain progress in society, they are strongly influenced by a love of song, and listen with raptured attention to the strains that record the tale of other times, and the deeds of heroes of old. They listen till they imbibe the enthusiasm of warfare, and in the day of battle the hero's arm has not unfrequently been nerved by the rough energy of the early bard. It is a well known fact, that the Greeks were accustomed to march to the fight while singing in praise of Apollo, and that the songs written in honour of Harmodius and Aristogiton, by being habitually recited at their banquets and solemn festivals, tended in no inconsiderable degree to preserve among the Athenians an enthusiastic love of liberty. Nor is the power of the muses done away by the progress of civilization. Every nation, at every period of its existence, possesses some indigenous poetry, which nourishes the flame of patriotism.

Such is the wonderful influence of poetical composition. Like all other powerful instruments, it may be, and it has been abused. But when directed to worthy objects, it is one of the most pleasant and most efficacious means of forming the youthful mind, and of exciting the emotions and enforcing the principles of virtue.

POHLIA, in botany, a genus of the Cryptogamia Musci class and order. Generic character: capsule ovate, oblong, placed on an abconical, narrower apophysis; peristome double: outer with sixteen broadish teeth: inner with a sixteen parted membrane. Males gemmaceous, on a distinct plant.

POINT, in geometry, as defined by Euclid, is a quantity which has no parts, or which is indivisible. Points are the ends or extremities of lines. If a point be supposed to be moved any way, it will, by its motion, describe a line. See LINE.

POINT, in physics, the least sensible object of sight, marked with a pen, point of a compass, or the like. Of such points all physical magnitude consists. This physical point is the same with what Mr. Locke calls the point sensible, and which he defines to be the least particle of matter, or space, we can discern. He adds, that to the sharpest eye, this is seldom less than thirty seconds of a circle, whereof the eye is the centre.

Point, in grammar, a character used to mark the divisions of discourse. A point proper is that which we otherwise call a full stop or period. See Punctuation.

Point, in astronomy, a term applied to certain points or places, marked in the heavens, and distinguished by proper epithets. The four grand points or divisions of the horizon, *viz.* the east, west, north, and south, are called the cardinal points. The zenith and nadir are the vertical points; the points wherein the orbits of the planets cut the plane of the ecliptic are called the nodes: the points wherein the equator and ecliptic intersect are called the equinoctial points; particularly, that whence the sun ascends towards the north pole, is called the vernal point; and that by which he descends to the south pole, the autumnal point. The points of the ecliptic, where the sun's ascent above the equator, and descent below it, terminate, are called the solsticial points; particularly the former of them, the estival, or summer point; the latter, the brumal or winter point.

Point *of the horizon*, or *compass*, in navigation and geography.

Point is also used for a cape or headland, jutting out into the sea: thus, seamen say, two points of the land are in one another, when they are so in a right line against each other, as that the innermost is hindered from being seen by the outermost.

Point, in perspective, is used for various parts or places, with regard to the perspective plane. See Perspective.

Points, in heraldry, are the several different parts of an escutcheon, denoting the local positions of any figure. There are nine principal points in an escutcheon: the dexter chief; the precise middle chief; the sinister chief; the honour point; the fess-point, called also the centre; the nombril-point, that is, the navel point; the dexter base; the sinister base; the precise middle base.

Point is also used in heraldry for the lowest part of the escutcheon, which usually terminates in a point.

Point is also an iron or steel instrument, used with some variety in several arts. Engravers, etchers, cutters in wood, &c. use points to trace their designs on the copper, wood, stone, &c. See Engraving.

Point, in the manufactories, is a general term used for all kinds of laces, wrought with the needle; such are the point de Venice, point de France, point de Genoa, &c. which are distinguished by the particular economy and arrangement of their points. Point is sometimes used for lace woven with bobbins, as English point, point de Malines, point d'Havre, &c.

Point *of view*, with regard to building, painting, &c. is a point at a certain distance from a building or other object, in which the eye has the most advantageous view of the same. This point is usually at a distance equal to the height of the building.

Point *blank*, in gunnery, is the horizontal position of a gun. The point blank range is the distance the shot goes before it strikes the level ground, when discharged in the horizontal or point blank direction. See Gunnery.

POINTED, in heraldry. A cross pointed, is that which has the extremities turned off into points by straight lines.

POINTING, in grammar, the art of dividing a discourse, by points, into periods, and members of periods, in order to show the proper pauses to be made in reading, and to facilitate the pronunciation and understanding thereof. See Punctuation.

Pointing, in war, the levelling a cannon or mortar, so as to play against any certain point. See Gunnery, &c.

Pointing *the cable*, in the sea language, is untwisting it at the end, lessening the yarn, twisting it again, and making all fast with a piece of marline, to keep it from ravelling out.

POISONS, those substances which, when applied externally, or taken into the human body, uniformly cause such a derangement of the animal economy as to produce disease. As it is extremely difficult, however, to give a definition of a poison, the above is subject to great inaccuracy. Poisons are divided, with respect to the kingdom to which they belong, into animal, vegetable, mineral, and vaporous poisons. Poisons are only deleterious in certain doses; for the most active, in small doses, form very valuable medicines. There are, nevertheless, certain poisons, which are really such in the smallest quantity, and which are never administered medicinally, as many of the animal poisons, the poison of hydrophobia, &c. There are likewise substances which are innocent when taken into the stomach, but which prove deleterious when taken into the lungs, or when applied to an abraded surface. Thus carbonic acid gas is continually swallowed with fermented liquors, and thus the poison of the viper may be swallowed with impunity; whilst inspiring carbonic acid instantly destroys, and the poison of the viper inserted into the flesh produces formidable effects. Many substances also act as poisons when applied either externally or internally, as arsenic, lead, &c. When a deleterious substance produces its effects, not only in mankind, but in all other animals, it is distinguished by the term common poison, as arsenic, caustic, alkali, &c. whilst that which is poisonous to man only, or to brute animals, and often to one genus only, is said to be a relative poison; thus, aloes is said to be poisonous to dogs and wolves; the phellandrium aquaticum kills horses, whilst oxen devour it greedily and with impunity. It appears, then, that substances act as poisons only in regard to their dose, the part of the body they are applied to, and the subject on which their powers are exerted.

It is often of great importance to be able to discover, by certain chemical tests, copper and lead, particles of which frequently find their way into the stomach, either through inadvertencies, as by the employment of certain kitchen utensils made of these materials, or by fraud, as when acetate of lead (sugar of lead) is made use of to revive wines that have grown sour by long keeping. If copper be suspected in any liquor, its presence may be ascertained by adding to it a solution of pure ammonia, which will strike a beautiful blue colour. If the solution be very dilute, it may be concentrated by evaporation; and if it contain a great excess of acid, as in the liquor of pickles, so much alkali must be added as will be sufficient to saturate the acid.

Lead is affirmed by Dr. Lamb to exist in water that passes through leaden pipes, in such quantities as to be injurious to the human frame; this has, however, been much doubted; but it is well known that petty dealers in wine have occasionally recourse to the acetate of lead to revive bad wines. Lead may be discovered in water, by adding to a portion of it about half its bulk of water impregnated with sulphuretted hydrogen gas. If lead be present, it will be manifested by a dark brown, or blackish tinge. For discovering the presence of lead in wine, a test is employed, called, from the name of the inventor, Hahnemann's wine test. This is prepared by putting together into a small phial, sixteen grains of sulphuret of lime prepared in the dry way, and twenty grains of acidulous tartrite of potash (cream of tartar). The phial to be filled with water and well corked, and occasionally shaken for a few minutes. When the powder has subsided, decant the clear liquor, and preserve it in a well stopped bottle for use. The test, when newly prepared, discovers lead by a dark coloured precipitate. Lead may be likewise discovered by adding to the wine a solution of the sulphate of soda, which will throw down a precipitate. If a large quantity of the acetate of lead has been taken, as by a child, inadvertently, on account of its saccharine taste, an active emetic must first be given, and then the hydro sulphuret of potash, or of ammonia, be taken; a solution of the common sulphuret will answer.

POLAR, in general, something relating to the poles of the world, or poles of the artificial globes: thus we meet with polar circles, polar dial, polar projection, &c.

POLARITY, the quality of a thing considered as having poles; but chiefly used in speaking of the magnet. See MAGNETISM.

POLE, in astronomy, one of the extremities of the axis, on which the sphere revolves. These two points, each ninety degrees distant from the equinoctial or equator, are by way of eminence called the poles of the world; and the extremities of the axis of the artificial globes, corresponding to these points in the heavens, are termed the poles thereof. See GLOBE.

POLE, in spherics, a point equally distant from every part of the circumference of a great circle of the sphere, as the centre is a plane figure; or it is a point of ninety degrees distant from the plane of a circle, and in a line, called the axis, passing perpendicularly through the centre. The zenith and nadir are the poles of the horizon; and the poles of the equator are the same with those of the sphere.

POLES *of the ecliptic*, are two points on the surface of the sphere, 23° 30′ distant from the poles of the world, and 90° distant from every part of the ecliptic.

POLES, in magnetics, are two points of a loadstone, corresponding to the poles of the world; the one pointing to the north, the other to the south. See MAGNETISM.

POLE, PERCH, or ROD, in surveying, is a measure containing sixteen feet and a half.

POLE, or POLAR *star*, is a star of the second magnitude, the last in the tail of ursa minor. Its longitude Mr. Flamstead makes 24° 14′ 41″; its latitude, 66° 4′ 11″. The nearness of this star to the pole, whence it happens that it never sets, renders it of vast service in navigation, &c. for determining the meridian line, the elevation of the pole, and, consequently, the latitude of the place, &c. See LATITUDE.

POLEMONIUM, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Campanaceæ. Polemonia, Jussieu. There are five species, chiefly natives of the Cape of Good Hope.

POLEMOSCOPE, in optics, a kind of reflecting perspective glass, invented by Hevelius, who commends it as useful in sieges, &c. for discovering what the enemy is doing, while the spectator lies hid behind an obstacle.

POLIANTHES, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Narcissi, Jussieu. Essential character; corolla funnel form, curved in, equal, filaments inserted into the jaws of the corolla; germ at the bottom of the corolla. There is but one species, *viz.* P. tuberosa, tuberose.

POLICY *of assurance*, is the deed or instrument by which a contract of assurance is effected. The premium paid for the risk must be inserted in the policy, and likewise the date. Policies for assurance against the risks of the sea are distinguished into valued and open policies; in the former the property is assured at prime cost, at the time of effecting the policy; in the latter, the value is not mentioned, but is left to be afterwards declared, or to be proved in the event of a claim.

POLISHER, or BURNISHER, among mechanics, an instrument for polishing and burnishing things proper to take a polish. The guilders use an iron-polisher to prepare their metals before guilding, and the bloodstone to give them the bright polish after guilding. The polisher used by the makers of spurs and bits, &c. is partly iron, partly steel, and partly wood; it consists of an iron-bar with a wooden handle at one end, and a hook at the other, to fasten it to another piece of wood held in the vice, while the operator is at work. In the middle of the bow, withinside, is what is properly called the polisher, being a triangular piece of steel, with a tail, whereby it is rivetted to the bow. The polishers, among cutlers, are a kind of wooden wheels made of walnut-tree, about an inch thick, and of a diameter at pleasure, which are turned round by the great wheel; upon these they smooth and polish their work with emery and putty. The polishers for glass consist of two pieces of wood; the one flat, covered with old hat, the other long and half-round, fastened on the former, whose edge it exceeds on both sides by some inches, which serve the workmen to take hold of, and to work backwards and forwards by. The polishers, used by spectacle-makers, are pieces of wood a foot long, seven or eight inches broad, and an inch and a half thick, covered with old beaver-hat, whereon they polish the shell and horn-frames their spectacle glasses are to be set in.

POLISHING, in general, the operation of giving a gloss or lustre to certain substances, as metals, glass, marble, &c.

POLITICAL *arithmetic*, is the application of arithmetical calculation to political subjects, as the public revenues, number of people, extent and value of lands, taxes, trade, manufactures, &c. of any commonwealth. See STATISTICS.

POLITY, or POLICY, denotes the peculiar form and constitution of the government of any state or nation; or the laws, orders, and regulations, relating thereto.

Polity differs only from politics, as the theory from the practice of any art. See LAW, GOVERNMENT, &c.

Some divide polity into that which relates to the regulations respecting mercantile affairs; and to those which concern the judiciary government of the citizens: some add other branches, *viz.* those relating to ecclesiastical and military affairs, &c.

POLL, a word used in ancient writings for the head: hence, to poll, is either to vote or to enter down the names of those persons who give in their votes at an election.

POLL *money*, a capitation or tax imposed by the authority of parliament on the head or person, either of all indifferently, or according to some known mark of distinction.

POLLEN, in botany, the fecundating or fertilizing dust contained within the anthers or tops of the stamina, and dispersed on the pistil when ripe, for the purpose of impregnation. This dust is commonly of a yellow colour, and is very conspicuous in the tulip and lily. If this powder is examined by the microscope, it will be found to assume some determinate form, which often predominates, not only through the different species of one genus, but through all the genera of an order. Being triturated in the stomach of bees, by whom great quantities are collected in the hairy brushes with which their legs are covered, is supposed to produce the wax. See WAX.

POLLIA, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Junci, Jussieu. Essential character: corolla inferior, six-petalled; berry many-seeded. There is but one species, *viz.* P. japonica.

POLLICHIA, in botany, a genus of the Monandria Monogynia class and order. Natural order of Amaranthi, Jussieu. Essential character: calyx one-leafed, five-toothed; corolla five-petalled; seed solitary; receptacle producing succulent aggregate scales, sustaining the fruit. There is but one species, *viz.* P. campestris, whorled-leaved pollichia, a native of the Cape of Good Hope.

POLLUX, in astronomy, a fixed star of the second magnitude in the constellation gemini, or the twins. The same name is also given to the hindermost twin, or posterior part of the same constellation.

POLYADELPHIA, in botany, a class of plants, the eighteenth in order, whose stamina are connected together at their bases into several serieses. The plants of this class are subdivided into orders, according to the number of their stamina; thus the polyadelphia pentandria, contain five stamina; and the polyadelphia icosandria and polyandria, contain twenty or more stamina. There are but few genera included in this class. The chocolate-nut has five stamina, or rather five bundles of stamina; each filament has five anthers. Monsonia has fifteen stamina in five bundles. The citron, lemon, and orange, belonging to the genus citrus, have twenty stamina in several bundles. The St. John's wort have many stamina collected into five bundles.

POLYANDRIA, in botany, a class of plants, the thirteenth in order, with hermaphrodite flowers, and a large number of stamina in each; these always exceed the number of twelve, and grow on the receptacle of the future seeds. By this circumstance, chiefly, the class is distinguished from the ICOSANDRIA, which see. The most striking character is the situation of the stamina, which are inserted into the calyx or petals, or both. This is an unerring mark of distinction. This class is subdivided into seven orders, from the number of the styles; the poppy, water-lily, &c. have one style; the peony, two; lark-spur, three; tetracera, four; columbine, five; water-soldier, six; virgin's bower, tulip-tree, &c. have many.

POLYCARDIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: petals five-rounded; stigma lobed; capsule five-celled, five-valved; seeds arilled. There is only one species, *viz.* P. madagascarensis, a native of Madagascar, where it was found by Commerson.

POLYCARPON, in botany, a genus of the Triandria Trigynia class and order. Natural order of Caryophyllei. Essential character: calyx five-leaved; petals five, ovate, very small; capsule one-celled, three valved; seeds very many. There is only one species, *viz.* P. tetraphyllum, four-leaved all-seed, a native of the South of Europe.

POLYCNEMUM, in botany, a genus of the Triandria Monogynia class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: calyx three-leaved; petals five, calycine; seed one, almost naked. There are five species.

POLYGALA, in botany, *milk-wort*, a genus of the Diadelphia Octandria class and order. Natural order of Lomentaceæ. Pediculares, Jussieu. Essential character: calyx five-leaved, with two of the leaves shaped like wings, and coloured; legume obcordate, two-celled. There are forty-five species.

POLYGAMIA, in botany, a class of plants, the twenty-third in order, the characters of which are, that they have flowers of different structure; some having male flowers, others female ones, and others hermaphrodite.

A polygamous plant must have some of its flowers hermaphrodite. By this circumstance its connection is cut off with the plants of the classes monœcia, and diœcia; in the former of these the plants are androgenous, that is, bear male and female flowers on the same root; in the latter on different roots. 1. We have instances of hermaphrodite and male flowers on the same plant, in the white hellebore, &c.; also in several of the umbelliferous plants, as the carrot, coriander, chervil, &c. 2. Instances of hermaphrodite and male flowers on distinct plants, may be given in the palmetto, ginseng, Indian date plum. 3. Hermaphrodite and female on the same plant, as in the pellitory and orack. 4. Hermaphrodite and female on different plants, as in most species of the ash-tree.

POLYGAMY, a plurality of wives or husbands, in the possession of one man or woman, at the same time.

POLYGLOTT, among divines and critics, chiefly denotes a Bible printed in several languages. In these editions of the Holy Scriptures, the text in each language is ranged in opposite columns. The first polyglott Bible was that of Cardinal Ximenes, printed in 1517, which contains the Hebrew text, the Chaldee Paraphrase on the Pentateuch, the Greek version of the LXX., and the ancient Latin version. After this, there were many others, as the Bible of Justiniani, Bishop of Nebio, in Hebrew, Chaldee, Greek, Latin, and Arabic; the Psalter, by John Potken, in Hebrew, Greek, Ethiopic, and Latin; Plantin's Polyglott Bible in Hebrew, Chaldee, Greek, and Latin, with the Syriac version of the New Testament; M. le Jay's Bible, in Hebrew, Samaritan, Chaldee, Greek, Syriac, Latin, and Arabic; Walton's Polyglott, which is a new edition of Le Jay's Polyglott, more correct, extensive, and perfect, with several new oriental versions, and a large collection of various readings, &c.

POLYGON, in geometry, a figure with many sides, or whose perimeter consists of more than four sides at least: such are the pentagon, hexagon, heptagon, &c.

Every polygon may be divided into as many triangles as it has sides; for if you assume a point, as *a*, (see Plate XII. Miscel. fig. 14), any where within the polygon, and from thence draw lines to every angle, *a b*, *a c*, *a d*, &c. they shall make as many triangles as the figure has sides. Thus, if the polygon hath six sides (as in the figure above) the double of that is twelve, from whence take four, and there remains eight: I say, that all the angles, *b*, *c*, *d*, *e*, *f*, *g*, of that polygon, taken together, are equal to eight right angles. For the polygon having six sides, is divided into six triangles; and the three angles of each by 1.32 Eucl. are equal to two right ones; so that all the angles together make twelve right ones; but each of these triangles hath one angle in the point, *a*, and by it they complete the space round the same point; and all the angles about a point are known to be equal to four right ones, wherefore those four taken from twelve, leave eight, the sum of the right angles of the hexagon. So it is plain the figure hath twice as many right angles as it hath sides, except four.

Every polygon circumscribed about a circle, is equal to a rectangled-triangle, one of whose legs shall be the radius of the circle, and the other the perimeter (or sum of all the sides) of the polygon. Hence, every regular polygon is equal to a rectangled-triangle, one of whose legs is the perimeter of the polygon, and the other a perpendicular drawn from the centre to one of the sides of the polygon. And every polygon circumscribed about a circle is bigger than it; and every polygon inscribed is less than the circle, as is manifest, because the thing containing is always greater than the thing contained. The perimeter of every polygon circumscribed about a circle, is greater than the circumference of that circle, and the perimeter of every polygon inscribed is less. Hence, a circle is equal to a right-angled triangle, whose base is the circumference of the circle, and its height the radius of it.

For this triangle will be less than any polygon circumscribed, and greater than any inscribed; because the circumference of the circle, which is the base of the triangle, is greater than the compass of any inscribed, therefore it will be equal to the circle. For, if this triangle be greater than any thing that is less than the circle, and less than any thing that is greater than the circle, it follows, that it must be equal to the circle. This is called the quadrature, or squaring of the circle; that is, to find a right-lined figure equal to a circle, upon a supposition that the basis given is equal to the circumference of the circle; but actually to find a right line equal to the circumference of a circle, is not yet discovered geometrically.

POLYGON, in fortification, denotes the figure of a town, or other fortress. The exterior or external polygon is bounded by lines drawn from the point of each bastion to the points of the adjacent bastions; and the interior polygon is formed by lines joining the centres of the bastions.

POLYGONS, *problems concerning*. 1. On a regular polygon to circumscribe a circle, or to circumscribe a regular polygon upon a circle; bisect two of the angles of the given polygon, A and B, (fig. 15), by the right lines, A F, B F; and on the point, F, where they meet, with the radius, A F, describe a circle, which will circumscribe the polygon. Next, to circumscribe a polygon, divide 360 by the number of sides required, to find *e* F *d;* which set off from the centre, F, and draw the line, *d e*, on which construct the polygon as in the following problem. 2. On a given line to describe any given regular polygon: find the angle of the polygon in the table, and in E set off an angle equal thereto; then drawing E A =E D through the points E, A, D, describe a circle, and in this applying the given right line as often as you can, the polygon will be described. 3. To find the sum of all the angles in any given regular polygon: multiply the number of sides by 180°; from the product subtract 360°, and the remainder is the sum required: thus, in a pentagon, 180 × 5 = 900, and 900 — 360 = 540, the sum of all the angles in a pentagon. 4. To find the area of a regular polygon: multiply one side of the polygon by half the number of sides; and then multiply this product by a perpendicular, let fall from the centre of the circumscribing circle, and the product will be the area required: thus, if A B (the side of a pentagon) =54 × 2½ = 135, and 135 × 29 (the perpendicular) = 3915 = the area required. 5. To find the area of an irregular polygon, let it be resolved into triangles, and the sum of the areas of these will be the area of the polygon.

POLYGONAL *numbers*, are so called, because the units whereof they consist may be disposed in such a manner as to represent several regular polygons.

The side of a polygonal number is the number of terms of the arithmetical progression that compose it; and the number of angles is that which shows how many angles that figure has, whence the polygonal number takes its name.

"To find any polygonal number proposed," having given its side, n, and angles, a. The polygonal number being evidently the sum of the arithmetical progression, whose number of terms is n, and common difference $a-2$, and the sum of an arithmetical progression being equal to half the product of the extremes, by the number of terms, the extremes being 1, and $1+d$.

$\overline{n-1} = 1 + \overline{a-2}.\overline{n-1}$; therefore, that number, or this sum, will be

$$\frac{n^2 d - n.\overline{d-2}}{2} \text{ or } \frac{n^2.\overline{a-2} - n.\overline{a-4}}{2},$$

where d is the common difference of the arithmeticals that form the polygonal number, and is always 2 less than the number of angles, a.

Hence, for the several sorts of polygons, any particular number, whose side is n, will be found from either of these two formulæ, by using for d, its values 1, 2, 3, 4, &c.; which gives these following formulæ for the polygonal number in each sort, *viz.* the

Triangular................ $\dfrac{n^2+n}{2}$,

Square........................ $\dfrac{2n^2-0n}{2} = n^2$,

Pentagonal................ $\dfrac{3n^2-n}{2}$,

Hexagonal................. $\dfrac{4n^2-2n}{2}$,

Heptagonal................ $\dfrac{5n^2-3n}{2}$,

&c.

POLYGONUM, in botany, a genus of the Octandria Trigynia class and order. Natural order of Haloraceæ. Polygoneæ, Jussieu. Essential character; calyx none; corolla five-parted, calycine; seed one, angular. There are thirty-six species.

POLYGYNIA, among botanists, denotes an order or subdivision of a class of plants, comprehending such plants of that class as have a great number of pistils, or female organs of generation.

POLYHEDRON, in geometry, denotes a body or solid comprehended under many sides, or planes. A gnomonic polyhedron is a stone with several faces, whereon are described various kinds of dials.

POLYHEDRON, *polyscope*, in optics, is a multiplying glass or lens, consisting of several plane surfaces disposed into a convex form.

POLYMNIA, in botany, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx exterior, four or five-leaved; interior ten-leaved; the leaflets concave; down none; receptable chaffy. There are five species.

POLYNEMUS, the *polyneme*, in natural history, a genus of fishes of the order Abdominales. Generic character: head compressed, covered with scales; snout very obtuse and prominent; gill-membrane, five or seven-rayed; separate filaments near the base of the pectoral fins. Shaw enumerates ten species; Gmelin only four.

The P. paradiseus, or Paradise polyneme, or Mango-fish, inhabits the Indian and American seas, and is thirteen inches long, elegantly shaped, and with thoracic filaments frequently far larger than the body; its colour is yellow. At Calcutta it is in the highest estimation for the table.

P. plebeius, or the grey polyneme, abounds on the Malabar coast, and has five filaments on each side, but all rather short. It is sometimes four feet long, and is in some parts of India denominated the royal fish, from its extraordinary excellence. The application of the epithets, royal and plebeian, to the same animal, constitutes a curious coincidence: the former probably refers to the plainness of its appearance, and the other to its exquisiteness for food.

P. niloticus, is both in form and taste superior to every other fish in the rivers which flow into the Mediterranean or Atlantic seas. It is covered with scales, resembling the most brilliant silver spangles, and is of the weight of thirty, in some instances, of seventy pounds. It is a native of the Nile, and Mr. Bruce has minutely detailed the process adopted by the Egyptians for taking it, by a cake of flour, dates, and other ingredients, with a considerable number of hooks concealed in it; but attached to a string held by the fisherman, who floats on the stream, upon a blown-up goat's skin, in order to sink this mass, and then returns to the bank. He then fixes the line to some tree, connecting it with a bell, the sounds of which give him notice of the success of his experiment, being produced by the twitchings and pulls of the fish.

POLYPE, or Polypus, in zoology, a small fresh-water insect of a cylindric figure, but variable, with very long tentacula. See Hydra.

POLYPODIUM, in botany, a genus of the Cryptogamia Filices class and order. Natural order of Filices, or Ferns. Generic character: capsules distributed in roundish dots, on the back or lower surface of the frond. There are one hundred and thirty-seven species; most of these are of American growth, and very little known in Europe, except from dried specimens, not always collected with judgment enough to show satisfactorily the true characters of the fronds and fructification.

POLYPREMIUM, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Caryophyllei. Scrophulariæ, Jussieu. Essential character: calyx four-leaved; corolla four-cleft; wheel-shaped, with obcordate lobes; capsule compressed, emarginate, two-celled. There is but one species, *viz.* P. procumbens, a native of Carolina and Virginia.

POLYTRICHUM, in botany, a genus of the Cryptogamia Musci class and order. Natural order of Musci or Mosses. Essential character: capsule lidded, on a very small apophysis or receptacle; capsule, villose. There are nineteen species, chiefly natives of the north-west coast of North America.

POMACEÆ, in botany, the name of the thirty-sixth order in Linnæus's Fragments of a Natural Method, consisting of genera, which have a pulpy esculent fruit, of the apple, berry, and cherry kind; such are the prunus, pyrus, ribes, &c. The plants of this order are most of the shrub and tree kind: the roots are branched, fibrous, and long. In the dropwort they consist of a number of oval knobs, which hang, or are fastened together by slender fibres: hence, its English name, and also the Linnæan name, spiræa filipendula. The stems and branches are cylindric; the bark is thick and wrinkled. The buds are of a conical form, placed in the angles of the leaves, and covered with scales, which lie over one another like tiles. In the apple, pear, plum, &c besides the buds of the leaves, there are scaly buds or eyes of a different form, from which proceed bundles or clusters of flowers. The leaves, which differ in form, being in some genera simple, in others winged, are, in the greater number, placed alternate. The flowers are universally hermaphrodite, except in the spiræa aruncus, in which male and female flowers are produced upon distinct plants. The flower-cup is of one piece, with five divisions, which are permanent, and placed above the seed-bud, in the apple, currant, &c.; in others they fall off with the flower, or wither upon the stalk. The petals are five, inserted into the tube of the calyx. The stamina are generally twenty and upwards, attached also to the margin of the tube of the calyx, the anthers are short, and slightly attached to the filaments. The seed-bud is single; and the seed-vessel is a pulpy fruit of the apple, berry, or cherry-kind. Those of the apple kind are divided internally into a number of cells. The seeds in the pomegranate, apple, and currant-trees, are numerous; in the service-tree three; in the medlar five: in peach, plum, &c. a single nut or stone, containing a kernel.

POMETIA, in botany, a genus of the Monoecia Hexandria class and order. Essential character: calyx, one-leafed, six-cleft; petals six: male, stamens six: female, berry globular, with one seed in the centre. There are two species, *viz.* P. pinnata and P. ternata.

POMMEREULLIA, in botany, so named in memory of Lady du Gage de Pommereull, a genus of the Triandria Monogynia class and order. Natural order of Gramina, or Grasses. Essential character: calyx, turbinate, two valved, three or four flowered; valves four cleft, awned at the back; corolla, two valved, awned. There is but one species, *viz.* P. cornucopiæ, a native of the East Indies, whence it was found by Koenig.

POMUM, in botany, an *apple:* a species of seed-vessel composed of a succulent fleshy pulp, in the middle of which is generally found a membranous capsule, with a number of cavities for containing the seeds. Seed-vessels of this kind have no external opening or valve. At the end opposite to the foot stalk is frequently a small cavity, called by gardeners the eye of the fruit, and by botanists "umbilicus," from its fancied resemblance to the navel in animals.

PONÆA, in botany, so named in memory of John Pona, a genus of the Octandria Trigynia class and order. Natural order of Sapindi, Jussieu. Essential character: calyx five parted, spreading; petals four, with pilliferous glands at the tip; germ three-sided; capsule, three winged, three celled, with one seed in each cell. There is only one species, *viz.* P. guianensis.

PONTEDERIA, in botany, so named in memory of Julius Pontedera, professor of botany at Padua, a genus of the Hexandria Monogynia class and order. Natural order of Ensatæ. Narcissi, Jussieu. Essential character: corolla one petalled, six-cleft, two lipped; stamens three, inserted into the top, three into the tube of the corolla; capsule three celled. There are seven species; these are aquatic herbaceous perennial plants, with fibrous roots, chiefly natives of the East Indies; both root and stem leaves sheathing, frequently sagittate; flowers in spikes or umbels terminating, or put forth from the cloven sheath of the leaves, each having a spathe.

PONTON, or PONTOON, in war, denotes a little floating bridge made of boats and planks. The ponton is a machine consisting of two vessels, at a little distance, joined by beams, with planks laid across for the passage of the cavalry, the cannon, infantry, &c. over a river, or an arm of the sea, &c. The late invented ponton is of copper, furnished with an anchor, &c. to fix it. To make a bridge, several of these are disposed two yards asunder with beams across them; and over those are put boards or planks. They are also linked to each other, and fastened on each side of the river by a rope run through a ring in each of their heads, and fixed to a tree or stake on either shore: the whole makes one firm uniform bridge, over which a train of artillery may pass.

POOP, the stern of a ship, or the highest, uppermost, and hinder part of the ship's hull.

POOR *laws.* Of the general outline of this most enormous and almost ineffectual burden on the people, much has been said in the excellent treatise of Mr Colquhoun. The 43 of Elizabeth, c. 2, is the foundation of all that is good in the poor laws; making provision for finding work for the industrious and able; for compelling the idle and able to labour; and for affording relief to the diseased and impotent: and the 13, 14 Charles II. c. 12, is the foundation of all that is evil, by forming the system of settlements and removals; a system, establishing oppression, litigation, and expense, and which has been made more oppressive, and more productive of litigation and expense, by every subsequent statute, till the statute of the 35th of his present Majesty; which, by forbidding removals in case the pauper is not absolutely chargeable, has remedied more than half the evils occasioned by the former laws.

Overseers. The churchwardens of every parish, with two, three, or four substantial householders, according to the size of the parish, to be nominated in Easter week, or within a month after, under the hands and seals of two or more neighbouring justices, and who shall be called overseers of the poor. 43 Elizabeth, c. 2, s. 1.

Where there are no churchwardens, the whole power is vested in the overseers, 17 George II. c. 38, s. 15

Overseer dying, or becoming incapable of acting, two justices may appoint another. *Ibid.* s. 3. If any person shall find himself aggrieved by any act of the justices, Ap.* sessions, whose determination shall be final. *Ibid* s. 6.

* In this article the following abbreviations will be used: P. denotes penalty;

Where there is no nomination of overseers, P. *5l.* on every justice of the division. R. by distress from the sessions, to be levied by the churchwardens and overseers. 43 Elizabeth, c. 2, s. 10.

Parish officers, with consent of two justices, shall set children to work, whose parents cannot maintain them, and all persons, married or single, who cannot maintain themselves, and have no regular trade or calling ; and one justice may send persons to the house of correction who will not work ; and the parish officers, not having an excuse, to be allowed by two justices, shall meet once in a month, at least, in the church, on a Sunday after evening service, to consult. P. 20s. R. distress, and in default, commitment till paid. J. 2. A. the poor. Ap. sessions. *Ibid.* s. 1, 2, 6, 11.

Overseers, within four days after the end of their year, shall account to two justices for all sums received and paid, and pay over what remains to their successors; who, in default, may levy it by distress, under warrant of two justices ; who, in default of distress, may commit till paid. *Ibid.* s. 2, 4.

Every parish officer, neglecting to obey the regulations of the above act, P. 40s. to *5l.* R. distress. J. 2. A. the poor. 17 George II. c. 38, s. 14.

Parish officer neglecting his duty, or disobeying the warrant of a justice, P. 40s. R. distress, and in default, commitment not exceeding ten days. J. 2. A. the poor. Ap. sessions, giving ten days notice. 33 George III. c. 55, s. 1, 2.

Rate. Parish officers shall raise, by a rate on all the inhabitants, a stock of flax, &c. to set the poor to work, and sums for the relief of the old and lame, who are not able to work, and for apprenticing poor children. Rate to be made by consent of two justices. 43 Elizabeth, c. 2, s. 1.

Parish officers shall cause notice to be given publicly in the church, of such consent of the justices, the next Sunday ; and no rate shall be collected till such notice is given. 17 George II. c. 3, s. 1. They shall permit the inhabitants to inspect such rates at all seasonable hours, on payment of 1s. ; and give copies on payment of *6d.* for every twenty-four names. P. 20s. A. to the party aggrieved. *Ibid.* s. 2, 3.

Persons aggrieved by assessment. Ap. sessions. 17 George II. c. 38, s. 4.

R. the mode of recovering it ; A. the application ; Ap. the appeal ; J. 1 or 2, and W. 1 or 2, justices or witnesses.

Goods of persons refusing to pay, may be distrained in any part of the county : and of any other county, on oath made before a justice of such other county, which oath shall be certified in the warrant. Ap. to the sessions of the county where the assessment was made. *Ibid.* s. 7.

If two justices perceive that the inhabitants of any parish are not able to levy money sufficient for the relief of the poor, they shall assess any neighbouring parishes within the hundred, in aid ; and if the hundred shall not be of sufficient ability, then any parishes within the county. 43 Elizabeth, c. 2, s. 3.

Father, grandfather, mother, or grandmother, of persons wanting relief, shall maintain them ; P. 20s. per month. R. distress, and, in default, commitment till paid. J. 2. A. the poor. *Ibid.* s. 2, 11.

Fathers leaving their wives and children, and mothers their children, chargeable to the parish, having ability to maintain them, the parish officers, where such are left, may, by warrant of two justices, seize so much of the goods and chattels, or receive so much of the annual rent, as such justices shall appoint, to reimburse the parish ; and such order to be confirmed by the sessions. 5 George I. c. 8. s. 1.

Parish officers, with consent of the lord of the manor, may, by order of two justices, erect cottages on waste lands, for the poor. 43 Elizabeth, c. 2, s. 5.

They may also, with consent of two justices, set up trades, &c. for the employment of the poor. 3 Charles II. c. 4, s. 22.

Relief. Parish officers, with consent of the majority of the inhabitants, may contract with any person for the lodging, keeping, maintaining, and employing the poor ; and persons refusing such relief are not entitled to any other. 9 George I. c. 7, s. 4.

The abominable oppression of this execrable law has, however, been removed by another humane statute of the present reign ; for by 36 George III. c. 25, s. 1, 2, 3, it is enacted, that it shall be lawful for the parish officers, with the approbation of one justice in writing, to relieve any industrious person at his own habitation, under certain circumstances of temporary illness or distress ; and one justice may order such relief for any time not exceeding one month, provided the cause be written on the back of the order, which the parish officers are bound to obey : and two justices may continue such order from time to time, each period in succession not being more than one month.

A justice, or a medical man, or clergyman, by warrant of a justice, may visit workhouses, and examine the state of them, and hear complaints, and certify to the sessions; and if there should be any infectious disorder, the visiting justice shall apply to another justice, or any other person visiting, which two justices shall order such regulations as they deem necessary, till the next sessions. 30 George. III. c. 49, s. 1, 2.

Names of persons receiving parish relief to be entered in a book. 3. William, c. 11, s. 11. And no other person to be relieved but by order of a justice. *Ibid.*

No relief to be ordered by a justice unless for a reasonable cause, proved on oath, and unless the pauper shall have first applied to a parish officer or a vestry, nor before the justice shall have summoned the parish officers. 9 George I. c. 7, s. 1.

The name of such person to be entered with the others; and no parish officer, except on sudden emergency, shall bring any charge on the parish for persons not so registered. P. 5*l.* R. distress. J. 2. A. poor. *Ibid.* s. 2.

Persons receiving relief to be badged on the shoulder with a large Roman P, and the initial of the name of the parish. P. forfeiture of the relief, or commitment for not above twenty-one days. J. 1. And on every peace officer who shall relieve any person not so badged, 20*s.* R. distress. J. 1. A. half to the informer, half to the poor. 8, 9 William, c. 3. s. 2.

Settlements. The general heads on which settlements are founded are, birth, apprenticeship, service, serving offices, renting 10*l.* per annum, marriage, and estate.

1. *Birth.* Children, *primâ facie*, whether bastard or legitimate, are settled where born: but with respect to bastards, if a woman goes collusively to be delivered in another parish, the child gains no settlement there.

Bastards born during an order of removal, or the suspension of it, belong to the mother's parish. 35 George III. c. 101, s. 6. And so of bastrads born in vagrancy. 17 George II. c. 5, s. 25. And so if born in houses of industry in incorporated districts. 20 George III. c. 36. Or in friendly societies. 33 George III. c. 54, s. 25. Or in lying-in hospitals. 13 George III. c. 82.

Legitimate children are settled as their parents, till old enough to gain a settlement of their own; the earliest period of which is seven years: at which age, by 5 Elizabeth, c. 5, s. 12, a child may be apprenticed to a person using the seas; and by 17 George II. c. 5, justices may bind the child of a vagrant of the same age; and any apprentice gains a settlement in a place where he has resided as such for forty days.

2. *Apprenticeship.* The time required to gain a settlement has just been mentioned. The apprentice must be legally bound, except that the contract not being indented, which is fatal to the legality in every other case, is not in this. 31 George II. c. 11.

3. *Service.* Unmarried person without children, hired and serving for a year, gains a settlement. 3. William, c. 11. But must continue a whole year in such service. 8, 9 William, c. 30. Serving a certificated member of a benefit society, no settlement. 33 George III. c. 54, s. 24. Forty days residence in the place necessary, but they need not be all together. Where the last forty days are in different places, settlement where the servant slept the last night. General hiring deemed hiring for a year. Hiring for a year, with liberty to be absent at harvest, sheep-shearing, &c. gains no settlement; but to serve a month in the militia does. Hiring for one day short of a year no settlement. Serving for three hundred and sixty-five days, if leap-year, no settlement. Hiring at so much per week, conditionally to part at a month's warning, deemed a general hiring; and, as such, a hiring for a year.

4. *Serving Offices.* Persons coming to inhabit a place, and executing any annual and public office for a year, settlement. 3 William, c. 11. s. 6.

5. *Renting* 10*l. per Annum.* This gains a settlement, if resided on forty days. 13, 14 Charles II.

6. *Marriage.* As a general rule, the wife follows the husband's settlement; but if the husband has no settlement, or it is not known at his death, her own settlement is restored, and if the husband deserts his wife, her settlement remains.

7. *Estate.* No person shall be removed from any estate while he remains on it. 9 George I. c. 7. But no person gains a settlement by any estate whose purchase was less than 30*l.* *Ibid.*

Persons who have no settlement, as foreigners, or whose settlement cannot be known, as deserted infants, must be kept by the parish where they happen to be.

Certificates. This head is almost done away by the salutary law which will be noticed under.

Removals. So much of 13, 14 Charles II. c. 12, as enables justices to remove persons likely to become chargeable, is repealed; and no person can now be removed till actually chargeable. 35 George III. c. 101, s. 1.

Justices may suspend removal of persons ill, either under a vagrant pass, or order of removal; expense attending the suspension to be paid by the parish officers of the place to which the pauper is to be removed; on refusal to pay within three days, R. distress and sale, with costs, not exceeding 40*s*. J. 1. If out of the jurisdiction, warrant of distress to be backed by a justice having jurisdiction. Ap. to the sessions, if charges and costs exceed 20*l* *Ibid.* s. 2.

Every person convicted of larceny or felony, or deemed a rogue and vagabond, or disorderly person, or who shall appear to two justices, on oath of one witness, to be a person of evil fame or a reputed thief, and shall not give a satisfactory account of himself and way of living, and every unmarried woman with child, shall be deemed actually chargeable, and be removed as such. *Ibid.* s. 6.

Person refusing to go with an order of removal, or returning when removed, P. commitment as a vagabond. J. 1. 13, 14 Charles II. c. 12, s. 3.

Parish officer refusing to receive a person so sent, P. bound to the assizes or sessions, to answer the contempt. J. 1. *Ibid.*

If removed into another county or jurisdiction, and the parish officers refuse to receive, P. 5*l*. A. to the poor of the place from which the pauper is removed. R. distress, and, in default, commitment for forty days. J. 1. of the jurisdiction to which removed. W. 2. 3 William, c. 11. s. 10.

Appeal from orders of removal to the sessions of the county from which the pauper was removed. 8, 9 William, c. 30, s. 6. It must be to the sessions of the county, and not of any corporate town.

Poor's *rate*, an assessment raised throughout England and Wales, for the temporary relief, or permanent maintenance, of all such persons, as, from age, infirmity, or poverty, cannot themselves procure the means of subsistence. The first statute, or law made in England, which gives any particular directions concerning paupers, was 11 Henry VII. c. 2. It directs, "that every beggar, not able to work, shall resort to the hundred where he last dwelt, is best known, or was born: and shall there remain, upon pain of being set in the stocks, three days and three nights, with only bread and water, and then shall be put out of town." The insufficiency of this regulation soon became evident, and in 1531 an act was passed, whereby the justices of every county were empowered to grant licences to poor, aged, and impotent persons, to beg within a certain precinct; but if they were found begging without licence, or beyond the limits specified, they were either to be whipped or set in the stocks. This, however, was a very inadequate mode of providing for the poor; and in 1536 an act was passed, directing the governors and magistrates of counties, towns, and parishes, to provide for every aged, poor, and impotent person, who should have dwelt three years in any place, by means of the voluntary alms of charitable persons, which were to be collected for this purpose, in every parish. The act likewise directed, that sturdy vagabonds should be compelled to work, and that chidren from five to fourteen years of age, who lived in idleness, and were found begging, should be put to service.

Upon the destruction of the monasteries, from the charities of which the poor had derived their principal support, some further ineffectual attempts were made for their relief, by means of voluntary donations; but it was at length found necessary to stimulate public charity by a compulsory clause, in an act passed in 1563. This act directed, that if any parishioner shall obstinately refuse to pay reasonably towards the relief of the poor, or should discourage others, the justices of the peace, at their quarter-sessions, might tax him to a reasonable weekly sum, which if he refused to pay, they might commit him to prison. This may be considered as the origin of the poor's rate, which was rendered more general by an act passed in 1572, which directed that assessments should be made of the parishioners of every parish, for the relief of the poor of the same parish; which was the first regular and effectual parochial assessment for the poor in England. In 1601, further regulations were adopted on this subject; it being enacted by 43 Elizabeth, c. 2, that every parish should be bound to provide for its own poor, and that overseers of the poor should be annually appointed, who, with the church wardens, should raise, by a parish rate, competent sums for this purpose: the mode in which the assessment was directed to be made was, that the justices of the peace of every county or place corporate, or the major part of them, at the general sessions to be held after Easter following, and so yearly, as often as they should think fit, should rate every parish to such a weekly sum of money as they should think convenient; which sum, so taxed, was to be yearly assessed by an agreement of the parishioners within themselves, or in default thereof, by the churchwardens and petty constables, or by an order of the justices of the peace: and if any person refused or neglected to pay the portion of money so taxed, it might be levied by distress, and in default thereof, the person to be committed to prison till the money was paid. In this mode, or with very little variation, the poor's-rate has continued to be annually levied; but as, from the increase of population, the advanced price of all the necessaries of life, and other causes, the number of the poor has been greatly augmented, the sum raised for their support has progressively advanced to a very important magnitude.

According to an estimate, published by Dr. Davenant, of the sum raised by the poor's rate in England and Wales, in the latter part of the reign of Charles II. it amounted to 665,362*l.* As the number of the poor increased, it not only became necessary to raise a greater sum for their maintenance, but new cases arose with respect to the claims of individuals to this kind of relief, in consequence of which various acts were passed for explaining and amending the laws for the relief of the poor. In 1735, the House of Commons appointed a committee to consider of the existing laws relative to the maintenance and settlement of the poor, and what further provisions might be necessary for their better relief and employment. The committee came to several resolutions, which were agreed to by the house; the most important were, "that the laws in being, relating to the maintenance of the poor of this kingdom are defective; and, notwithstanding they impose heavy burdens on parishes, yet the poor, in most of them, are ill taken care of:" and, that it is very expedient, that the laws relating to the poor should be reduced into one act of parliament.

In 1776, a return was ordered to be made to parliament, of the total expenditure on account of the poor, for one year, ending at Easter; pursuant to which, accounts were received from 14,113 parishes, or places, in England and Wales, from which it appeared, that the aggregate sum expended was 1,530,804*l.* 6*s.* 3*d.* and that there were then 1970 workhouses, capable of accommodating 89,775 persons. In 1786, a return was again ordered to be made, of the average annual expenditure of the three preceding years, when accounts were obtained from 14,240 parishes, or places, and the total was found to have increased, in the short period of ten years, to 2,004,238*l.* 5*s.* 11*d.* since which time, a still greater increase has taken place.

In the year 1803, an act was passed for procuring returns relative to the expense and maintenance of the poor; from the answers and returns made pursuant thereto, the following particulars are derived.

Out of 14,611 parishes and places from which accounts were received, 3765 parishes maintain all, or part of, their poor in workhouses. The number of persons so maintained during the year, ending Easter 1803, was 83,468; and the expense incurred therein, amounted to 1,016,445*l.* 15*s.* 3*d.* being at the rate of 12*l.* 3*s.* 6¾*d.* for each person maintained in that manner.

The number of persons relieved out of workhouses was 956,248, besides 194,052, who were not parishioners. The expense, incurred in the relief of the poor, not in workhouses, amounted to 3,061,446*l.* 16*s.* 10½*d.* A large proportion of those, who were not parishioners, appear to have been vagrants, and it is probable, that the relief given to this class of poor could not exceed two shillings each, amounting to 19,405*l.* 4*s.* This sum being deducted from the above 3,061,446*l.* 16*s.* 10½*d.* leaves 3,042,041*l.* 12*s.* 10½*d.* being at the rate of 3*l.* 3*s.* 7½*d* for each parishioner relieved out of any workhouse.

The number of persons relieved in and out of workhouses, was 1,039,716, and as the resident population of England and Wales, in the year 1801, appeared from the returns made under the population act to have been 8,872,980, the number of parishioners relieved from the poor's rate appears to be twelve in a hundred of the resident population.

The expenditure, in suits of law, removal of paupers, and expenses of overseers and other officers, amounted to 190,072*l.* 17*s.* ½*d.* and the sum expended in purchasing materials for employing the poor, to 47,523*l.* 11*s.* 4¼*d.*

The poor of 293 parishes, are stated in the returns, to be farmed, or maintained under contract; and the poor of 764 parishes are maintained and employed under the regulations of special acts of parliament.

The total sum raised by the poor's rate, and other parochial rates, within the year ending Easter 1803, was 5,348,205*l.* 9*s.* 3¾*d.* The average rate in the pound was, in England 4*s.* 4¼*d.* and in Wales 7*s.* 1½*d.* the average of England and Wales 4*s.* 5¼*d.*

The great increase of the sum thus levied upon the public, and its present magnitude, naturally suggests a doubt, whether the established claim to this kind of relief may not have become, in many instances, the dependance of idleness, instead of the support of age and helplessness. It is also probable, that the laws, by which the poor's rate was originally established, had no relation to the pecuniary relief of the able bodied labourer, and that it was only meant for the relief of those, who either had not work, or who were unable to work. In later years, however, it has been generally extended to the relief of the labourer; and the quantity of that relief has been measured by the high price of provisions, which is one of the principal causes of the great augmentation of the poor's rate.

Mr. Malthus, in his "Essay on the Principle of Population," advises the total abolition of this system of parochial relief, by proposing, that a regulation should be made, declaring that no child born from any marriage, taking place after the expiration of a year from the date of the law, and that no illegitimate child, born two years after the same date, should ever be entitled to parochial assistance.— To give a more general knowledge of this law, he proposes, that the clergyman of the parish should, previously to every marriage, read a short address to the parties, stating the strong obligation on every man to support his own children, and the necessity, which had at length appeared, of abandoning all public institutions for their relief, as having produced effects totally opposite to those which were intended. See POPULATION.

POPPY, we have, under the word PAPAVER, given a botanical account of the plant; we are now to speak of it as productive of opium. The officinal poppy is a native of the southern parts of Europe, but it is thought to have been originally from Asia, where it is cultivated in great abundance. Opium, called, also, opium thebaicum, from its being anciently prepared chiefly at Thebes, has been long and highly celebrated as a medicine. It is imported into this country, and the continent of Europe, in flat cakes, covered with leaves, to prevent their sticking together. It has a reddish-brown colour, and a strong peculiar smell. It is the chief narcotic now employed; it acts directly upon the nervous power, diminishing the irritability and mobility of the system. From the sedative power of opium, by which it allays pain, inordinate action, and restlessness, it is employed in various diseases. Besides the sedative power, it is known to act more or less as a stimulant, exciting the motion of the blood; and by the conjoined effort of the sedative and stimulant effect, opium has been thought to produce intoxication, a quality for which it is much used in the eastern countries. The manner in which this drug is collected in the east is as follows: when the capsules are about half grown, at sun-set, they make two longitudinal double incisions, passing from below upwards, and taking care not to penetrate the internal cavity. The incisions are repeated every evening, until each capsule has received six or eight wounds; they are then allowed to ripen their seeds. If the wounds were made in the heat of the day, a cicatrix would be too soon formed. The night dews favour the distillation of the juice. Early in the morning, old women, boys, and girls, collect the juice, by scraping it off, and deposit the whole in an earthen pot, where it is worked by the hands in the open sun-shine, until it becomes of a considerable thickness. It is then formed into cakes, of a globular shape, and of about four pounds each in weight, and laid into little earthen vessels to be further dried. They are then covered over with poppy or tobacco leaves, and thus dried, they are fit for sale.

From a variety of experiments, made on a large scale, it is found, that opium may be obtained from the poppy cultivated in this country, which, in colour, consistence, taste, &c. is, in every respect, as good as that which is imported from foreign parts. It is thus procured: when the leaves die away and drop off, the capsules, being then in a green state, are cut in slits about an inch long, on one side of the head only: immediately on the incision being made, a milky fluid will issue out, which being of a glutinous nature, will adhere to the bottom of the incision; but some are so luxuriant, that it will drop from the head. The next day, if the weather should be fine, the opium will be of a greyish substance, and then may be scraped off with the edge of a knife, and in a day or two it will be of a proper consistence to make into a mass, and to be put in pots. The white poppy is commonly considered as the officinal plant, but any of the varieties may be employed indiscriminately, since no difference is discovered in their sensible qualities or effects.

The heads, or capsules, being boiled in water, impart a narcotic juice. The liquor, strongly pressed out, suffered to settle, clarified with whites of eggs, and evaporated to a due consistence, yields an extract, possessing the virtues of opium, only in a much milder degree. This is called the syrup of the white poppy, and is adapted to the use of children. It may be observed, that the seeds possess no narcotic powers; they consist of a simple farinaceous matter, united with an oil, and in some countries they are eaten as food.

POPULATION, the proportion of inhabitants which a country or district contains. The increase or diminution of the members of a state has at all periods been thought an object deserving the attention of governments; but very different opinions have been entertained on the subject.

Some ancient nations adopted regulations to prevent any augmentation of the number of citizens; but in modern times it has generally been thought proper to encourage population as essential to the strength and prosperity of a state. Positive regulations against the increase of population are superfluous and nugatory; it is limited in every country by the means of subsistence, and if it ever actually passes this barrier, it must in a very short time, be restored to its former level. So long as there is a facility of subsistence, men will be encouraged to early marriages, and to a careful rearing of their children. In the American states, the inhabitants, particularly such as are engaged in agriculture, congratulate themselves upon the increase of their families, as upon a new accession of wealth; for the labour of their children, even in an early stage, soon redeems, and even repays with interest, the expence and trouble of rearing them. In such countries the wages of the labourer are high, for the number of labourers bears no proportion to the demand and to the general spirit of enterprise. In many European countries, on the other hand, a large family has become a proverbial expression for an uncommon degree of poverty and wretchedness.

The obvious principle, that population is necessarily limited by the means of subsistence, has been stated, and conclusions drawn from it, by many different writers; but it has lately been discussed at great length in an "Essay on the Principle of Population," by Mr. T. R. Malthus, who has endeavoured to prove that population invariably increases where the means of subsistence increase, unless prevented by some very powerful and obvious checks; and that these checks, and the checks which repress the superior power of population, and keep its effects on a level with the means of subsistence, are all resolvable into moral restraint, vice, and misery. Under whatever denomination the causes which adjust population to the circumstances of the country may be classed, it is certain that they exist in every civilized country, and while the nature of man remains the same, they must continue to exist, although operating in a greater or less degree, according to the progress the country has made in cultivation, commerce, and political power. In the northern states of America, where the means of subsistence are more ample, the manners of the people more pure, and the impediments to early marriages fewer than in any of the modern states of Europe, the population was found to double itself for some successive periods every twenty-five years, while in Great Britain, where commerce and manufactures have created large towns, where an almost constant supply is wanting to recruit a formidable army and navy, and where many other causes exist which prevent any considerable increase, the population has not doubled itself in more than one hundred and fifty years.

If a powerful check to increase must exist in some form or other, Mr. Malthus observes, that it is clearly better it should arise from a foresight of the difficulty of rearing a family, and the fear of dependant poverty, than from the actual presence of pain and sickness; moral restraint, or the determination to defer or decline matrimony from a consideration of the inconveniences or deprivations to which a large portion of the community would subject themselves by pursuing the dictate of nature, is therefore a virtue, the practice of which is most earnestly to be encouraged. If no man were to marry, who had not a fair prospect of providing for the presumptive issue of his marriage, population would be kept within proper bounds; men and women would marry later in life, but in the full hope of their reward they would acquire habits of industry and frugality, and inculcate the same in the minds of their children. Mr. Malthus does not actually propose that any restraint upon marriage between two persons of proper age should be enforced by law, but insists that the contract of marriages, between persons who have no other prospect of providing for their offspring than by throwing them on a parish, should not be, as it is at present, encouraged by law. With this view he suggests a plan for the gradual abolition of the poor laws; but, until the poor are more enlightened, and better instructed in moral duties, it is much to be feared that the total abolition of these laws would produce much more vice and misery than at present exists among them.

Although a knowledge of the state of the population has been deemed important in most countries, few attempts had been made to ascertain this circumstance with precision, till within a very late period. In the year 1757 a general enumeration was taken in the kingdom of Sweden, which has since been continued; but most of the other governments of Europe were satisfied with the returns of the number of houses, families, or persons paying particular taxes. It remained for the new government of the United States of America to set the example of a complete enumeration throughout a very extensive territory, and apparently made with as much precision as the nature of the subject admits. The act of Congres, for the first census, passed the first of March, 1790; it directed the marshal of every district to superintend the enumeration of the state where he exercised his functions, and authorised him to call in what aid and assistance he might judge proper. He was ordered to make a return within nine months to the President of the United States, distinguishing in the return the number of free males under and above the age of sixteen years, the number of free females, and of slaves. The Indians, who might live in the districts, were not to be included in the list of population. Every assistant in the enumeration was directed, before transmitting his account to the marshal, to affix it in two or three of the most frequented places of assembly within his bounds, that it might receive any corrections which the inhabitants might suggest. In this manner the census was completed, and the result announced a population of 3,929,326 inhabitants, including 697,697 slaves. The inhabitants of the north-west territory were not included in this number, but the population of that part was then so inconsiderable, that it would have made no important difference in the total number. On the twenty-eighth of February, 1800, an act was passed for taking the second census, pursuant to which the returns were transmitted to the President in December, 1801. The particulars of this enumeration, with the totals of the former, are given in the following statement:

POPULATION.

States.	Total 1791.	Free white Males.	Free white Females.	All other free persons.	Slaves.	Total 1801.
Maine	96,540	76,832	74,069	818		151,719
New Hampshire . . .	141,885	91,258	91,740	852	8	183,858
Vermont	85,539	79,328	74,580	557		154,465
Massachusetts	378,787	205,135	211,258	6,452		422,845
Rhode Island	68,825	31,858	33,580	3,304	380	69,122
Connecticut	237,946	121,193	123,528	5,330	951	251,002
New York	340,120	287,094	268,122	10,374	20,613	586,203
New Jersey	184,139	98,725	95,600	4,402	12,422	211,149
Pennsylvania	434,373	301,467	284,628	14,564	1,706	602,365
Delaware	59,094	25,033	24,819	8,268	6,153	64,273
Maryland	319,728	113,683	108,310	19,987	107,707	349,692
Virginia	747,610	264,399	254,275	20,507	346,968	886,149
Kentucky	73,677	93,961	85,915	741	40,343	220,960
North Carolina	393,751	171,648	166,116	7,043	133,296	478,103
South Carolina	249,073	100,916	95,339	3,185	146,151	345,591
Georgia	82,548	53,968	48,293	1,019	59,404	162,648
Tennessee	35,691	47,180	44,529	309	13,584	105,602
Territory N.W. of Ohio		24,433	20,595	337		45,365
Mississippi territory		2,907	2,272	182	3,489	8,850
Indiana territory . . .		2,979	2,318	188	156	5,641
	3,929,326	2,194,002	2,109,886	108,419	893,331	5,305,638

The most striking circumstance which this account exhibits, is the great increase which has taken place since the enumeration in 1791, the addition being more than a third part of the whole number of inhabitants at that period, or 1,376,312 persons. Should they continue thus to increase one-third of their number in each succeeding ten years, they would, in about twenty-five years, equal the population of Great Britain, as it appeared by the account of 1801; but should they only make the same addition in each succeeding ten years, as in the above period, it would require about forty years to attain the same degree of population.

The increase shown by the above account, being much greater than any other civilized nation can boast, it may be doubted, whether, having already made such considerable progress, this increase will still continue; but the United States are so differently circumstanced from any European nation, with respect to the means of subsistence, that while they preserve peace with other powers, the vast tracts of unsettled lands which they possess, will long continue to favour the greatest natural increase of the inhabitants, as well as attract emigrants from other countries.

Another peculiarity which these accounts present, is the proportion of males and females. In Great Britain, and most other parts of Europe, the number of females living has been found to exceed that of the males, although the difference is not so great as was formerly supposed; in America, however, the fact is the contrary, the number of the females being equal to that of the males only in three or four of the states, and taking the total numbers of males and females, the proportion is ninety-six females to one hundred males.

The population of Great Britain was long a subject of great uncertainty, both with respect to the actual number of inhabitants, and their increase or diminution; it became a subject of frequent controversy among writers on the internal policy and strength of the country, till it was at length set at rest by an act of parliament, passed 31st December, 1800, which directed a general enumeration of houses, families, and persons, to be named on the 10th March, 1801, in England and Wales, and in Scotland as soon as possible after that day. This difference was necessary, because, in the colder climate of Scotland, it was not certain that all parts of the country would be easily accessible so early in the year. An abstract of the answers and returns made, was laid before both houses of parliament, in December following, which, though unavoidably defective in some respects, furnishes much unexceptionable information on the subject.

POPULATION.

SUMMARY OF ENUMERATION, 1801.

	HOUSES.			PERSONS.		
	Inhabited.	By how many families occupied.	Uninhabited.	Males.	Females	Total.
England	1,472,870	1,787,520	53,965	3,987,935	4,343,499	8,331,434
Wales	108,053	118,303	3,511	257,178	284,368	541,546
Scotland	294,553	364,079	9,537	734,581	864,487	1,599,068
Army, including Militia	———	———	——	198,351	———	198,351
Navy, including Marines	———	———	——	126,279	———	126,279
Seamen, in Registered Shipping . . .	———	———	——	144,558	———	144,558
Convicts, on board the Hulks	———	———	——	1,410	———	1,410
Totals . .	1,875,476	2,269,902	67,013	5,450,292	5,492,354	10,942,646

The islands of Guernsey, Jersey, Alderney, and Sark, the Scilly Islands, and the Isle of Man, were not comprised in the enumeration; the total population of these islands has been usually estimated at about 80,000. The number of houses in Ireland has been nearly ascertained, by the collection of a hearth-money tax, from whence it has been computed, that the population of that part of the united kingdom somewhat exceeds four millions of persons. Therefore, with a very moderate allowance for those places from which no returns were received, and for omissions in others, the total population of the united kingdom of Great Britain and Ireland amounted to 15,100,000 persons.

At the beginning of the preceding century, Dr. Davenant published an account of the total number of houses in England and Wales, according to the hearth books of Lady-Day 1690; this account was probably as correct as the above, and a comparison of them shows an increase from 1690 to 1801 of 261,708 houses, which, at $5\frac{3}{5}$ persons to a house, makes an increase of 1,465,563 persons. This appears to be the least increase that can have taken place, but it has certainly been greater, on account of the number of soldiers and seamen far exceeding those employed in 1690.

A circumstance, which caused considerable disagreement in the estimates, which, previously to the enumeration, had been formed on this subject, was the want of sufficient accounts to determine the proportion of persons to a house. Dr. Davenant and Dr. Brakenridge reckoned six persons to a house; while Mr. G. King allowed rather more than $4\frac{1}{2}$ in London, $4\frac{3}{10}$ in the cities and market-towns, and four in the villages. Dr. Price asserted, that six persons to a house for London, and five to a house for all England, was too large an allowance; but the fact now appears to be, that in England and Wales the proportion is $5\frac{3}{5}$ persons to a house, and in Scotland $5\frac{2}{5}$.

The proportion of inhabitants to a house differs very considerably in some of the counties of England; the chief cause of this difference is the large towns, and particularly the sea-ports, which some of them contain, as in such places the inhabitants live more crowded together than in moderate sized inland towns. The difference, in this respect, between large towns and those of less extent will be shown, with tolerable accuracy, by the following statements.

Inhabitants.	Towns.	Persons to a House.
864,845	London	$7\frac{1}{4}$
84,020	Manchester	$6\frac{3}{4}$
77,653	Liverpool	$6\frac{3}{4}$
63,645	Bristol	6
43,194	Plymouth	$9\frac{3}{4}$
32,200	Bath	$7\frac{1}{2}$
32,166	Portsmouth	6
29,516	Hull	$6\frac{1}{4}$
28,366	Newcastle	9

The other towns in England, containing upwards of twenty thousand inhabitants, are the following:

Inhabitants.	Towns.	Persons to a House.
73,670	Birmingham	5
53,162	Leeds	4¾
36,832	Norwich	4½
31,314	Sheffield	4¾
28,861	Nottingham	5¼

The latter are all manufacturing towns, the trade of which had for several years previously to the enumeration, been in a very distressed situation, and had reduced the population much below its usual standard; a few years of peace will restore the inhabitants which these towns had lost, and reduce, in some degree, the population of the principal out-ports.

Proportion of persons to a house in towns of a moderate size.

Inhabitants.	Towns.	Persons to a House.
7,909	Devizes	5
7,668	Salisbury	5¼
7,655	Bury	5¾
7,579	Gloucester	5¾
7,531	Wellington	5¼
7,398	Lincoln	5
7,020	Northampton	5¼
6,828	Hereford	5
6,730	Newark	5
6,505	Tiverton	5¼
5,794	Taunton	5

The enumeration has not only ascertained with precision the proportion of inhabitants to the houses, but likewise the proportion of males and females. It has been long known, that more male children come into the world than females, of which, additional evidence is furnished by the registers of baptisms collected on this occasion, the total of the twenty-nine years for which returns were required, being 3,285,188 males, and 3,150,922 females, or 104 males born to 100 females. This approaches much nearer to equality, than the proportion which previous accounts had appeared to establish, and will probably be found nearer the truth. It has been asserted, that although more males are born than females, there are more females living than males. This opinion appears to have been formed from accounts of places of small extent, or in which the males belonging to such places, who at the time were employed in the army and sea-service, were not included; and if only the resident population is considered, there certainly will appear an excess of females in almost every part of Great Britain. In the maritime counties there appears to be on an average 110 females to 100 males, and in the inland counties 104 females to 100 males. There can be no sufficient reason assigned for a greater proportion of females residing in the counties which contain sea-ports, but their connection with males engaged in a seafaring life; and in reality the proportion of females is not greater in these counties than in the others, but it unavoidably appears so, in consequence of persons in the navy and merchants service having been accounted for in a body, and therefore not being included in the returns of the parishes to which they belong. Of the total number of males in Great Britain, it appears that one in twenty-seven, or nearly four in 104, are in the army and militia, which corresponds with the appearance of an excess of females in the inland counties, whence most of our soldiers, but scarce any sailors, are supplied; and of the total number of males in Great Britain, the army, navy, and seamen in the merchants service, amount together to one in 11½, or somewhat less than 10 out of 110; which agrees so nearly with the average excess of females in the maritime counties, that little doubt can remain that the appearance of an excess of females has been caused merely by soldiers and seamen not being included in the parochial returns.

The total number of males, including the army, navy, &c. was 5,450,292; the total of females 5,492,354, exceeding the males by 42,062, which difference, of less than one in 100, may be accounted for by emigration from this country to the East and West Indies, America, &c. very few females going from hence to reside in foreign parts, in comparison with the number of males who are continually leaving the country in commercial pursuits, or from other motives. The result of the enumeration, therefore, strongly proves that the number of males and females living is as nearly equal as in a subject of this nature could be expected; and the circumstance, of a greater proportion of males being born, appears a necessary provision for maintaining this equality, as providing against the greater adventitious mortality among males, in consequence of the casualties to which they are exposed, and particularly from war and navigation.

An attempt was made to ascertain the population of France, by command of the government, in the tenth year of the Republic, but the account does not appear to have been very accurately taken. The total population of the 102 departments, into which France was then divided, was stated at 33,104,343 persons, over an extent of about 185,600 square miles. This account included thirteen departments incorporated with the north of France, four departments in the south, and some smaller acquisitions, comprehending, in the whole 23,790 square miles, containing 5,114,419 inhabitants.

POPULUS, in botany, *poplar*, a genus of the Dioecia Octandria class and order. Natural order of Amentaceæ. Essential character: calyx of the ament a flat scale, torn at the edge; corolla turbinate, oblique, entire: female, stigma four-cleft; capsule two celled; seeds many, pappose. There are eleven species; among which we shall notice the P. tremula, trembling poplar-tree, or asp, as it is called from the German *espe*, which is the general name for all poplars; it has a green smooth bark; the leaves at first breaking out are hairy above, and cottony underneath, but when full grown are smooth. Linnæus observes that they are rolled inwards at the edge, having two glands, running one into the other, on the inner side above the base; he also observes that the leaf-stalks are flatted towards the end, which occasions the perpetual trembling of the leaves with every breath of wind; the petioles being flat in the white and black poplars, as well as in this. Dr. Stokes accounts better for the phenomenon, from the plane of the long leaf-stalks being at right angles to that of the leaves, allowing them a much freer motion than could have taken place had their planes been parallel. The Highlanders of Scotland account for it from a superstitious notion that our Saviour's cross was made of this tree, and that therefore the leaves can never rest.

PORANA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx five-cleft, in the fruit larger; corolla bell-shaped; style semibifid, longer, permanent; stigmas globular; pericarp two valved.—There is only one species, *viz.* P. volubilis, a native of the East Indies.

PORCELAIN, a fine sort of earthenware, chiefly manufactured in China, and thence called china-ware.

The combination of silex and argil is the basis of porcelain: and, with the addition of various proportions of other earths, and even of some metallic oxides, forms the different varieties of pottery, from the finest porcelain to the coarsest earthenware. Though siliceous earth is the ingredient which is present in largest proportion in these compounds, yet it is the argillaceous which more particularly gives them their character, as it communicates ductility to the mixture when soft, and renders it capable of being turned into any shape on the lathe, and of being baked.

The clays are native mixtures of these earths; but they are often rendered unfit for the manufacture of at least the finer kinds of porcelain, from other ingredients which they also contain.

The perfection of porcelain will depend greatly on the purity of the earths of which it is composed; and hence the purest natural clays, or those consisting of silex and argil alone, are selected. Two substances have been transmitted to Europe, as the materials from which the Chinese porcelain is formed, which have been named KAOLIN and PETUNSE, which see; it was found difficult to procure, in Europe, natural clays equally pure, and hence, in part, the difficulty of imitating the porcelain of the east. Such clays, however, have now been discovered in different countries; and hence the superiority to which the European porcelain has attained. The fine Dresden porcelain, that of Berlin, the French porcelain, and the finer kinds which are formed in this country, are manufactured of such clay, which, from the use to which it is applied, has received the name of porcelain earth, and which appears, in general, to be derived from the decomposition of the felspar of granite. It appears, also, that natural earths, containing magnesia, are used with advantage in the manufacture. The proportion of the earths to each other must likewise be of importance; and from differences in this respect arise, in part, the differences in the porcelain of different countries, as well as the necessity frequently of employing mixtures of natural clays. The argil communicates tenacity and ductility to the paste, so that it may be easily wrought: the silex gives hardness and infusibility; and on the proper proportion of these depends, in a great measure, the perfection of the compound. The proportion of silex in porcelain of a good quality is, at least, two-thirds of the composition; and of argil, from a fifth to a third. Magnesia is of utility, by lessening the tendency which the composition of silex and argil alone has to contract in baking, and which is convenient in the manufacture. In the manufacture of the finer kinds of porcelain, the ingredients are carefully washed, dried, and ground by a mill to a very fine powder, which is passed through a sieve. This is made into a paste with water, which is well kneaded, so as to be uniform in composition. The vessels shaped from this paste are baked in earthen pots, to render them tolerably hard and compact: they are then covered with the materials for glazing, which, in the better kinds of porcelain, consist of a mixture of earths, which form a compound more vitrifiable than the porcelain itself.

These materials are diffused in a very fine powder in water, into which the baked vessels are dipped: the surface is thus covered with a thin crust, the water being absorbed. When dry, they are again placed in the earthen pots, and exposed to a very intense heat. The solid matter of the porcelain undergoes a semi-vitrification, whence it possesses all the hardness of glass, and has an additional value, in being less brittle, and much more able to bear sudden alterations of temperature: it derives also much beauty from its semi-transparency and white colour. The glazing on the surface is, from its greater fusibility, more completely vitrified, and is, of course, more smooth and impervious. See GLAZING, ENAMELLING, &c.

PORCH, in architecture, a kind of vestibule supported by columns; much used at the entrance of the ancient temples, halls, churches, &c. See ARCHITECTURE. Such is that before the door of St. Paul's, Covent Garden. When a porch had four columns in front, it was called a tetrastyle; when six, hexastyle; when eight, octostyle, &c. See TETRASTYLE, &c.

PORCUPINE. See HISTRIX.

PORE, in anatomy, a little interstice or space between the parts of the skin, serving for perspiration. See CUTIS and PHYSIOLOGY.

PORES, are the small interstices between the particles of matter which compose bodies; and are either empty, or filled with some insensible medium.

Condensation and rarefaction are only performed by closing and opening the pores. Also the transparency of bodies is supposed to arise from their pores being directly opposite to one another. And the matter of insensible perspiration is conveyed through the pores of the cutis.

Sir Isaac Newton shows, that bodies are much more rare and porous than is commonly believed. Water, for example, is nineteen times lighter and rarer than gold; and gold itself is so rare, as very readily, and without the least opposition, to transmit magnetic effluvia, and easily to admit even quicksilver into its pores, and to let water pass through it: for a concave sphere of gold hath, when filled with water, and soldered up, upon pressing it with a great force, suffered the water to ooze through it, and stand all over its outside, in multitudes of small drops, like dew, without bursting or cracking the gold. Whence it may be concluded, that gold has more pores than solid parts, and consequently that water has above forty times more pores than solid parts. Hence it is that the magnetic effluvia passes freely through all cold bodies that are not magnetic; and that the rays of light pass, in right lines, to the greatest distances through pellucid bodies.

PORISM, in geometry, has been defined a general theorem, or canon, deduced from a geometrical locus, and serving for the solution of other general and difficult problems. But Dr. Simson defines it a proposition, either in the form of a problem or theorem, in which it is proposed either to investigate or demonstrate. Euclid wrote three books of Porisms, which are lost; and nothing remains in the works of the ancient geometricians on this subject, besides what Pappus has preserved in his mathematical collections. Dr. Simson, among the moderns, left behind him a considerable treatise on the subject of Porisms, which was printed at the expense of the late Earl Stanhope, who was himself a very able mathematician, and the patron of several persons who had distinguished themselves in that branch of science.

POROSTEMA, in botany, a genus of the Polyadelphia Polyandria class and order. Natural order of Lauri, Jussieu. Essential character: calyx six-parted, unequal; corolla none; filaments nine, with four anthers on each; capsule covered, four or six-celled, many-seeded. There is but one species, *viz*. P. guianensis, a native of the woods of Guiana.

PORPHYRY, in mineralogy, a name appropriated to that rock where grains or crystals of felspar are imbedded in a certain basis, as in horn-stone, pitch-stone, or indurated clay. There are five species of rocks belonging to the porphyritic formation, *viz*. 1. Horn-stone porphyry; the horn-stone, which serves as the base of this substance, is generally red or green, and incloses crystals of quartz and felspar. 2. Felspar porphyry; the base of this is red compact felspar, inclosing crystals of felspar and quartz. 3. Scenitic porphyry; containing crystals of hornblende, in addition to the other ingredients. 4. Pitch-stone porphyry; the base of which is red, green, brown, or black. 5. Clay porphyry; the base of which is indurated clay passing into horn-stone, it is of a reddish colour, and contains crystals of quartz and felspar. Horn-stone porphyry is the oldest of the class; and clay porphyry the most recent. The red porphyries are employed in ornamental architecture for columns.

PORT, a commodious place situated on the sea-coast, or at the mouth of a river, screened from the wind and the enterprizes of an enemy, with depth of water sufficient for ships of burden, and where vessels lie by to load and unload.

Ports are either natural or artificial; the natural are those formed by Providence, and the artificial such as are formed with moles running into the sea. The city of Constantinople is called "The Port," from its having one of the finest ports in Europe. All the ports and havens in England are within the jurisdiction of the county; and the Court of Admiralty cannot hold jurisdiction of any thing done in them. 30 Henry VI.

Port *holes*, in a ship, are the holes in the sides of the vessel, through which are put the muzzels of the great guns. These are shut up in storms to prevent the water from driving through them. The English, Dutch, and French ships, have the valves, or casements, fastened at the top of the port holes, and the Spanish vessels aside of them.

PORTAL, in architecture, a little gate where there are two gates of a different bigness; also a little square corner of a room cut off from the rest by the wainscot, and forming a short passage into the room. The same name is also sometimes given to a kind of arch of joiners' work before a door.

PORTCULLICE, in fortification, is an assemblage of several large pieces of wood, joined across one another like a harrow, and each pointed with iron at the bottom. They are sometimes hung over the gateway of old fortified towns, ready to let down in case of surprise, when the gates could not be shut.

PORTER, a kind of malt liquor, which differs from ale and pale beer in its being made with high-dried malt.

PORTGREVE, or Portgrave, anciently the principal magistrate in ports and other maritime towns. The word is formed from the Saxon "port," and "geref," a governor. It is sometimes also written "portreve." It is said by Camden, that the chief magistrate of London was anciently called port-greve, which was exchanged by Richard I. for two bailiffs: and these again gave place, in the reign of King John, to a mayor, who was an annually elected magistrate.

PORTICO, in architecture, a kind of gallery on the ground, supported by columns, where people walk under covert.

PORTLAND-STONE, is a dull whitish species of stone, much used in buildings; it is composed of a coarse grit, cemented together by an earthy spar: it will not strike fire with steel, but makes a violent effervescence with nitric acid.

Portland *vase*, a celebrated funeral vase, which was long in the possession of the Baberini family; but which was some years since purchased for 1000 guineas by the Duke of Portland, from whom it has derived its present name. Its height is about ten inches, and its diameter, where broadest, six. There are a variety of figures upon it, of most exquisite workmanship, in bas relief, of white opaque glass, raised on a ground of deep blue glass, which appears black, except when held against the light. It appears to have been the work of many years, and there are antiquarians who date its production several centuries before the Christian era; since, as has been said, sculpture was declining in excellence in the time of Alexander the Great. Respecting the purpose of this vase, and what the figures on it were meant to represent, there have been a variety of conjectures. We shall, therefore, give a short account of the several figures, without noticing any of the theories or conjectures that have been made about them. In one compartment three exquisite figures are placed on a ruined column, the capital of which is fallen, and lies at their feet among other disjointed stones: they sit under a tree on loose piles of stone. The middle figure is a female, in a reclining and dying attitude, with an inverted torch in her left hand, the elbow of which supports her as she sinks, while the right hand is raised and thrown over her drooping head. The figure on her right hand is a man, and that on the left a woman, both supporting themselves on their arms, and apparently thinking intensely. Their backs are to the dying figure, and their faces are turned to her, but without an attempt to assist her. On another compartment of the vase is a figure coming through a portal, and going down with great timidity into a darker region, where he is received by a beautiful female, who stretches forth her hand to help him: between her knees is a large and playful serpent. She sits with her feet towards an aged figure, having one foot sunk into the earth, and the other raised on a column, with his chin resting on his hand. Above the female figure is a Cupid preceding the first figure, and beckoning him to advance. This first figure holds a cloak or garment, which he seems anxious to bring with him, but which adheres to the side of the portal through which he has passed. In this compartment there are two trees, one of which bends over the female figure, and the other over the aged one. On the bottom of the vase there is another figure, on a larger scale than the one we have already mentioned, but not so well finished nor so elevated. This figure points with its finger to its mouth. The dress appears to be curious and cumbersome, and above there is the foliage of a tree. On the head of the figure there is a Phrygian cap; it is not easy to say whether this figure be male or female. On the handles of the vase are represented two aged heads, with the ears of a quadruped, and from the middle of the forehead rises a kind of tree without leaves: these figures are, in all probability, mere ornaments, and have no connection with the rest of the figures, or the story represented on the vase.

PORTLANDIA, in botany, so named in honour of the Duchess of Portland, a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: corolla club, funnel-shaped; anthers longitudinal; capsule five cornered, obtuse, two-celled, two-valved, many-seeded, crowned with a five-leaved calyx. There are four species.

PORTMANTEAU, a cloak bag of cloth, leather, &c. in which the cloak, linen, and other habiliments of travellers are disposed and laid on the horse's crupper. The same name is also given to a piece of joiners' work fastened to the wall in a wardrobe, armoury, &c. proper for the hanging on of cloaks, hats, &c.

PORTRAIT, Pourtrait, or Pourtraiture, in painting, the representation of a person, and especially of a face done from the life. In this sense we use the term portrait-painting, in contradistinction to history-painting, where a resemblance of person is usually disregarded. Portraits, when as large as the life, are usually painted in oil-colours; sometimes they are painted in miniature with water-colours, crayons, pastils, &c. See Painting.

PORTULACA, in botany, *purslane*, a genus of the Dodecandria Monogynia class and order. Natural order of Succulentæ. Portulaceæ, Jussieu. Essential character: calyx bifid; corolla five-petalled; capsule one-celled, cut round, or three-valved. There are twelve species; of which P. oleracea, garden purslane, is an annual herbaceous plant, with a round, procumbent, succulent stem; diffused branches, often throwing out fibres at the joints; leaves wedge-shaped, oblong, blunt, fleshy, sessile, clustered, especially at the ends of the branches: flowers sessile, corollas yellow, spreading; it is a native of both Indies, China, and Japan.

PORTULACARIA, in botany, a genus of the Pentandria Trigynia class and order. Essential character: calyx two-leaved; petals five; seed one, three-sided and winged. There is but one species, *viz.* P. afra, a native of Africa.

POSITION, or the *rule of false* Position, otherwise called the *rule of* Falsehood, in arithmetic, is a rule so called, because, in calculating on several false numbers taken at random, as if they were the true ones, and from the differences found therein, the number sought is determined. This rule is either single or double. Single position is when there happens in the proposition some partition of numbers into parts proportional, in which case the question may be resolved, at one operation, by this rule. Imagine a number at pleasure, and work therewith according to the tenor of the question, as if it were the true number: and what proportion there is between the false conclusion and the false proportion, such proportion the given number has to the number sought. Therefore the number found by argumentation shall be the first term of the rule of three; the second number supposed, the second term; and the given number, the third. Or the result is to be regulated by this proportion, *viz.* As the total arising from the error to the true total, so is the supposed part to the true one. Example, A, B, and C, designing to buy a quantity of lead to the value of 140*l.* agree that B shall pay as much again as A, and C as much again as B; what then must each pay?

Now suppose A to pay 10*l.* then B

must pay 20*l.* and C 40*l.* the total of which is 70*l.* but should be 140*l.* Therefore, if 70*l.* should be 140*l.* what should 10*l.* be?

Answer, 20*l.* for A's share, which doubled makes 40*l.* for B's share, and that again doubled gives 80*l.* for C's share, the total of which is 140*l.* Double position is when there can be no partition in the numbers to make a proportion. In this case, therefore, you must make a supposition twice, proceeding therein according to the tenor of the question. If neither of the supposed numbers solve the proportion, observe the errors, and whether they be greater or less than the supposition requires, and mark the errors accordingly with the sign + and —.

Then multiply contrarywise the one position by the other error, and if the errors be both too great, or both too little, subtract the one product from the other, and divide the difference of the products by the difference of the errors. If the errors be unlike, as the one + and the other —, add the products, and divide the sum thereof by the sum of the errors added together: for the proportion of the errors is the same with the proportion of the excesses or defects of the numbers supposed to be the numbers sought: or, the suppositions and their errors being placed as before, work by this proportion as a general rule, *viz.* as the difference of the errors, if alike; or their sum, if unlike, to the difference of the suppositions, so either error to a fourth number, which accordingly, added to or subtracted from the supposition against it, will answer the question.

Position, in geometry, is a term sometimes used in contradistinction to magnitude: thus a line is said to be given in position, *positione data,* when its situation, bearing, or direction, with regard to some other line, is given: on the contrary, a line is given in magnitude, when its length is given, but not its situation.

POSITIVE, a term of relation sometimes opposed to negative; hence a positive quantity, in algebra, is a real or affirmative quantity, or a quantity greater than nothing: thus called in opposition to a privative or negative quantity, which is less than nothing, and marked by the sign —. Positive quantities are designed by the character + prefixed, or supposed to be prefixed to them.

Positive, in music, denotes the little organ usually placed behind or at the feet of an organist, played with the same wind, and the same bellows, and consisting of the same number of pipes with the larger one, though those much smaller, and in a certain proportion: this is properly the choir-organ.

Positive *degree*, in grammar, is the adjective in its simple signification, without any comparison; or it is that termination of the adjective which expresses itself simply, and absolutely, without comparing it with any other.

Positive *electricity.* According to the Franklinian system, all bodies are supposed to contain a certain quantity of electricity: and those, that by any means, are made to contain more or less than their natural quantity, are said to be positively or negatively electrified. These electricities being first produced by the friction of glass and resin, were called by some philosophers vitreous and resinous; the former answering to the positive or plus electricity; the latter to the negative or minus electricity.

POSSE *comitatus.* The power of the county, is the attendance of all knights and others, above fifteen years of age, to assist the sheriff in quelling riots, &c.

POSSESSION is two-fold; actual, and in law: actual possession is, when a man actually enters into lands and tenements to him descended; possession in law is, when the lands or tenements are descended to a man, and he has not as yet actually entered into them.

POSSESSIVE, in grammar, a term applied to pronouns which denote the enjoyment or possession of any thing, either in particular or in common: as *meus,* mine, and *tuus,* thine; *noster,* ours, and *vester,* yours.

POST, a word synonymous with *courier,* which is supposed to be originally derived from horses for the conveyance of dispatches, being *positi,* or placed at convenient distances, as relays or changes for those fatigued, and unable to proceed the whole journey with the desired speed. Hence it has become the practice to term horses employed for this and similar purposes, post-horses; their riders, post-boys: the houses for the reception of letters thus conveyed, post-offices; and even the drivers of chaises, postilions; and their vehicles, post-chaises; it is natural, besides, to say, he who continues a journey on fresh horses, without stopping for more than necessary refreshment, rides post. The spaces between certain inns, for the reception of travellers in England, forming a post, varies from twelve to fifteen miles, beyond which it is deemed imprudent to urge a horse, without a long interval of repose; and the charges per mile for horses furnished from those inns, have occasioned continual discontent, and frequent general meetings of certain classes of the public.

Before the establishment of a system for the conveyance of important intelligence, and in the earliest state of society, it may be supposed, horses were seized, or, to use a modern term, put into requisition, where they were wanted; though it is still more probable, that men were tutored to run from station to station, as is now the practice in the Eastern nations, whose couriers fly their prescribed distance with astonishing velocity, and delivering their dispatches to fresh persons, they are by this means conveyed almost as rapidly as by horses. The Emperor Trajan appears to have been the first who ordained the keeping of horses for this purpose only, and the example has appeared so rational to succeeding generations, that it is highly probable, posting of every description has now reached its full possible perfection.

It was customary, in ancient times, to convey information by boats, and in chariots, exclusive of on foot and horseback; nay, even pigeons have been taught to fly from place to place, with letters attached to them; in England, men who conveyed letters were called carriers, which was certainly, in the then state of the roads, a much more appropriate term than the present, implying, in one acceptation, exceeding swiftness. Louis XI., King of France, established the first regular conveyance of this description in the year 1464, for the more speedy and certain information he thought it necessary to possess, concerning the state of his extensive dominions; the utility of the invention was too apparent to escape the observation of the surrounding continental nations, which adopted the idea, and each suited the regulations to their own peculiar circumstances; England, alone, seems to have preferred her old and tedious system of carriers, till the twelfth year of the reign of Charles II., when Parliament passed an act, which empowered the King to establish a post-office, and to appoint a Post-master General; from that time to the present, numerous other acts of the legislature have been made, to improve and amend the system, which, during the time of peace, is carried on by an incredible number of clerks, and officers, and receivers, and letter-carriers, whose regularity and punctuality are not to be exceeded in any department of the government. In the time of Queen Anne, Sir Thomas Frankland, and John Evelyn, Esquire, held the office of Post-master General jointly, and received a salary of 2000*l.* per annum, about which time the following notice appeared in the London Gazette. "These are to give notice, that by the act of Parliament for establishing a general post-office, all letters and packets directed to, and sent from places distant ten miles or above, from the said office in London, which, before the second of this instant, June, were received and delivered by the officers of the penny-post, are now subjected to the same rates of postage as general post letters; and that for the accommodation of the inhabitants of such places, their letters will be conveyed with the same regularity and dispatch as formerly, being first taxed with the rates, and stamped with the mark of the general post-office; and that all parcels will likewise be taxed at the rate of two shillings per ounce, as the said act directs."

Although the value of money has infinitely decreased since the above period, such has been the increase in commerce, and trade, and population, that the charges for the conveyance of letters is still comparatively moderate, as a single letter is sent one hundred and fifty miles for eight-pence. This may be attributed, in a great measure, besides, to the modern invention of mail coaches, for which the public are indebted to Mr. Palmer, who has not, however, reaped that advantage from it originally intended. Those that have travelled in these vehicles need not be informed of their rapid motions, nor of the constant uninterrupted assiduity of the coachmen, the guards, the officers of the different post-towns, and even of the hostlers, to expedite their progress, and to those who have not, and foreigners, the regulations under which they are placed, must give an exalted idea of the commercial character of the British nation.

At eight o'clock in the evening of every day, the mail coaches depart from London, freighted with such letters and packets as have been conveyed during the day, either to the office in Lombard-street, or to that place from the various receiving-offices scattered in every direction, by the letter-carriers, who walk through their districts, ringing a bell from five o'clock to six, to collect those letters which have been delayed to that late hour. The coaches, which proceed to London from all parts of the kingdom, regulate their movements so as to arrive by six o'clock each morning, and from that time the sorters at Lombard-street are employed in preparing the letters for the different carriers waiting to receive them, who generally complete their delivery by twelve at noon.

Newspapers are conveyed gratis to all parts of the country, and if frivolous, vexatious, or malicious letters are sent through the medium of the post-office, upon a proper representation the money is returned; persons are also appointed to open such letters as may be directed to individuals improperly, or who cannot be found, when they are carefully inclosed in an envelope, explaining why the seal has been violated, and returned to the writer. Letters directed to any part of England, may be sent without paying; or the receiver will take the postage, and the receipt, or non-payment, is explained to the carriers by marks stamped on the letter; but all letters sent out of England must be payed for on putting them into the office. Other marks, pointing out the day and hour of putting the letter into the receiver's hands, prevent the possibility of neglect without discovery, and so great is the vigilance of the officers, that, though millions of money pass through the post-office, it is a very rare circumstance that dishonesty is discovered in the sorters or carriers: when an individual commits a theft of this description, he is pursued with unrelenting severity to punishment, and the office makes good the loss.

The general post-office was originally situated in Cloak-lane, near Dowgate, whence it was afterwards removed to the Black Swan, in Bishopsgate-street, and finally to the mansion of Sir Robert Vyner, in Lombard-street; and although it has been repeatedly enlarged and improved, and may answer for the purposes required, yet it must be admitted, that such an establishment requires an uniform and superb building.

The penny-post, as it was termed for more than a century, originated from the public spirit of a merchant, named Docwra, and a Mr. Murray, who, with much difficulty and great expense, in the reign of Charles II., proceeded so far as to establish it; but, strange and perverse as it may appear, every species of opposition and misrepresentation attended its progress, both from the public and the government, and, after a trial with the latter in the court of King's Bench, the projectors had the mortification to find it adjudged to belong to the Duke of York, as a branch of the general-post-office.

In an advertisement used by them, in 1681, they say, "that undertakers have set up and hitherto carried on the said practice with much pains and industry, and at the expense of a great sum of money, and are as desirous to continue it for the public service of their native place, as to benefit themselves thereby; yet they have met with much opposition, and many discouragements from the self-interested, the envious, and the ignorant: from the last of which (to pass by the others at present) there are daily complaints of the delays of letters causelessly charged on the office, which hath proved very injurious to the progress and prosperity of their honest design, and hindering the inhabitants from reaping the advantage and conveniency thereof." After some explanations how the delay complained of occurred, through the carelessness of persons not connected with the undertaking, they add, "for some remedy to prevent such unjust reflections for the time to come, and that any person may discover where the fault lies, if his letter be delayed, the undertakers have provided stamps of the like form in the margin, (similar to those still used) which shall be set on each letter every hour of the day; (at the time they are given out of their office for delivery) and all persons are to expect their letters in an hour (little more or less) after the time stamped, according as the distance is further from, or nearer to, the office from whence they are sent; and if people will but consider, that there must be an hour's time allowed for collecting every round of letters, another for sorting and distributing, and a third for delivery, (besides an over-allowance for remote parts) they would not so often mistake in their reckonings, and expect a letter should go or come as soon as if a special messenger were immediately sent away with it, although they hope, that all ingenuous and thinking persons do find such dispatches as do answer their reasonable expectations."

An establishment of decided and obvious utility, like that of the penny-post, could not fail of succeeding in time, and accordingly we find it has flourished for more than a hundred years; but well-founded complaints were sometimes urged against it during that period, which at length induced the government to take it under their immediate inspection, at the close of the last century, when, in order to meet the increased expences of every portion of the undertaking, it was determined to double the charge, and from that period it received the denomination of the two-penny post. In order to facilitate the conveyance of letters and packets, boys are employed, who ride small swift horses to and from the principal office, situated in Gerard-street, Soho, where may be seen a miniature copy of the proceedings at the general post-office, already described.

POST-*office*, a general post office was erected 12 Charles II. c. 35. It was made perpetual, and part of the general fund, 3 George I. c. 7. The postmaster is not like a common carrier, and is not answerable for the loss of any money by post, nor can the country postmaster add any charge to the postage for carrying the letters out to the inhabitants of the town. The case has been several times tried and decided. A principal object in the erection of the post-office, was in order to have the means of inspecting letters of individuals, and discovering attempts against the Government, (see the Ordinance 1657); and now letters may be opened by an order from a Secretary of State. For this, and other purposes, there are several penalties levied upon persons carrying or sending letters by private conveyance. Letters coming by private ships from abroad, and even letters belonging to the owners, must also pass through the post office.

POST, in the military art, is any place or spot of ground, fortified or not, where a body of men may make a stand and fortify themselves, or remain in a condition to fight an enemy. Hence it is said, that the post was relieved, the post was taken sword in hand, &c.

POST, *advanced*, is a spot of ground seized by a party to secure the army, and cover the posts that are behind.

POSTERN in fortification, is a small gate generally made in the angle of the flank of a bastion, or in that of the curtin, or near the orillon, descending into the ditch; by which the garrison may march in and out unperceived by the enemy, either to relieve the works, or to make private sallies, &c.

POSTIL, a name anciently given to a note in the margin of the bible, and afterwards to one in any other book posterior to the text.

POSTING, among merchants, the putting an account forward from one book to another, particularly from the journal or waste-book to the ledger.

POSTULATE, in mathematics, &c. is described to be such an easy and self-evident supposition, as needs no explication or illustration to render it intelligible; as, that a right line may be drawn from one point to another. That a circle may be described on any centre given, of any magnitude, &c.; however, authors are not well agreed as to the signification of the term postulatum; some make the difference between axioms and postulata to be the same as that between theorems and problems; axioms, according to those authors, being truths that require no demonstration. But others will have it, that axioms are primitive and common to all things, partaking of the nature of quantity, and which therefore may become the objects of mathematical science; such as number, time, extension, weight, motion, &c. and that postulata relate particularly to magnitude, strictly so called, as to things having local extension, such as lines, surfaces, and solids; so that in this sense of the word postulatum, Euclid, besides axioms, or those principles which are common to all kinds of quantities, has assumed certain postulata to be granted him peculiar to extensive magnitude. Hence several of the principles assumed in his Elements, and ranked among the axioms by the moderns, are by Proclus ranked among the postulata, which has induced Dr. Wallis to judge, that the last of the two senses given to the term postulatum is most agreeable to the meaning of the ancient geometers.

POSTURE, in painting and sculpture, the situation of a figure with regard to the eye, and of the several principal members thereof with regard to one another, whereby its action is expressed. A considerable part of the art of a painter consists in adjusting the postures, in giving the most agreeable postures to his figures, in accommodating them to the characters of the respective figures, and the part each has in the action, and in conducting and pursuing them throughout.

POTAMOGETON, in botany, *pondweed*, a genus of the Tetrandria Tetragynia class and order. Natural order of Inundatæ. Naiades, Jussieu. Essential character: calyx none; petals four; style none; seeds four. There are fourteen species; these are perennial, herbaceous plants, inhabitants of the water.

POTASH, in chemistry, a substance

which is procured from the burnt ashes of vegetables, hence the termination *ash;* the prefix *pot* was given on account of its being prepared in iron pots. It obtained the name of vegetable alkali, because it was supposed to exist only in vegetable substances: and being prepared from nitre and tartar, it was called the "alkali of nitre," and likewise "salt of tartar," a name by which it is still known in the shops. By some it is distinguished by the name of "kali," the plant from which it was originally procured. This substance, in its rough state, is prepared by burning wood, or other vegetable matter, and thus reducing them to ashes. The ashes are washed repeatedly with fresh waters, till the liquid comes off perfectly tasteless. The liquid thus obtained is evaporated, and the salt obtained is potash. If this substance is exposed to a red heat, many of the substances which are mixed with it are driven off, and what remains is much whiter, and on account of its colour it is called "pearl-ash." In this state it is deemed sufficiently pure for the ordinary purposes of life, though by no means adapted to the purposes of the experimental chemist. Even when apparently freed from all extraneous substances, it is found to possess very different properties after having been subjected to certain processes. In one state it is mild and inactive; in another extremely acrid and corrosive. In the former case it is united with carbonic acid gas, and is a carbonate of potash, and not pure potash. When deprived of this acid gas, it is powerful, corrosive, and highly caustic. Different methods have been proposed by different chemists to obtain this substance quite pure: we shall transcribe that given by Professor Lowitz, of Petersburgh. He boils in an iron pot for two or three hours any quantity of potash with double its weight of quicklime, and eight times the weight of the whole mixture of distilled or rain water. The liquor is to be set by to cool, and then filtered and evaporated, till a thick pellicle is formed on the surface. It is then set by till crystals are formed on it, which are crystals of extraneous salts, that are to be removed. The evaporation is to be continued, and the several pellicles removed as fast as they are formed. When the fluid ceases to boil, and no more pellicles arise, it is removed from the fire, and kept stirring till it is cold. It is then dissolved in double its weight of water; the solution is filtered and evaporated in a glass retort, till regular crystals begin to be deposited. When a sufficient quantity has been formed, the liquid is decanted, and the salt is re-dissolved, after it is suffered to drain, in the same quantity of water. The decanted liquor is preserved in a well-closed bottle for several days, till it subside and become clear. It is then decanted, evaporated, and crystallized again, and the process repeated as long as the crystals afford with the least quantity of water solutions that are perfectly limpid.

Potash thus obtained is a white solid substance, which is susceptible of crystallization in long compressed, quadrangular prisms, terminating in sharp-pointed pyramids. These crystals, which are only obtained from very concentrated solutions, are soft and deliquescent. The taste is extremely acrid; and it is so corrosive, that it destroys the texture of the skin the moment it touches it: hence it has derived the name of caustic, and is employed in surgery for the purpose of opening abscesses, or for destroying excrescences. Its specific gravity is about 1.7. By a similar mode to that above described, pure soda may be prepared, substituting the carbonate of soda for the pearl-ash. They both possess the following properties:—1. They convert vegetable blues into a green colour. 2. They powerfully attract moisture. 3. They readily dissolve in water, and produce heat during the solution. They are not volatilized by a moderate heat, hence they are called fixed alkalies. Fixed alkalies have till very lately been numbered among the simple substances, not, however, without exciting in the minds of chemists a suspicion that they were compounds. Professor Davy has, in the course of the present and preceding years, put the matter beyond all doubt, and has proved to the satisfaction of every chemist, that they are compound of oxygen and certain metallic bases, to which he has given the names of

POTASIUM, and SODIUM, or SODAIUM. Of these, and of the experiments which led to the discoveries, we shall proceed to give some account, having attended the repetition of his experiments at the lectures delivered last spring at the Royal Institution. Mr. Davy, in his first attempts to decompose the alkalies, made use of the aqueous solutions, and failed. He next made use of the potash in a state of igneous fusion, which he brought within the sphere of the galvanic battery: with this also he was unsuccessful in the main point; but some brilliant phenomena were produced. The potash appeared a conductor in a high degree: a most intense light was exhibited at the negative wire, and a column of flame, which seemed to be owing to the developement of combustible matter, arose from the point of contact. Mr. Davy next tried several experiments on the electrization of potash rendered fluid by heat, with the hope of being able to collect the combustible matter, but he was still unsuccessful, "and I only," says he, "attained my object by employing electricity as the common agent for fusion and decomposition." Potash perfectly dried by ignition is a non-conductor; by a very slight addition of moisture, which does not perceptibly destroy it aggregation, it is rendered a conductor, and in this state it readily fuses and decomposes by strong electrical powers. A small piece of pure potash was placed upon an insulated disc of platina, connected with the negative side of the battery, in a state of intense activity; and a platina wire, communicating with the positive side, was brought in contact with the upper surface of the alkali, a vivid action took place, and the potash began to fuse at both points of electrization. There was a violent effervescence at the upper surface; at the lower, or negative surface, there was no liberation of elastic fluid; but small globules, having a high metallic lustre, appeared; these were similar in visible character to quicksilver: some of them burnt with explosion and bright flame as soon as they were formed, and others remained, and were merely tarnished, and finely covered with a white film, which formed on them. "These globules," said the professor, "numerous experiments soon shewed to be the substance I was in search of, and a peculiar inflammable principle the basis of potash. I found that the platina was in no way connected with the result, except as the medium for exhibiting the electrical powers of decomposition; and a substance of the same kind was produced when pieces of copper, silver, gold, plumbago, or even charcoal, were employed for completing the circuit."

Soda, when acted upon in the same manner, exhibited an analogous result, and these effects equally took place in the atmosphere, and when the alkali was acted upon in the vacuum of an exhausted receiver; but these globules could not in either case be produced from crystallized alkalies. When a globule of the base of potash was exposed to the atmosphere, it immediately attracted oxygen, and a white crust formed upon it, which proved to be pure potash. When the globules were strongly heated, and then suspended in oxygen gas, a rapid combustion with a brilliant white flame was produced, and these metallic globules were converted to an alkali, whose weight greatly exceeded that of the combustible matter consumed. When Mr. Davy had thus detected the basis of the fixed alkalies, he had considerable difficulty to preserve and confine them, so as to examine their properties and submit them to experiments. He found, however, at length, that in recently distilled naphtha they may be preserved many days, and that their physical properties may be easily examined in the atmosphere, when they are covered by a thin film of it. The basis of potash, at 60° Fahrenheit, is only imperfectly fluid; at 70° it becomes more fluid; and at 100° its fluidity is perfect, so that different globules may be easily made to run into one. At 50° it becomes a soft and malleable solid, which has the lustre of polished silver; and at about the freezing point of water it becomes harder and brittle, and when broken in fragments exhibits a crystallized texture, of perfect whiteness and high metallic splendour. To be converted into vapour, it requires a temperature approaching that of the red heat. It is an excellent conductor of heat, and a perfect conductor of electricity.

Resembling the metals in all these properties, it is, however, remarkably different from any of them in specific gravity; for it will not sink in double distilled naphtha, whose specific gravity is only .770, that of water being considered a 1.000. Mr. Davy has determined by experiment, that its specific gravity is to that of mercury as 10 to 223, which gives a proportion to that of water nearly as 6 to 10; so that it is the lightest fluid body known. When this substance is introduced into oxymuriatic acid gas, it burns spontaneously with a bright red light, and muriate of potash is formed. When thrown upon water, it decomposes it with great violence, and an instantaneous explosion is produced with brilliant flame, and a solution of pure potash is the result.

When a globule is placed upon ice, not even the solid form of the two substances can prevent their union; for it instantly burns with a bright flame, and a deep hole is made in the ice, which is found to contain a solution of potash. When a globule is dropped upon moistened turmeric paper, it immediately burns, and moves rapidly upon the paper, as if in search of moisture, leaving behind it a deep reddish brown trace. So strong is the attraction of the basis of potash for oxygen, that it discovers and decomposes the small quantities of water contained in alcohol and ether, even when they are carefully purified. When thrown into the mineral acids, it inflames and burns on the surface. In sulphuric acid, sulphate of potash is formed; in nitrous acid, nitrous gas is disengaged, and nitrate of potash formed. When brought in contact with a piece of phosphorus, and pressed upon, there is a considerable action: they become fluid together, burn, and produce phosphate of potash. When a glogule is made to touch a globule of mercury about twice as large, they combine with a considerable heat; the compound is fluid at the temperature of its formation: but when cool it appears as a solid metal, similar in colour to silver. If this compound be exposed to air, it rapidly absorbs oxygen; potash which deliquesces is formed; and in a few minutes the mercury is found pure and unaltered.

When a globule of the amalgam is thrown into water, it rapidly decomposes it with a hissing noise, potash is formed, hydrogen disengaged, and the mercury remains free. The basis of potash readily reduces metallic oxides when heated in contact with them. It decomposes common glass by a gentle heat, and at a red heat effects a change even in the purest glass. Mr. Davy has discovered that its base, like that of potash, is white, opaque, and has the lustre of silver. The property of welding, which belongs to iron and platina, at a white heat only, is possessed by this substance at common temperatures. It is very similar, in its more obvious properties, to the base of potash; but it has greater specific gravity, being to that of water nearly as nine to ten, or as 9348 to 1.0000. In oxygen gas it produces a white flame, and sends forth bright sparks, occasioning a very beautiful effect. In oxy-muriatic acid gas it burns vividly, with numerous scintillations of a bright red colour. In the quantity of $\frac{1}{40}$, it renders mercury a fixed solid, of the colour of silver, and forms an alloy with tin. When amalgamated with mercury, the amalgam will combine with other metals.

Mr. Davy tried this with iron and platina, and had reason to believe that these latter metals remain in combination with the mercury, even when deprived of the new substance by exposure to the air. From several curious and ingenious experiments to ascertain the proportions of the bases and oxygen in the two fixed alkalies, he concludes that 100 parts of potash consist of about 84 basis, and 16 oxygen; and 100 parts of soda consist of about 76 or 77 basis, and 24 or 23 oxygen; or that potash may be considered as consisting of about 6 parts basis, and 1 of oxygen; and soda of 7 basis, and 2 oxygen. In reply to the question, whether the bases of potash and soda should be called metals, it may be said that they agree with metals in opacity, lustre, malleability, conducting powers as to heat and electricity, and in their qualities of chemical combination. Even their low specific gravity does not appear a sufficient reason for making them a new class; for amongst the metals themselves there are remarkable differences in this respect, platina being nearly four times as heavy as tellurium; and tellurium is not much more than six times as heavy as the basis of soda. Conceiving the basis of the two fixed alkalies to be metals, Mr. Davy has named one Potasium, and the other Sodium; adopting that termination which, by common consent, has been applied to other newly discovered metals.

On an examination of the volatile alkali, and after a great number of complex and tedious experiments, Mr. Davy saw reason to conclude that ammonia contains oxygen as an essential ingredient, and that this cannot well be estimated at less than 7 or 8 parts in the hundred: this body may therefore, as he says, be considered as the principle of alkalescence, with as much reason as the French have made it the principle of acidity. After making some general remarks on the preceding facts, he suggests the probability, that the muriatic, fluoric, and boracic acid all contain oxygen as one of their constituent principles. The earths of barytes and strontian, as being most analogous to the alkalies, were likewise examined, and both yielded oxygen. In concluding this very important communication, Mr. Davy remarks, that an immense variety of objects of research is presented in the powers and affinities of the new metals produced from the alkalies. In themselves they will undoubtedly prove powerful agents for analysis; and having an affinity for oxygen, stronger than any other known substances, they may possibly supersede the application of electricity to some of the undecompounded bodies. Further experiments, it is said, have enabled Mr. Davy, since his communication to the Royal Society, from which the above has been partly abridged, to decompose, in the most satisfactory manner, the barytes and strontites, and to show that the other alkaline earths are oxides of highly combustible metals. It cannot now be doubted, that, in the hands of this great chemist, other bodies, hitherto deemed simple, or at least never yet analysed, will speedily yield to the powers either of the highly inflammable metals already discovered, or of a still further increase of the galvanic battery. Mr. Davy has decomposed carbonic acid by means of those metals, and has oxydated them by muriatic acid; and an excellent writer says, "it is now by no means improbable that charcoal itself, hitherto regarded as the most refractory of all substances, may be decomposed by the new instruments; and that the means of obtaining it pure, and even crystallized, shall at last be found; a discovery which would enable art to vie with nature in the fabrication of her most valuable produce." At any rate, to use the words of the Professor himself: "In sciences kindred to chemistry, the knowledge of the nature of the alkalies, and the analogies arising in consequence, will open many new views; they may lead to the solution of many problems in geology, and show that agents may have operated in the formation of rocks and earths, which have not hitherto been suspected to exist." See Philosophical Transactions of the Royal Society for 1808. Part I.

POT *stone*, in mineralogy, a species of the Clay genus. The colour of this mineral is a greenish grey, of different degrees of intensity. It occurs massive. The internal lustre is glistening and pearly. Fracture, sometimes curved, foliated, sometimes imperfectly slaty. It is soft, feels greasy, and difficultly frangible. It is found in beds with serpentine, at Como in the Grisons; in some parts of Saxony, and in Hudson's Bay. It is very nearly allied to indurated talc. It is refractory in the fire, and may be used for lining furnaces. It may be turned in a lathe, and made into a variety of vessels fit for culinary and other purposes.

POTATOE, in botany, the English name for a species of the tuberose-rooted Solanum. See SOLANUM.

POTENT, or POTENCE, in heraldry, a term for a kind of cross, whose ends all terminate like the head of a crutch. It is otherwise called the Jerusalem cross.

POTENTILLA, in botany, *cinquefoil*, a genus of the Icosandria Polygynia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Essential character: calyx ten-cleft; petals five; seeds roundish, naked, fastened to a small juiceless receptacle. There are thirty-two species, chiefly natives of the South of Europe.

POTERIUM, in botany, *burnet*, a genus of the Monoecia Polyandria class and order. Natural order of Miscellaneæ. Rosaceæ, Jussieu. Essential character: male, calyx four-leaved; corolla four-parted; stamina thirty to forty; female, calyx four-leaved; corolla wheel-shaped, five-parted; pistils two; berry formed of the hardened tube of the corolla. There are five species.

POTHOS, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Piperitæ. Aroideæ, Jussieu. Essential character: spathe; spadix simple, covered; calyx none; petals four; stamina four; berries two-seeded. There are thirteen species.

POTTERY, the manufacture of earthen ware, or the art of making earthen vessels. The inferior kinds of porcelain, or pottery, are prepared by the same process as that which has been described under the word PORCELAIN; less pure, but more fusible materials being employed, and, of course, a less degree of heat being applied.

The better kinds of English stone-ware are composed of pipe-clay and pounded flints. The yellow stone-ware is made of the same materials, in other proportions. The first is glazed by throwing sea-salt into the furnace in which it is baked, when the heat is strong; the salt is converted into vapour, and this, being applied to the surface of the stone-ware, vitrifies it, and forms an excellent glazing. The yellow stone-ware is glazed by dipping the baked ware in water, in which is suspended a mixture of pounded flint, glass, and oxide of lead. In the glazing of some kinds of stone-ware, oxide of tin enters into the composition with the oxide of lead, and gives a whiter glaze. All the coarser kinds of pottery are glazed with oxide of lead; this promoting so much the fusion and vitrification, that the low heat at which they are baked is sufficient.

The wheel and lathe are the chief, and almost the only, instruments used in pottery; the first for large works, and the last for small. The potter's-wheel consists principally in the nut, which is a beam, or axis, whose foot or pivot plays perpendicularly on a free-stone sole or bottom. From the four corners of this beam, which does not exceed two feet in height, arise four iron-bars, called the spokes of the wheel; which, forming diagonal lines with the beam, descend, and are fastened at bottom to the edges of a strong wooden circle, four feet in diameter, perfectly like the felloes of a coach-wheel, except that it has neither axis nor radii, and is only joined to the beam, which serves it as an axis, by the iron-bars. The top of the nut is flat, of a circular figure, and a foot in diameter; and on this is laid the clay which is to be turned and fashioned. The wheel, thus disposed, is encompassed with four sides of four different pieces of wood, fastened on a wooden frame; the hind-piece, which is that on which the workman sits, is made a little inclining towards the wheel; on the fore piece are placed the prepared earth; on the side-pieces he rests his feet, and these are made inclining, to give him more or less room. Having prepared the earth, the potter lays a round piece of it on the circular head of the nut, and, sitting down, turns the wheel with his feet till it has got the proper velocity: then, wetting his hands with water, he presses his fist or his fingers-ends into the middle of the lump, and thus forms the cavity of the vessel, continuing to widen it from the middle; and thus turning the inside into form with one hand, while he proportions the outside with the other, the wheel constantly turning all the while, and he wetting his hands from time to time. When the vessel is too thick, he uses a flat piece of iron, somewhat sharp on the edge, to pare off what is redundant; and when it is finished, it is taken off from the circular head, by a wire passed underneath the vessel.

The potter's lathe is also a kind of wheel, but more simple and slight than the former; its three chief members are, an iron-beam or axis, three feet and a half high, and two feet and a half diameter, placed horizontally at the top of the beam, and serving to form the vessel upon; and another large wooden wheel, all of a piece, three inches thick, and two or three feet broad, fastened to the same beam at the bottom, and parallel to the horizon. The beam or axis turns by a pivot at the bottom, in an iron stand. The workman gives the motion to the lathe with his feet, by pushing the great wheel alternately with each foot, still giving it a greater or lesser degree of motion, as his work requires. They work with the lathe, with the same instruments, and after the same manner, as with the wheel. The mouldings are formed by holding a piece of wood or iron, cut in the form of the moulding, to the vessel, while the wheel is turning round, but the feet and handles are made by themselves, and set on with the hand; and if there be any sculpture in the work, it is usually done in wooden moulds, and stuck on, piece by piece, on the outside of the vessel.

POUCH, in military affairs, a case of black stout leather, with a flap over it, which is generally ornamented by a brass crown, &c. for the battalion men; a fuse for the grenadiers; and a bugle-horn for the light infantry. The pouch hangs from a buff cross belt over the left shoulder, and is worn in that manner by the infantry for the purpose of carrying the ammunition.

POULTICE. See PHARMACY.

POUNCE, gum sandaric pounded and sifted very fine, to rub on paper, in order to preserve it from sinking, and to make it more fit to write upon.

POUNCE is also a little heap of charcoal dust, inclosed in a piece of muslin, or some other open stuff, to be passed over holes pricked in a work, in order to mark the lines or designs thereof on paper, silk, &c. placed underneath; which are to be afterwards finished with a pen and ink, a needle, or the like. This kind of pounce is much used by embroiderers, to transfer their patterns upon stuffs; by lace-makers, and sometimes also by engravers.

POUND, a certain weight, which is of two kinds; *viz.* the pound troy, and the pound avoirdupois; the one is divided into 12 ounces, the other into 16. The pound troy is to the pound avoirdupois as 576 to 700.

POUND also denotes a money of account; so called because the ancient pound of silver weighed a pound troy.—See MONEY.

POUND, in law, any place inclosed to keep beasts in; a common pound belongs to a lordship, or village, and there ought to be such a pound in every township. Some persons have of late very reasonably complained of the ancient practice of keeping beasts for many days, in a comman pound, without food; and it would seem well, if there could be some remedy in this respect, and the constable or others were bound to give them sufficient food, to be repaid by the owner.

The use of the pound is, to put cattle in which have been taken trespassing on other persons lands, and they are to remain there for some days, when the lord of the manor takes the cattle in his possession, and they are cried in three neighbouring market towns, and if not claimed within a year and a day, are sold as estrays, and the damage they have done is paid out of the produce.

POURSUIVANT, or PURSUIVANT, in heraldry, the lowest order of officers at arms. See COLLEGE and HERALDRY. The poursuivants are properly attendants on the heralds, when they marshal public ceremonies. Of these, in England, there were formerly many; but at present are only four, *viz.* Blue-mantle, Rouge cross, Rouge-dragon, and Portcullice.—In Scotland, there is only one king at arms, who is stiled Lion, and has no less than six heralds, and as many pursuivants, and a great many messengers at arms, under him.

POWDER, a dry medicine, well broken, either in a mortar, by grinding, or by chemical operations. See PHARMACY.

POWDER, *fulminating.* When three parts of nitre, two parts of potash, and one of sulphur, are previously well dried, and mixed together by trituration, they form a compound which is known by the name of fulminating powder. A few grains of this mixture exposed to heat in an iron ladle, first melt, assuming a darker colour; and when the whole is in fusion, there is a violent explosion. The heat should be applied slowly and gradually, till it is completely fluid, and then, by bringing it nearer the heat, the full effect of the explosion is obtained. This combustion and explosion are also owing to the instantaneous evolution of elastic fluids. The potash unites with the sulphur, and forms a sulphuret, which, with the assistance of the nitre, is converted into sulphurated hydrogen. At a certain temperature, the sulphurated hydrogen gas is disengaged, along with the oxygen gas of the nitre, and suddenly taking fire, strikes the air by the explosion which accompanies the evolution of the gases.—When the mixture is made with equal parts of nitre and solid sulphuret of potash, the detonation is more rapid, but the explosion is less violent. With three parts of nitre, one of sulphur, and one of saw-dust, well mixed together, what is called powder of fusion is formed. If a little of this powder is put into a walnut-shell, with a thin plate of copper rolled up, and the mixture set fire to, it detonates rapidly, and reduces the metal to a sulphuret, without any injury to the shell.

POWER, in mechanics, denotes any force, whether of a man, a horse, a spring, the wind, water, &c. which being applied to a machine, tends to produce motion.

The intensity of a power is its absolute force; that is, its force, supposing its velocity equal to its weight: for its moving or acting force may be greater or less, according as its velocity is increased or diminished, in respect of that of the weight. As, for example, if a man be the power, and can raise from the ground a certain weight, that weight will express or be equal to the intensity of the power; for in this case, whatever engine be made use of, that part of the engine, where the weight is duly applied, will move just as fast as that on which a man acts with his whole force. A power may act in any direction whatever; but a weight has only one direction, *viz.* towards the centre of the earth.

When we speak of the mechanical powers, the word power is taken in a very different sense from that above laid down; since, in this case, it signifies only an organ or instrument, whereby a power of a known intensity is made to act upon a weight; and, therefore, we must take care not to attribute any real force to any simple or compound machine, as many are apt to do, merely because the name power has been given to mechanical organs, not from their effect, but from the effect which the power produces by their means. For how much soever the force of a power is thereby increased, in order to sustain or raise a weight far superior to it in intensity, yet this cannot be done without losing in space and time what is gained in force; contrary to what some have vainly imagined, because the vulgar commonly speak of a machine as they do of an animal; attributing that effect to the machine, which is only the effect of the power by means of the machine: thus, it is usual to say, such a machine raises such a quantity of water, or performs such and such work; when we should say, if we would speak philosophically, such a running stream, such a fall of water, the wind, or so many men, horses, oxen, &c. raise so much water in such a time, &c. by means of such or such a machine. It were, therefore, to be wished, that the word power were to be confined to its proper sense, and not used to signify one of the mechanical organs; however, as it has been customary to use it in that sense, we have done so too, but have nevertheless thought proper to give the above caution. See MECHANICS.

POWER *of attorney*, an instrument, or deed, whereby a person is authorised to act for another, either generally, or in a specific transaction.

This power is always revoked by the death of the grantor, and no person who has a power of attorney can grant a power under him.

POWERS, in arithmetic and algebra, are the products arising from the continual multiplication of a number, or quantity, into itself: thus, 2, 4, 8, 16, 32, &c. are the powers of the number 2; and a, a^2, a^3, a^4, &c. the powers of the quantity a; which operation is called involution. Powers of the same quantity are multiplied by only adding their exponents, and making their sum the exponent of the product: thus, $a^4 \times a^5 = a^{4+5} = a^9$. Again, the rule for dividing powers of the same quantity is, to subtract the exponents, and make the difference the exponent of the quotient: thus, $\frac{a^6}{a^4} = a^{6-4} = a^2$.

Negative powers, as well as positive, are multiplied by adding, and divided by subtracting, their exponents, as above. And, in general, any positive power of a, multiplied by a negative power of a, of an equal exponent, gives unit for the product; for the positive and negative destroy each other, and the product is a^0, which is equal to unit. Likewise, $\frac{a^{-5}}{a^{-2}} = a^{-5+2} = a^{-3} = \frac{1}{a^3}$; and $\frac{a^{-2}}{a^{-5}} = a^{-2+5} = a^3 = \frac{1}{a^{-3}}$. And, in general, any quantity placed in the denominator of a fraction may be transposed to the numerator, if the sign of its exponent be changed: thus, $\frac{1}{a^3} = a^{-3}$, and $\frac{1}{a^{-3}} = a^3$.

The quantity a^m expresses any power of a, in general; the exponent m being undetermined: a^{-m} expresses $\frac{1}{a^m}$, or a negative power of a, of an equal exponent: and $a^m \times a^{-m} = a^{m-m} = a^0 = 1$. Again, a^n expresses any other power of a; and $a^m \times a^n = a^{m+n}$, and $\frac{a^m}{a^n} = a^{m-n}$.

To raise any simple quantity to its second, third, or fourth power, is to add its exponent twice, thrice, or four times, to itself; so that the second power of any quantity is had by doubling its exponent; and the third, by tripling its exponent; and, in general, the power expressed by m, of any quantity, is had by multiplying the exponent by m: thus the second power, or square of a, is $a^{2\times 1} = a^2$; its third power, $a^{3\times 1} = a^3$; and the mth power of a, is $a^{m\times 1} = a^m$. Also the square of a^4, is $a^{2\times 4} = a^8$; the cube of a^4, is $a^{3\times 4} = a^{12}$; and the mth power of a^4, is $a^{4\times m}$. The square of $a\,b\,c$, is $a^2\,b^2\,c^2$; its cube $a^3\,b^3\,c^3$; and the mth power, $a^m\,b^m\,c^m$.

POX, or SMALL-POX. See MEDICINE.

PRACTICE, in arithmetic, or rules of practice, are certain compendious ways of working the rule of proportion, or golden-rule.

1. When a question in the rule of three being duly stated, and the extremes are simple numbers of one name; whether the middle term be simple or mixed; if the extreme, which by the general rule is the divisor, be 1, and the middle term, an aliquot part of some superior species; then divide the other extreme by the denominator of that aliquot part, the quote is the answer in that superior species; and if there is any remainder, it must be reduced, and its value found. Example. What is the price of 67 yards of cloth at 5*s.* per yard? The state of the proportion is, as 1 yard : 5*s.* : : 67; and because the divisor is 1 yard, and the middle term 5*s.* which is a fourth part of one pound. Therefore divide 67 yards by 4, the quote is 16*l.* and 3 remains, which reduced to shillings, and divided by 4, quotes 15*s.*

The reason of this practice is obvious; for if 1 yard cost one-fourth of 1*l.* 67 yards must cost 67¼th parts, or, which is the same thing, the fourth part of 67*l.*

II. If the price of an unit is an even number of shillings, multiply the other extreme (of the same name with the unit) by the half of that number; double the first figure of the product for shillings, and the remaining figures to the left are pounds in the answer. Example. What is the value of 324 yards at 6*s.* per yard? Multiply 324 by 3 (the one-half of 6) the product is 972, which according to the rule, is 97*l.* 4*s.* which is the answer. And it is very easy to set down the shillings and pounds separately, without writing first down the total product, and then separating them.

III. If the middle term is not an aliquot part of some superior integer, (the divisor being always 1), yet it may be equal to the sum of several aliquot parts; and then if you divide by the denominators of each of these separately, and add all the quotes, the same is the answer required. Example. If 1 yard cost 15*s.* what cost 49 yards? Answer 36*l.* 15*s.*: found thus; 15*s.* is 10*s.* and 5*s.* *viz.* the one-half and one-fourth of a 1*l.* so I take the one half of 49*l.* which is 24*l.* 10*s.* and one-fourth, which is 12*l.* 5*s.* whose sum is 36*l.* 15*s.*

IV. If the middle term is so mixed as to have in it any number of the highest species, first multiply the number, and then the other parts, by some of the former cases, if possible; and if this cannot be done, or not without much working, then the common method of reduction is to be taken. Example. If 1 yard cost 4*l.* 6*s.* 8*d.* what cost 734 yards? Answer 3,180*l.* 15*s.* 4*d.* for 4*l.* multiplied by 734, produces 2,936*l.* and for 6*s.* 8*d.* which is the one-third of 1*l.* you must take the one-third of 734, which is 244*l.* 15*s.* 4*d.* and the sum of both is 3,180*l.* 13*s.* 4*d.*

V. If the extreme which is the multiplier is an aliquot part, or the sum of certain aliquot parts, of the unit, which is the divisor, then take by division such part or parts of the middle term (whether this be a simple or mixed number) and if the multiplier has also some number of the same species with the unit, you must work for that number separately by some of the former cases, or the common rule; then add all the parts, which is the answer.

Example 1. If 1 pound weight cost 32*l.* what cost 4 ounces? Answer 8*l.* *viz.* one-fourth of 32*l.* because 4 ounces are one-fourth of 1 pound.

These are the chief and fundamental practices by aliquot parts, which, whoever understands, will easily find many particular abridgments depending upon the same principles.

PRÆCIPE, is the name of several writs in the English law, which are so called from the form of commanding the defendant to do the thing required.

PRÆMUNIRE, is a punishment inflicted upon him who denies the King's supremacy the second time; upon him who affirms the authority of the Pope, or refuses to take the oath of supremacy; upon such as are seditious talkers of the inheritance of the crown; and upon such as affirm that there is any obligation by any oath, covenant, or engagement whatsoever, to endeavour a change of government either in church or state; or that both or either house of Parliament have or hath a legislative power without the King, &c. The judgment in præmunire at the suit of the King, against the defendant being in prison, is, that he shall be out of the King's protection; that his lands and tenements, goods and chattels, shall be forfeited to the King; and that his body shall remain in prison at the King's pleasure; but if the defendant be condemned upon his default of not appearing, whether at the suit of the King or party, the same judgment shall be given as to the being out of the King's protection and the forfeiture; but instead of the clause that the body shall remain in prison, there shall be an award of a capiatur or arrest. Upon an indictment of a præmunire, a peer of the realm shall not be tried by his peers.

PRAGMATIC *sanction*, in the civil law, is defined by Hottoman to be a rescript, or answer of the sovereign, delivered, by advice of his council, to some college, order, or body of people, upon consulting him on some case of their community. The like answer, given to any particular person, is called simply rescript. The term pragmatic sanction, is chiefly applied to a settlement of Charles VI. Emperor of Germany, who, in the year 1722, having no sons, settled his hereditary dominions on his eldest daughter, the Archduchess Maria Theresa, which was confirmed by the diet of the Empire, and guaranteed by Great Britain, France, the States General, and most of the powers in Europe.

PRAM, or PRAME, a kind of lighter, used in Holland and the ports in the Baltic Sea, to carry the cargo of a merchant ship along-side, in order to lade it, or to bring it to the shore to be lodged in warehouses. The same term is in use in military affairs, for a kind of floating battery, being a flat bottomed vessel, which draws little water, mounts several guns, and is exceedingly useful in transporting troops over the immense lakes in North America.

PRASIUM, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: berries four, one-seeded. There are two species, *viz.* P. majus, great Spanish hedge-nettle, and P. minus, small Spanish hedge-nettle.

PRAYER, in theology, a petition put up to God, either for the obtaining some future favour, or the returning of thanks for a past one.

PREBEND, the maintenance a prebendary receives out of the estate of a cathedral or collegiate church. Prebends are distinguished into simple and dignitary; a simple prebend has no more than the revenue for its support: but a prebend with dignity, has always a jurisdiction annexed to it.

PREBENDARY, an ecclesiastic who enjoys a prebend. The difference between a prebendary and a canon is, that the former receives his prebend, in consideration of his officiating in the church; but the latter merely by his being received into the cathedral or college.

PREBENDARY, *golden, of Hereford,* called also *prebendarius episcopus,* is one of the twenty-eight minor prebendaries, who has, *ex officio,* the first canon's place that falls. He was anciently confessor of the bishop and cathedral, and had the offerings at the altar; on which account he was called the golden prebendary.

PRECEDENCE, or PRECEDENCY, a place of honour to which a person is entitled: this is either of courtesy or of right. The former is that which is due to age, estate, &c. which is regulated by custom and civility: the latter is settled by authority, and when broken in upon, gives an action at law.

The order of precedency, which is observed in general, is this: that persons of every degree of honour or dignity take place according to the seniority of their creation, and not of years, unless they are descended from the blood-royal; in which case, they have place of all others of the same degree.

The younger sons of the preceding rank take place from the eldest son of the next mediate, *viz.* the younger sons of Dukes from the eldest sons of Earls; the younger sons of Earls from the eldest sons of Barons. All the chain of precedency is founded upon this gradation, and thus settled by act of parliament, 31 Henry VIII. c. 10, anno 1539.

But there have been since some alterations made in this act, by several decrees and establishments in the succeeding reigns, whereby all the sons of Viscounts and Barons are allowed to precede Baronets. And the eldest sons and daughters of Baronets have place given them before the eldest sons and daughters of any Knights, of what degree or order soever, though superior to that of a Baronet; these being but temporary dignities, whereas that of Baronets is hereditary: and the younger sons of Baronets are to have place next after the eldest of Knights.

There are some great officers of state, who take place, although they are not noblemen, above the nobility of higher degrees; so there are some persons, who, for their dignities in the church, degrees in the universities, and inns of court, officers in the state, or army, although they are neither knights, nor gentlemen born, yet take place amongst them. Thus, all colonels and field-officers who are honourable, as also the master of the ordnance, quarter-master general, doctors of divinity, law, physic, and music; deans, chancellors, prebendaries, heads of colleges in universities, and serjeants at law, are, by courtesy, allowed place before ordinary Esquires. And all bachelors of divinity, law, physic, and music; masters of arts, barristers in the inns of courts; lieutenant-colonels, majors, captains, and other commissioned military officers; and divers patent officers in the King's household may equal, if not precede, any gentleman that has none of these qualifications.

In towns corporate, the inhabitants of cities are preferred to those of boroughs; and those who have borne magistracy to all others. And herein a younger alderman takes not precedency from his senior being knighted, or as being the elder Knight, as was the case of Alderman Craven, who, though no Knight, had place, as senior alderman, before all the rest who were Knights, at the coronation of King James. This is to be understood as to public meetings relating to the town; for it is doubted whether it will hold good in any neutral place. It has been also determined in the Earl Marshal's court of honour, that all who have been Lord Mayors of London, shall every where take place of all Knights-bachelors, because they have been the King's lieutenants.

It is also quoted by Sir George Mackenzie, in his Observations on Precedency, that in the case of Sir John Crook, serjeant at law, it was adjudged by the judges in court, that such serjeants as were his seniors, though not knighted, should have preference notwithstanding his knighthood. The precedency among men is as follows:

PRECEDENCE.

The King
Prince of Wales
King's sons
King's brothers
King's uncles
King's grandsons
King's brothers or sisters grandsons
Vicegerent { When there is any such officer
Archbishop of Canterbury, Lord Primate of all England
{ by statute 34 Henry VIII.

Lord High Chancellor, or Lord Keeper, by statute 5 Elizabeth.

Archbishop of York, Primate of England, by statute 31 Henry VIII.

Lord High Treasurer
Lord President of the Privy Council
Lord Privy Seal
{ being of the degree of Barons by statute 31 Henry VIII.

By the statute 31 Henry VIII. the Lord Great Chamberlain of England had place next Lord Privy Seal; but in the year 1714, the Marquis of Lindsey, then Hereditary Lord Great Chamberlain of England, being created Duke of Ancaster, &c. gave up the precedency as Lord Great Chamberlain from him and his heirs, except only when he or they shall be in the actual execution of the said office of Great Chamberlain of England, attending the person of the King or Queen for the time being, or introducing a Peer or Peers into the House of Lords, which was confirmed by statute 1 George I.

Lord High Constable
Earl Marshal
Lord High Admiral
Lord Stewart of his Majesty's Household
Lord Chamberlain of his Majesty's Household
{ above all of their degrees, *viz.* if Dukes, above Dukes; if Earls, above Earls, &c. by statute 31 Henry VIII.

Dukes according to their patents of creation
Marquisses according to their patents
Dukes eldest sons
Earls according to their patents
Marquisses eldest sons
Dukes younger sons
Viscounts according to their patents
Earls eldest sons
Marquisses younger sons
Bishop of London
Bishop of Durham
Bishop of Winchester

All other Bishops, according to their seniority of consecration; but if any Bishop be principal Secretary of State, he shall be placed above all other Bishops, not having any of the great offices before mentioned.

Barons according to their patents.

But if any Baron be principal Secretary of State, he shall be placed above all Barons, unless they have any of the before-mentioned great offices.
{ By stat. 31 of Hen. VIII.

By the 23d article of the Union, which was confirmed by statute of 5 Queen Anne, c. 8, all Peers of Scotland shall be Peers of Great Britain, and have rank next after the Peers of the like degree in England at the time of the Union, which commenced May 1, 1707, and before all Peers of Great Britain, of the like degree, created after the Union.

Speaker of the Hon. House of Commons.
Viscounts eldest sons.
Earls younger sons.
Barons eldest sons.
Knights of the most noble order of the Garter.
Privy Counsellors.
Chancellor of the Exchequer.
Chancellor of the duchy of Lancaster.

The Peers of Ireland take place in England, at all public ceremonies, (except coronations) next the youngest English peer of the same degree.—Vide 1, 25, p. 61, in Officio Armorum Council Books, 4 Car. I. 28 June, 1629.

Lord Chief Justice of the King's Bench.
Master of the Rolls.
Lord Chief Justice of the Common Pleas.
Lord Chief Baron of the Exchequer.

Judges and Barons of the degree of the Coif of the said Courts, according to seniority.
Bannerets made under the King's own royal standard, displayed in army royal in open war, by the King himself in person, for the term of their lives only, and no longer.
Viscounts younger sons.
Barons younger sons.
Baronets of England, Scotland, and Ireland.
Bannerets not made by the King himself in person.
{ Rot. Pat. X. Jac. I, Parl. X. n. VIII.

Knights of the most honourable Order of the Bath.
Flag and field officers.

The priority of signing any treaty, or public instrument, by public Ministers,

is always taken by rank of place, and not by title.
Knights Bachelors.
Masters in Chancery.
Doctors, Deans, &c.
Serjeants at Law.
Eldest sons of the younger sons of Peers.

Baronets eldest sons. Knights of the Garter eldest sons. Bannerets eldest sons. Knights of the Bath eldest sons. Knights eldest sons.	Vide infra for the younger sons.

Baronets younger sons, Rot. Pat. 14 Jac. Ibid.

Esquires of the Sovereign's body or Gentlemen of the Privy Chamber.	by stat. 20 Ed. IV. and 9 Hen. VI.

Esquires of the Knights of the Bath.
Esquires by creation, by stat. 20 Edw. IV. and 9 Hen. VI.
Esquires by office.

Younger sons of Knights of the Garter. Younger sons of Bannerets of both kinds. Younger sons of Knights of the Bath. Younger sons of Knights Bachelors.	Estab. by H. VI & E. IV &c. Vincent's Precedence, 151, folio 124.

Gentlemen entitled to bear arms.
Clergymen, Barristers at Law, Officers in the Navy and Army, who are all Gentlemen by profession.
Citizens.
Burgesses, &c.

Almost every person above the lowest rank of mechanics assuming the title of Esquire, it may be worth while to give our readers the opinion of Judge Blackstone on this subject. Esquires and gentlemen are confounded together by Sir Edward Coke, who observes, that every esquire is a gentleman, and a gentleman is defined to be one *qui arma gerit*, who bears coat armour, the grant of which adds gentility to a man's family: in like manner as civil nobility among the Romans was founded in the *jus imaginum*, or having the image of one ancestor at least, who had borne some curule office. It is indeed a matter somewhat unsettled, what constitutes the distinction, or who is a real esquire; for it is not an estate, however large, that confers this rank upon its owner. Camden, who was himself a herald, distinguishes them the most accurately, and he reckons up four sorts of them: 1. The eldest sons of Knights, and their eldest sons, in perpetual succession. 2. The eldest sons of younger sons of Peers, and their eldest sons, in like perpetual succession; both which species of esquires Sir Henry Spelman entitles *armigeri natalatii* 3. Esquires created by the King's letters patent, or other investiture, and their eldest sons. 4. Esquires by virtue of their offices, as justices of the peace, and others who bear any office of trust under the crown. To these may be added the esquires of Knights of the Bath, each of whom constitutes three at his installation; and all foreign, nay, Irish Peers; for not only these, but the eldest sons of Peers of Great Britain, though frequently titular lords, are only esquires in the law, and must be so named in all legal proceedings. As for Gentlemen, says Sir Thomas Smith, they be made good cheap in this kingdom; for whosoever studieth in the Universities, who professeth the liberal sciences, and (to be short) who can live idly, and without manual labour, and will bear the port, charge, and countenance of a gentleman, he shall be called master, and shall be taken for a gentleman. A yeoman is he that hath free land of forty shillings by the year; who was anciently thereby qualified to serve on juries, vote for knights of the shire, and do any other act, where the law requires one that is *probus et legalis homo*. The rest of the commonalty are tradesmen, artificers, and labourers, who (as well as all others) must, in pursuance of the statute 1 Henry V c. 5, be styled by the name and addition of their estate, degree, or mystery, and the place to which they belong, or where they have been conversant, in all original writs of actions personal, appeals, and indictments, upon which process of outlawry may be awarded; in order, as it should seem, to prevent any clandestine or mistaken outlawry, by reducing to a specific certainty the person who is the object of its process.

The precedency among men being known, that which is due to women, according to their several degrees, will be easily understood: but it is to be observed, that women, before marriage, have precedency by their father: with this difference between them and the male children, that the same precedency is due to all the daughters that belongs to the eldest, which is not so among the sons; and the reason of this disparity seems to be, that daughters all succeed equally, whereas the eldest son excludes all the rest.

By marriage, a woman participates of her husband's dignities; but none of the wife's dignities can come by marriage to her husband, but are to descend to her next heir.

If a woman have precedency by creation or birth, she retains the same, though she marry any commoner: but if a woman nobly born marry any Peer, she shall take place according to the degree of her husband only, though she be a Duke's daughter.

A woman privileged by marriage with one of noble degree, shall retain the privilege due to her by her husband, though he should be degraded by forfeiture, &c. for crimes are personal.

The wife of the eldest son of any degree takes place of the daughters of the same degree, who always have place immediately after the wives of such eldest sons, and both of them take place of the younger sons of the preceding degree. Thus the lady of the eldest son of an Earl takes place of an Earl's daughter, and both of them precede the wife of the younger son of a Marquis; also the wife of any degree precedes the wife of the eldest son of the preceding degree. Thus, the wife of a Marquis precedes the wife of the eldest son of a Duke.

The Queen.
Princess of Wales.
Princesses, and Duchesses of the Blood.
Duchesses.
Wives of the eldest sons; daughters, } of Dukes of the Blood.
Marchionesses.
Wives of the eldest sons; daughters, } of Dukes.
Countesses.
Wives of the eldest sons; daughters, } of Marquisses.
Wives of the younger sons of Dukes.
Viscountesses.
Wives of the eldest sons; daughters, } of Earls.
Wives of the younger sons of Marquisses.
Baronesses.
Wives of the eldest sons; daughters, } of Viscounts.
Wives of the younger sons of Earls.
Wives of the eldest sons; daughters, } of Barons.
Wives of the younger sons of Viscounts.
Wives of the younger sons of Barons.
Wives of Baronets.
Wives of Knights of the Garter.
Wives of Knights of the Bath.
Wives of Knights-Bachelors.
Wives of the eldest sons; daughters, } of Baronets.
Wives of the eldest sons; daughters. } of Knights of the Garter.
Wives of the eldest sons; daughters, } of Knights of the Bath.
Wives of the eldest sons; daughters, } of Knights-Bachelors.
Wives of the youngest sons of Baronets.
Wives of Esquires, by creation.
Wives of Esquires, by office.
Wives of Gentlemen.
Daughters of Esquires.
Daughters of Gentlemen.
Wives of Citizens.
Wives of Burgesses, &c.

The wives of Privy Counsellors, Judges, &c. are to take the same place as their husbands do. See the former list.

PRECENTOR, a dignitary in cathedrals, popularly called the chantor, or master of the choir.

PRECESSION *of the equinoxes*, is a very slow motion of them, by which they change their place, going from east to west, or backward, *in antecedentia*, as astronomers call it, or contrary to the order of the signs.

From the late improvements in astronomy it appears, that the pole, the solstices, the equinoxes, and all the other points of the ecliptic, have a retrogade motion, and are constantly moving from east to west, or from Aries towards Pisces, &c. by means of which, the equinoctial points are carried further and further back among the preceding signs of stars, at the rate of about $50''\frac{1}{4}$ each year; which retrograde motion is called the precession, recession, or retrocession of the equinoxes.

Hence, as the stars remain immoveable, and the equinoxes go backward, the stars will seem to move more and more eastward with respect to them; for which reason the longitudes of all the stars, being reckoned from the first point of Aries, or the vernal equinox, are continually increasing.

From this cause it is, that the constellations seem all to have changed the places assigned to them by the ancient astronomers. In the time of Hipparchus, and the oldest astronomers, the equinoctial points were fixed to the first stars of Aries and Libra: but the signs do not now answer to the same points; and the stars which were then in conjunction with the sun, when he was in the equinox, are now a whole sign, or 30 degrees, to the eastward of it: so, the first star of Aries is now in the portion of the ecliptic, called Taurus; and the stars of Taurus are now in Gemini; and those of Gemini in Cancer; and so on.

This seeming change of place in the stars was first observed by Hipparchus of Rhodes, who 128 years before Christ, found that the longitudes of the stars in his time were greater than they had been before observed by Tymochares, and than they were in the sphere of Eudoxus, who wrote 380 years before Christ. Ptolemy also perceived the gradual change in the longitudes of the stars; but he stated the quantity at too little, making it but 1° in 100 years, which is at the rate of only 36″ per year. Y-hang, a Chinese, in the year 721, stated the quantity of this change at 1° in 83 years, which is at the rate of 43″½ per year. Other more modern astronomers have made this precession still more, but with some small differences from each other; and it is now usually taken at 50″¼ per year. All these rates are deduced from a comparison of the longitude of certain stars, as observed by more ancient astronomers, with the later observations of the same stars; *viz.* by subtracting the former from the latter, and dividing the remainder by the number of years in the interval between the dates of the observations. Thus, by a medium of a great number of comparisons, the quantity of the annual change has been fixed at 50″¼, according to which rate it will require 25,791 years for the equinoxes to make their revolutions westward quite around the circle, and return to the same point again.

The phenomena of this retrograde motion of the equinoxes, or intersections of the equinoctial with the ecliptic, and consequently of the conical motion of the earth's axis, by which the pole of the equator describes a small circle in the same period of time, may be understood an illustrated as follows; Let NZSVL be the earth. (See Plate Perspective, &c. fig. 6.) SONA its axis produced to the starry heavens, and terminating in A, the present north pole of the heavens, which is vertical to N, the north pole of the earth. Let EOQ be the equator, T♋Z the tropic of cancer, and VT♑ the tropic of capricorn; VOZ the ecliptic, and BO its axis, both of which are immoveable among the stars. But as the equinoctial points recede in the ecliptic, the earth's axis SON is in motion upon the earth's centre O, in such a manner as to describe the double cone NO*n* and SO*s*, round the axis of the ecliptic BO, in the time that the equinoctial points move round the ecliptic, which is 25,791 years, and in that length of time, the north pole of the earth's axis produced, describes the circle ABCDA in the starry heavens, round the pole of the ecliptic, which keeps immoveable in the centre of that circle. The earth's axis being now 23° 28′ inclined to the axis of the ecliptic, the circle ABCDA, described by the north pole of the earth's axis produced to A, is 46° 56′ in diameter, or double the inclination of the earth's axis. In consequence of this, the point A, which is at present the north pole of the heavens, and near to a star of the 2d magnitude in the end of the Little Bear's tail, must be deserted by the earth's axis; which, moving backwards one degree every 71⅔ years, will be directed towards the star or point B in 6447¾ years hence; and in double of that time, or 12,895½ years, it will be directed towards the star or point C; which will then be the north pole of the heavens, although it is at present 8½ degrees south of the zenith of London L. The present position of the equator EOQ will then be changed into *eOq*, the tropic of cancer T♋Z into V*t*♋, and the tropic of capricorn VT♑ into *t*♑Z; as is evident by the figure. And the sun, in the same part of the heavens where he is now over the earthly tropic of capricorn, and makes the shortest days and longest nights in the northern hemisphere, will then be over the earthly tropic of cancer, and make the days longest and nights shortest. So that it will require 12,895½ years yet more, or from that time, to bring the north pole N quite round, so as to be directed towards that point of the heavens which is vertical to it at present. And then, and not till then, the same stars which at present describe the equator, tropics, and polar cricles, &c. by the earth's diurnal motion, will describe them over again.

From this shifting of the equinoctial points, and with them all the signs of the ecliptic, it follows, that those stars, which in the infancy of astronomy were in Aries, are now found in Taurus; those of Taurus in Gemini, &c. Hence likewise it is, that the stars which rose or set at any particular season of the year, in the times of Hesiod, Eudoxus, Virgil, Pliny, &c. by no means answer at this time their descriptions.

As to the physical cause of the precession of the equinoxes, Sir Isaac Newton demonstrates, that it arises from the broad or flat spheroidal figure of the earth; which itself arises from the earth's rotation about its axis: for as more matter has thus been accumulated all round the equatorial parts than any where else on the earth, the sun and moon, when on either side of the equator, by attracting this redundant matter, bring the equator sooner under them, in every return towards it, than if there was no such accumulation.

Sir Isaac Newton in determining the quantity of the annual precession from the theory of gravity, on supposition that the equatorial diameter of the earth is to the polar diameter, as 230 to 229, finds the sun's action sufficient to produce a precession of $9''\frac{1}{8}$ only; and collecting from the tides the proportion between the sun's force and the moon's, to be as 1 to $4\frac{1}{2}$, he settles the mean precession resulting from their joint actions at $50''$; which is nearly the same as it has since been found by the best observations.

PRECIÆ, in botany, the name of the twenty-first order in Linnæus's Fragments of a Natural Method: containing the primrose, and a few other plants which agree with it in habit and structure.

PRECIPITATE, in chemistry, is any matter or substance, which having been dissolved in a fluid, falls to the bottom of the vessel on the addition of some other substance, capable of producing a decomposition of the compound. The term is generally applied when the separation takes place in a floculent or pulverulent form, in opposition to crystallization, which implies a like separation in an angular form. But chemists call a mass of crystals a precipitate, when they subside so suddenly, that their proper crystalline shape cannot be distinguished by the naked eye, as in the instance of Glauber's salt, when separated from its watery solution by mixing with it a portion of alcohol.

PRECIPITATION, that process by which bodies dissolved, mixed, or suspended in a fluid, are separated from the fluid, and made to gravitate to the bottom of the vessel: this is one of the great operations in chemistry, and is opposed to that of solution. In truth the chief operations in the laboratory may be resolved into solution and precipitation. When a base is employed to precipitate a soluble acid, the substance thrown down is always a compound, consisting of the acid united to the base employed. In this case the acid is sometimes completely separated, and sometimes not, according to the energy of the base employed, and the degree of insolubility of the salt formed. The same explanation applies as in the first case. When a neutral salt is employed as a precipitant, the substance which falls is always a compound. It is composed of one of the ingredients of the precipitating salt united to one ingredient of salt in solution. Such salts alone can be employed as are known to form insoluble compounds with the acid or base which we wish to throw down. In these cases the separation is complete, when the new salt formed is completely insoluble. Neutral salts perform the office of precipitants in general much more readily and completely than pure bases or acids. Thus the alkaline carbonates throw down the earths much more effectually than the pure alkalies, and sulphate of soda separates barytes much more rapidly than pure sulphuric acid. This superiority is owing partly to the combined action of the acid and base, and partly to the comparatively weak action of a neutral salt upon the precipitate, when compared to that of an acid or alkali. For the precipitation takes place, not because the salts are insoluble in water, but because they are insoluble in the particular solution in which the precipitate appears. Now if this solution happens to be capable of dissolving any particular salt, that salt will not precipitate, even though it be insoluble in water. Hence the reason why precipitates so often disappear, when there is present in the solution an excess of acid, of alkali, &c.

PRECONTRACT *of marriage*, in the civil law, avoided the marriage; but by the statute 2 George I. c. 23, called the marriage act, it is declared, that it shall not be allowed, nor shall any contract of marriage be enforced in the ecclesiastical courts. The only remedy upon breach of a promise of marriage is by action for damages at common law.

PREDIAL *tithes*, those which are paid of things arising and growing from the ground only, as corn, hay, fruit of trees, and the like.

PREENING, in natural history, the action of birds dressing their feathers, to enable them to glide the more readily through the air, &c. For this purpose they have two peculiar glands on their rump, which secrete an unctuous matter into a bag that is perforated, out of which the bird occasionally draws it with its bill.

PREGNANCY. See MIDWIFERY.

PREHNITE, in mineralogy, a species of the flint genus. Its colours are green in almost all its shades. It is sometimes massive, sometimes crystallized. Externally the crystals are smooth and shining; internally they have a glistening pearly lustre. It is harder than glass, easily frangible: specific gravity 2.6 to 2.9. Before the blow-pipe it foams, and melts into a brownish enamel. This mineral has been compared with the zeolite, to which it bears some resemblance; but it does not, like that, become gelatinous with acids. According to Klaproth it consists of

Silica	43.83
Alumina	30.33
Lime	18.33
Oxide of iron	5.66
Water	1.83
	99.98
Loss	2
	100.00

It occurs in Dauphiny, and in many parts of Scotland.

PRELIMINARY, in general, denotes something to be examined and determined, before an affair can be treated of to the purpose. The preliminaries of peace consist chiefly in settling the powers of ambassadors, and certain points in dispute, which must be determined previously to the treaty itself.

PRELUDE, *præludium*, in music, is usually a flourish or irregular air, which a musician plays off-hand, to try if his instrument be in tune, and so lead him into the piece to be played. Very often the whole band in the orchestra run a few divisions, to give the tune.

PREMISES, in logic, an appellation given to the two first propositions of a syllogism, as going before, or preceding the conclusion. Premises are the foundation or principles of our reasoning; which being either self evident or demonstrative propositions, the truth of the conclusion is equally evident.

PREMISES, in law, from the Latin, *premissa* (the foregoing), is applied to that part in the beginning of a deed which expresses the names of the grantor and grantee, and the land or thing granted; but it is chiefly used to signify the thing granted only.

PREMIUM, or PRÆMIUM, properly signifies a reward or recompense; but it is chiefly used in a mercantile sense for the sum of money given to an insurer, whether of ships, houses, lives, &c. See INSURANCE. The term premium is also applied to what is given for a thing above par, or prime cost; thus if lottery tickets sell for 20*s.* more than prime cost, or the price at which the government issued them, this 20*s.* is called a premium.

PREMNA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx two-lobed; corolla four-cleft; berry four-celled; seeds solitary. There are two species; *viz.* P. integrefolia, and P serratifolia; both natives of the East Indies.

PRENANTHES, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx calycled; florets in a single row; pappus simple, subsessile; receptacle naked. There are nineteen species.

PREPOSITION, in grammar, one of the parts of speech, being an indeclinable particle, which yet serves to govern the nouns that follow it. See GRAMMAR.

PREPUCE. See ANATOMY.

PREROGATIVE, in law, means all the rights and privileges which by law the King hath, as chief of the commonwealth, and as intrusted with the execution of the laws; and this can be only according to Magna Charta. We shall here briefly set down those articles which are enumerated by Lord Chief Baron Comyns, in his "Digest," as belonging to the King's prerogative, premising only, that many things are laid down in our law-books from ancient authorities, which do not thoroughly accord with the spirit of the constitution, as improved at the revolution; and that every thing, which is contrary to that glorious spirit, may be well questioned to be law at the present day. Those who were formerly called prerogative lawyers were little better than the willing slaves of absolute monarchy.

As to his domestic concerns, the care of the marriages in the royal family belongs to the King, and is now regulated by statute 12 George III., c. 11.

As to foreign nations, he has the sovereignty of the seas surrounding England, and may make treaties and alliances, and send ambassadors and envoys to foreign states; and a league is said to be broken by a prohibition of all the commodities of a kingdom in amity. He may, in virtue of the same right, grant reprisals, by taking the goods of foreign subjects, here or elsewhere, and he is entitled to all prizes; but, by certain acts, called the prize-acts, they are distributed in certain shares amongst the captors, according to a proclamation to be made in every new war, and 5*l.* a head is allowed to ships of war for every man killed. The King may also grant letters of safe conduct to an enemy here; and without these, it is said, a foreign prince, though in amity, cannot come here.

With respect to the King's own subjects, he has the sole authority to declare war or peace, and to levy soldiers, and by 11 Henry VII. c. 1 and 18, every man is bound to serve the king in his wars, but not out of the realm, except for wages; nor can he be sent out of the kingdom even with an office. In like manner, the right of impressing seamen is acknowledged; but it must not be exercised wantonly, as by taking a captain of a merchantman to serve as a common man, and, by 13 George II. c. 17, persons of fifty-five years of age, and under eighteen, and every person going to sea for two years, and every apprentice during three years, are exempted; and also all foreigners; besides which there are other particular exemptions; nor are mariners, except deserters, to be impressed in the West Indies. He has also the sole command of the forces, as well militia as regulars, and that, by 13 Charles II. c. 6, independent of the Houses of Parliament. His troops may be billeted all over the kingdom; and no one but the King can build forts.

With respect to time of peace, he enacts laws, together with his Parliament; but cannot by grant or charter alter the law. He may issue proclamations to enforce laws; and, by 1 James, c. 25, and 12 Charles II. 4, s. 12, may restrain the transportation of corn, and gunpowder, arms, and ammunition, generally, or from particular places. By statute 31 Henry VIII. since repealed, he might, in effect, make new laws by his proclamation. But now he cannot suspend the execution of a law for any time, as till the meeting of the next Parliament. It is said, that the King may dispense with a thing prohibited, so as to make it lawful, in case of necessity, to the party to do the prohibited thing; but dispensations are odious, and, indeed, except under the following limitations, the King's dispensing power may now be questioned. As, however, he may grant a pardon when the offence is committed, it seems not of so much importance. He may unquestionably dispense with any thing which is for his benefit, as a penalty due to the King; but not with a thing *malum in se*, nor in which the subject has an interest. He may grant a pardon of all offences, as well in the ecclesiastical as the criminal court; but cannot reverse a judgment without process.

With respect to things ecclesiastical, he has jurisdiction in all ecclesiastical causes, is head of the church, and may punish and repress heresies and superstitions, by statute 37 Henry VIII. c. 17. And ecclesiastical laws, which consist of ancient synods, and canons, and constitutions, and customs, formed with the assent of the King, without the Parliament, are of legal authority in England, and, it is said, he may dispense with those laws. He may, with his commissioners, pass ecclesiastical censure, and shall have the ordering of all ecclesiastical appeals, without appeal to the Pope. The highest appeal, by statute 25 Henry VIII. c. 19, is to the King, in Chancery, who issues a commission to his delegates; but where the King is concerned, it is to the Upper House of Convocation; and although the appeal to the delegates is final, yet the King may grant a commission of review.

The King's prerogative, as to temporal jurisdiction, enables him to make what courts he pleases, for the administration of the common law, and where he pleases; but he cannot erect a court of Chancery, or Conscience, the common law being the birth-right of the subject. The King may also grant such commissions as are warranted or allowed by the common or statute law, as of oyer and terminer, &c.; but, it is said, he cannot grant a commission of inquiry only, without a clause to hear and determine. He may grant franchises also, because all franchises and liberties are derived from him, as a county palatine, or jurisdiction temporal, or ecclesiastical.

As to nobility and honour, the King is the fountain of all dignity, and may, it is said, compel all persons of 20*l.* per annum inheritance, to be knights, or persons named to be serjeants, to take the degree.

The King may also grant privileges, such as those of a forest, chase, warren, park, fair, market, with tolls, or casual profits, as wreck, waifs, strays, deodands, treasure-trove, royal fish, mines, derelict lands, most of which belong to the King, together with certain privileges in trade, for which see Trade. So he may grant exemptions from those charges which, by his grant, he may impose, as to be quit of toll for merchandize, in every town in England, and to be exempt from offices under the crown, such as that of constable, provided there be a sufficient number to serve; but he cannot grant an exemption from the jurisdiction of any court, if he does not erect a jurisdiction of the same nature in lieu of it, for that would create a failure of justice; nor to be exempt from punishment, from felony, or trespass. He may also by proclamation or special writ, directed to the party, or to the sheriff, restrain any person from quitting the kingdom, and may, for reasons of state, lay an embargo upon a ship. So he may inhibit a public nuisance. He may also recal, by summons, a subject who goes out of the kingdom with or without licence, and if he returns not, upon service of summons, then his lands and goods are forfeited. But, it is said, merchants may abide beyond sea, and a King, in amity, need not deliver up those who fly to him.

The King may, by his prerogative, command mayors and corporate officers to restrain annoyances, and keep streets clean; but not in places which are no corporations; and cannot inhibit a lawful occupation, such as making cards, under pretence of inconvenience, nor restrain the exercise of foot-ball, cock fighting, or other vain sports, except, perhaps, on Sundays.

As to offices, the King has the nomination of all public officers within the kingdom; but he cannot create a new office with a fee, nor appoint an old office with a new fee, to burthen the public, without his Parliament.

As to trade, he may erect societies for the management of it; but cannot grant an embargo on ships, for the benefit of a private trader or company.

As to matters of revenue, the King can alone coin money within his dominions, upon which the duties are now settled, as in statute 18 Charles II.; but the aid, for knighthood, marriage, &c. are taken away by statute 12 Charles II. c. 24.

With respect to purveyance, he may dig for saltpetre in the lands, stables, and other places of a subject; but not where he cannot leave the place in the same plight as before. He must leave room for the horses, &c. of the person, and not dig at improper times, nor return there for a long time, nor can he grant it to another, and the saltpetre must be used for the defence of the realm only, and the subject is at liberty still to dig in his own soil. But he cannot claim any other necessaries, such as timber, wood, fuel, cattle, grain, hay, victuals, carts, carriages, &c. without the consent of the owner, by statute 12 Charles II. c. 24.

The customs upon merchandise exported and imported, are the ancient inheritance of the crown, which, it is said, were originally by act of Parliament; they were distinguished into *custuma magna, et parva*, to which were added prisage, or a duty of two tons out of every ship laden with twenty tons of wine; and butlerage, or a levy of 2*s.* per ton, for every ton of wine of a merchant stranger. The citizens of London were exempt from this duty in the port of London. These duties, it seems, are now repealed by statute 27 George III. c. 13, called the Consolidation act, which affixes a certain rate to the commodities therein enumerated, and 27*l.* 10*s.* per cent. with a drawback of 25*l.* per cent. on exportation, upon every other commodity. We have, however, read in the public prints during this year, (1807) of the claim of prisage being made in Ireland, by one of the grantees of the crown, and allowed; but we presume, so heavy a tax, if it can be claimed, in addition to the duty on wines, must be repealed by Parliament. Customs are not paid where the King has granted goods of a pirate to a patentee, for the King shall not pay custom to himself; and it is said, the King may grant to an alien to pay no more customs than a subject; but this must be subject to the Consolidation act.

The King may, by his prerogative, charge an imposition upon the subject for his benefit, as he may grant a certain rate for things sold in a town, for the walls of the town, or repairing the bridge, or the security of those parts. Or that a man may build a wall, or keep a ferry, and take toll for the support of it. But he cannot charge the subject where he has no benefit from it, or a *quid pro quo*, nor levy new customs, &c. Nor can the merchants, by their consent, grant to the King a tax upon their goods, for their wares would thereby be sold the dearer. Upon all which we must observe, that it should appear this branch of the prerogative is fallen into disuse, and can scarcely now be claimed, as being altogether inconsistent with the spirit of the revolution in 1688. And we now see that in all cases where a pier is to be built, or a turnpike-road made, or improvements are made in cities, application is had to

Parliament, and a bill is passed. This, it is true, may be, partly, because it is often necessary to borrow large sums of money, and to purchase lands by compulsion, &c.; but we still may venture to question this prerogative, although we find it in books of great authority previously to the reigns of Charles the First and Second.

As to casual profits, the King is entitled to all goods which have no owner, as wreck, flotsan, jetsan, and ligan, waifs, strays, goods of felons, deodands, treasure-troves, escheats, and lands forfeited. He is entitled also to royal mines, and the fishery of every navigable river, as high as the sea flows: but every one may fish in the sea of a common right, although foreign nations cannot fish in the British Seas without the King's licence. There are also certain fines, upon legal proceedings, which the King claims by his prerogative; and anciently, a fine was paid for liberty to have right and justice, which is now abolished by Magna Charta 29, *nulli vendemus*, &c. So fines for beau pleader, for grants of liberties, and for misdemeanors, with all amerciaments, which are levied by the Sheriff and estreated into the Exchequer.

All the lands in the kingdom, it is said, are holden mediately, or immediately, of the King, who has no superior; and this is the foundation of the law of forfeiture and escheats: but this, however in practice it may be harmless, is a principle rather derived from the divine right of kings, than the spirit of the revolution, which considers the King rather as deriving every thing from the people, and holding the throne itself in trust.

Whatsoever lands, or tenements, the King has, belong to him in right of his crown, and are called the sacred patrimony, or demesnes of the crown, says Lord Coke; and whether lands descend, or are devised, or given to him and his heirs by statute, or otherwise, they go as parcel of the crown. The King, therefore, it seems, cannot divest himself of his public character, but has all his real possessions, for it does not seem to extend to money, merely as king.

All conveyances to the King ought to be by deed, enrolled; and where a subject would not have possession without entry, there the King has it not without office found, or other record. But if the King's title is so found upon an inquisition, he is in possession without seizure; and where a common person cannot enter without an action, there the King ought to have a *scire facias*. But no office is necessary where the King's title appears by other matter of record, and where he is so seized he can never be ejected, or disseized; but every one who enters upon his possessions is called an intruder; the remedy upon which is by an information of intrusion. The remedy against the King is by petition to the King in Parliament, in Chancery, or some other court, for there can be no writ, because the King cannot command himself, as it is quaintly expressed. There is also another proceeding by *monstrance de droit*, which is, where the suitor's title appears by the same record as that of the King. Even upon an office found, there may now be, by statute 34 Edward III. c. 14, a traverse, denial, or litigation of it.

The King, by his prerogative, may sue in what court he pleases, and shall not be prejudiced by any neglect to pursue his right, which is meant by the maxim *nullum tempus*, &c. or no time runs against the King. Though now, by statute 9 George III. c. 16, the King's suit, except for liberties and franchises, is limited, under certain conditions, to 60 years for lands.

As to the disposal of the personal revenue of the King, this can only be by the Great or Privy Seal; and every one who receives money out of the Exchequer, without due warrant, is accountable for it. He may, it is said, dispose of his lands and other real revenues of inheritance, by patent, to others, when he pleases. And by statute 1 Anne 7, s. 5. all grants by the King, of any manors, lands, &c. advowsons of churches and vicarages excepted, shall be void, except for 31 years or under, or for 3 lives, &c. subject to waste, and at the usual rent, or more, or if no usual rent, then a rent at least one-third of the annual value. By the same act, the hereditary excise, revenue of the post-office, first fruits and tenths, fines for writs of covenant, and entry at the alienation office, post fines, wine licences, sheriff's profers and compositions, and seizures for unaccustomed and prohibited goods, shall not be alienable for longer than the life of the King who grants them.

It is to be observed that much of the King's prerogative, producing revenue, has been from time to time granted out with various manors, and the article of forfeitures, which might in some cases be somewhat profitable, is very little enforced. When a forfeiture is discovered, the officers of the crown generally allow a portion to the informer; sometimes one-sixth. It has been proposed, by Mr. Bentham, to make forfeitures of land supply, in some measure, the place of taxes, and to restrain the power of bequest of land to certain degrees of kindred only. Blackstone and others, however, though they approve of the statute of Anne to prevent the improperly granting away crown lands, consider the great diminution of the landed demesnes of the crown well exchanged by the subject for the lighter burthen of taxes, since, had things remained as at the conquest, the King would, by forfeiture and otherwise, have possessed all the land in the kingdom. The observation is short-sighted enough, for no people would have tolerated it. William possessed all the lands by force, only to parcel them out like a robber among his troops, and had he not speedily parted with them, he and they must have found that he who grasps all loses all. See Revenue.

Prerogative *court*, the court wherein all wills are proved, and all administrations taken, which belong to the Archbishop by his prerogative; that is, in cases where the deceased had goods of any considerable value out of the diocese wherein he died; and that value is ordinarily *5l.* except it be otherwise, by composition, between the Archbishop and some other Bishop, as in the diocese of London it is *10l.*

PRESBYTERIANS. This denomination of Protestant Dissenters has been called by different names at different periods of time. In their first attempts for a further reformation of the church, they were, by way of reproach, termed Puritans, a name derived from the *Cathari* or *Puritini* of the third century. But reproachful names have not been the only species of persecution they have at various times suffered. The cruel persecutions they suffered in the reigns of Elizabeth, James I. and the two Charleses, will ever reflect disgrace upon the memory of those princes.

The reformed exiles who were driven to Franckfort, to avoid the cruelties of Mary I. and who afterwards set up congregations at Basil and Geneva, were first called Puritans, as their opponents obtained the name of Conformists. From the Puritans sprung the Presbyterians, whose form of church discipline was first established and is still followed by the Kirk of Scotland. The first Presbyterian church in England was erected at Wandsworth, a village near London; and, on the 20th of November, 1572, eleven elders were chosen, and their offices described in a register, entitled The Order of Wandsworth. Other churches, notwithstanding proclamations for uniformity, &c. were soon erected in other counties, though with the utmost privacy and secrecy. But we are compelled by our limits to omit many important particulars in the history of the Presbyterians, during the periods of their alternate sufferings and triumphs. Their history, like that of other numerous and powerful bodies of men, exhibit a melancholy picture of the instability of the human mind, and the evil tendency of religious prejudice, when combined with human power and authority. For who could have thought, that the very men, who had suffered every species of privation, who had been exiled for conscience sake, who had borne the most cruel persecutions at home, and the contumely of the Lutherans abroad, with the courage and the constancy of martyrs, that these very men, when armed by the same species of power that before had well nigh crushed them to atoms, should themselves imbibe the principles and follow the practices of their most cruel persecutors? It is hardly credible, but it is nevertheless a melancholy fact, that an Ordinance against blasphemy and heresy was passed in May, 1648, by the influence of the Presbyterians then in parliament, in which it was decreed, "that all persons who shall willingly maintain, publish, or defend, by preaching or writing,"—"that the Father is not God, that the Son is not God, that the Holy Ghost is not God; or that these three are not one eternal God; or that Christ is not God equal with the Father,"—"shall upon complaint or proof, by oath of two witnesses, before two justices of the peace, be committed to prison, without bail or mainprize, till the next gaol-delivery; and in case the indictment shall then be found, and the party upon his trial shall not abjure the said error, and his defence and maintenance of the same, he shall suffer the pains of death, as in case of felony, without benefit of clergy; and if he recant or abjure, he shall remain in prison till he find sureties that he will not maintain the said heresies or errors any more; but if he relapse, and is convicted a second time, he shall suffer death, as before." There were about seven other real or supposed heresies, besides that which we have just instanced, which were all and every one of them thus punishable by fine, imprisonment, and death. Such was the spirit which at that time influenced those who had caused the press to groan with publications about persecution, liberty, and the rights of private judgment! The clamours, however, about the divine right of Presbytery at length ceased, and the rights of conscience began to be better understood and more generally allowed.

Oliver Cromwell, though he, in some degree, favoured the Presbyterians, disarmed their discipline of its coercive power. Their church censures consequently lost their force, and at length were in a measure discontinued. When Richard Cromwell had resigned the protectorate, the period of their sufferings again commenced. Duped by General Monk, and deceived by Charles II. whose restoration they had effected, and the life of whose predecessor they had endeavoured to save from the cruelty of the Independents, they were made to discover that their expectations concerning the establishment of a Presbyterian government were to be cut off. Although when the King came to Whitehall ten of them were made his chaplains, before the expiration of the year 1660, many of the parochial clergy were prosecuted for not using the book of Common Prayer; the justices and others insisting that the laws returned with the King. The sequestered clergy came out of their hiding places, and took possession of their former livings, by which some hundreds of the Presbyterian clergy were at once dispossessed; in short, the Church of England was restored to its former power, except only the peerage of the bishops. Now it was that the nation became as completely deluged with licentiousness as it had just before been by enthusiasm and bigotry. The virtues of the Puritans were forgotten or despised, and a torrent of vice and irreligion issued from the court, and overwhelmed the people. Ancient religious ceremonies were revived, and an evident leaning towards popery manifested itself. "To appear serious," says Neale, "to make a conscience of one's words and actions, was the way to be avoided as a schismatic, a fanatic, or a sectarian. They who did not applaud the revived ceremonies were marked out for Presbyterians, and every Presbyterian was a rebel." The vindictive spirit of the restored bishops manifested itself against these unhappy people in every possible way. They were alternately elated with hopes of peace and liberty, and sunk to despair by disappointment and abuse. The doctrines of passive obedience and non-resistance were revived, and an open and flagrant persecution of the Presbyterians was commenced, which continued to increase, until the triumph of episcopacy was completed by the Act of Uniformity, which began to be in force on St. Bartholomew's day, in the year 1662. By this act two thousand of the worthiest and most learned men of the time were ejected from their livings, and exposed to every species of insult, deprivation, and distress. Thus did the hypocritical Charles reward those to whom he was indebted for his restoration to the throne of England! The Presbyterians had now no hopes of justice left, except what they owed to the King's private attachment to the Roman Catholics, and to the exercise of an illegal power in their sovereign, by which the entire liberties of the country might one day be destroyed. This was called the King's dispensing power, under colour of which he pretended to dispense with the execution of the established laws of the realm; thereby, in effect, creating a power above that of the law, and making the monarch an absolute sovereign. It was a painful alternative to the Presbyterians, either to suffer the most shameful deprivations, or countenance the exercise of this usurping power, and thereby endanger the liberties of their country by a kind of unnatural union with the Roman Catholics. In the succeeding reign, when this artifice of universal toleration, and the dispensing power, was again attempted to betray the Protestant interest, the Presbyterians manifested the most honourable disinterestedness, and refused to accept any toleration for themselves that might endanger the general interests of religion, or give countenance to those popish sentiments, that had so often deluged their country with the blood of its inhabitants.

In the year 1666, happened the memorable fire of London, a calamity so great and humiliating, that the rancour of bigotry and persecution was somewhat abated by it. This heavy judgment taught the persecutors some useful lessons of righteousness, and the despised Presbyterians were for a time connived at. They built wooden tabernacles to preach in, and their places of worship were crowded with penitent and devout auditors. In two years, however, after the fire of London, their persecutions were revived, and their private assemblies were dissolved. Drs. Patrick and Parker, afterwards bishops, wrote bitterly against them; but Parker met with a formidable, though a sarcastic, antagonist in the famous Andrew Marvel. In 1670, the conventicle act was revived, by which the Presbyterians again suffered the most cruel and vexatious persecutions.

The last penal statute against the Presbyterians, was the Test Act, for the repeal of which there was, a few years ago, a very warm but unsuccessful petition from the united body of Protestant Dissenters in England. This offensive act, which was passed in the year 1673, imports, that every person, in office or employment, shall take the oaths of allegiance and supremacy; "receive the sacrament in some parish-church before competent witnesses," and subscribe a declaration, renouncing all belief of the real presence in the eucharist. From this period to the year 1681, various attempts were made, by the successive parliaments, for the toleration of Dissenters, and for putting in force the laws against Popish Recusants; and many books and pamphlets were published in their defence: but all in vain; the court and the papists contrived, to the end of the reign, to oppress the Presbyterians in every possible way. In February 1685, died the thoughtless, the merry, the dissolute Charles II. and with him all hopes of redress or justice on the part of the Dissenters: for whatever were the errors in this prince's conduct, and the blemishes in his character, he was personally beloved by his people, who were overwhelmed with grief and astonishment at his death. He died in the communion of the church of Rome, having received, just before his death, the sacrament at the hands of a Roman Catholic priest.

James, Duke of York, brother to the late King, was crowned, with his Queen, on the 23d of April, 1685. He commenced his reign by disclaiming arbitrary principles, and, at the same time, declaring he would abide by and maintain the religion established by law. James soon gave the nation to understand what he meant by toleration on the one hand, and an adherence to established usages on the other. By toleration, he meant to encourage the principles and the practices of Popery, and by his support of the established religion, he meant the support of the doctrines of passive obedience, and non-resistance. In these principles and determinations he found himself supported by the articles of the English creed, and the importunities of numerous hot-headed Jesuits, by whose influence he suffered himself to be almost invariably guided.

Notwithstanding the plausible pretences of James II. of granting a free toleration to the Dissenters, his drift was easily seen through; and the Dissenters, much to their credit, as we have already remarked, joined with their persecutors of the established church, generously giving up their private resentments, however just, to their fears of Popery and slavery, which were making large strides towards the destruction of civil and religious liberty, of which the dispensing power, and the declaration for liberty of conscience, were to be the principal engines. This wise conduct of the Dissenters certainly saved the church and state. Thus an end was put to the prosecution of the Protestant Dissenters by the penal laws; though the laws themselves were not legally repealed, or suspended, till after the Revolution, in 1688. From this happy period of English history, the condition of the Presbyterians, and other Dissenters, began gradually to improve. William and Mary, who succeeded to the throne of England, after the abdication of it by James II. were favourable to the Protestant religion, and the rights of conscience. Notwithstanding the violent opposition which William met with from the high-church party, who were a numerous and powerful body, he succeeded, in many points, to soften the rigours, and abate the national prejudice against the Dissenters. Little else has occurred, since the happy era of the Revolution, but fruitless attempts for a repeal of the corporation and test acts. It is to be hoped, that the time is not far distant, when these, and some other statutes of an oppressive nature, will be repealed, and Englishmen, of whatever religious persuasion, shall feel and acknowledge, that no difference of opinion can divide their interests as Britons, nor disunite their affections as Christians.

Of the religious tenets of the Presbyterians, it is not necessary to enlarge very much. They continue to be one of the most numerous and respectable sects of Protestant Dissenters in England; are, doubtless, the richest and most learned body of men out of the pale of the establishment; and have now almost entirely forsaken the rigid and severe maxims of their forefathers. They are denominated Presbyterians, from their assertion, that the government of the church, as appointed in the New Testament, is by Presbyters. They acknowledge no head of the church but Jesus Christ. According to the original constitution of the Presbyterian church or congregation, they acknowledge the unity and equality of three persons in the Godhead: but the greater part of the Presbyterians, of the present day, are Unitarians, either what are opprobriously called Arians, or Socinians.

They acknowledge the authority and sufficiency of the Holy Scriptures to salvation. They generally believe, that all corruption and depravity is contracted, and not original. They are, for the most part, Pædobaptists, and admit the sacrament of the Lord's Supper, which Dr. Watts says, "is eating bread and drinking wine in the church, in remembrance of the death of Christ." They, in general, reject the doctrine of predestination, and some other doctrines intimately connected therewith. The belief and practice of the modern English Presbyterians are pretty faithfully described in "An Abstract of a Profession of Faith made at a public Ordination at the Old Jewry, in 1756;" and also in some "Questions proposed to the Rev. Thomas Wright, at his Ordination, May 31, 1759, with the Answers thereto." These papers may be seen in the "History of Religion," published anonymously, in four vols. 8vo. in the year 1764. We close our account of the Presbyterians by observing, that a lecture, first set up in the year 1695, at Salter's Hall, London, is still continued on the original foundation, and is supported by the contributions of the friends of Presbyterianism in the city of London, and its vicinity.

PRESENTMENT *of offences*, is that which the grand jury find of their own knowledge, and present to the court, without any bill of indictment laid before them at the suit of the King, as a presentment of a nuisance, a libel, and the like; upon which the officer of the court must afterwards frame an indictment, before the party presented can be put to answer it. There are also presentments by justices of the peace, constables, surveyors of the highways, churchwardens, &c.

PRESS, in the mechanic art, a machine made of iron or wood, serving to squeeze or compress any body very close.

The ordinary presses consist of six members, or pieces, viz. two flat smooth planks, between which the things to be pressed are laid; two screws, or worms, fastened to the lower plank, and passing through two holes in the upper; and two nuts, in form of an S, serving to drive the upper plank, which is moveable, against the lower, which is stable, and without motion. Presses, used for expressing of liquors, are of various kinds: some, in most respects, the same with the common presses, excepting that the under plank is perforated with a great number of holes, to let the juice run through into a tub, or receiver, underneath. Press used by joiners, to keep close the pieces they have glued, especially panels, &c. of wainscot, is very simple, consisting of four members, viz. two screws, and two pieces of wood, four or five inches square, and two or three feet long; whereof the holes at the two ends serve for nuts to the screws. Press, used by inlayers, resembles the joiner's press, except that the pieces of wood are thicker, and that only one of them is moveable; the other, which is in form of a tressel, being sustained by two legs or pillars, jointed into it at each end. This press serves them for sawing and cleaving the pieces of wood required in marquetry or inlaid work. Founder's Press is a strong square frame, consisting of four pieces of wood, firmly jointed together with tenons, &c. This press is of various sizes, according to the sizes of the mould; two of them are required to each mould, at the two extremes whereof they are placed; so as that, by driving wooden wedges between the mould and the sides of the presses, the two parts of the mould wherein the metal is to be run, may be pressed close together. Rolling-Press is a machine used for the taking off prints from copper-plates. It is much less complex than that of the Letter-Printers.

Press, *in Coining*, is one of the machines used in striking off money; differing from the balance, in that it has only one iron bar to give it motion, and press the moulds or coins; is not charged with lead at its extreme, nor drawn by cordage. See Coining.

Press, *Binder's Cutting*, is a machine used equally by book-binders, stationers, and paste-board makers; consisting of two large pieces of wood, in form of cheeks, connected by two strong wooden screws; which, being turned by an iron bar, draw together, or set asunder, the cheeks, as much as is necessary for the putting in the books or paper to be cut. The cheeks are placed lengthwise on a wooden stand, in the form of a chest, into which the cuttings fall. Aside of the cheeks are two pieces of wood, of the same length with the screws, serving to direct the cheeks and prevent their opening unequally. Upon the cheeks the plough moves, to which the cutting-knife is fastened by a screw; which has its key to dismount it, on occasion, to be sharpened. The plough consists of several parts; among the rest a wooden screw, or worm, which, catching within the nuts of the two feet that sustain it on the cheeks, brings the knife to the book or paper which is fastened in the press between two boards. This screw, which is pretty long, has two directories, which resemble those of the screws of the press. To make the plough slide square and even on the cheeks, so that the knife may make an equal paring, that foot of the plough, where the knife is not fixed, slides in a kind of groove, fastened along one of the cheeks. Lastly, the knife is a piece of steel, six or seven inches long, flat, thin, and sharp, terminating at one end in a point, like that of a sword, and at the other in a square form, which serves to fasten it to the plough. See Book-Binding.

As the long knives, used by us in the cutting of books or papers, are apt to jump in the cutting thick books, the Dutch are said to use circular knives, with an edge all round; which not only cut more steadily, but last longer without grinding. Press, in the Woollen Manufactory, is a large wooden machine, serving to press cloths, serges, rateens, &c. thereby to render them smooth and even, and to give them a gloss. This machine consists of several members; the principal whereof are the cheeks, the nut, and the worm or screw, accompanied with its bar, which serves to turn it round, and make it descend perpendicularly on the middle of a thick wooden plank, under which the stuffs to be pressed are placed. The Calender is also a kind of press, serving to press, or calender, linens, silks, &c.

We shall now give an account of some presses much in use, and from which, as they are not to be found in books, we have taken original drawings.

Press, *hop*, (Plate Press) a machine used in breweries for compressing bags of hops into a small compass, that they may take less room for the stowage. In the plantation where the hops are grown, (after being picked, dried, and made ready for sale) they are placed in an upper room which has a hole in the floor, the bag to receive them is hung in this hole, and the hops filled into it; a person gets into the bag when nearly full, and by his weight treads down the hops, that the bag may hold more than it otherwise would; the bag is then removed, and its mouth is sewed up. In this state the bags go to market, and are sold to the brewer, who conveys them to the brewery ready for use; it is here the hops are pressed into a much smaller compass, as breweries are generally situated in large towns, where warehouse-room is valuable, and where the saving of room amply compensates for the trouble of pressing.

Fig. 1 and 2 are upright elevations, at right angles to each other, of a press for packing hops into bags, made by Mr. Valentine Gotlieb, Lambeth-marsh, Southwark: *a a* is the bottom or fixed bed of the press, firmly bolted to the two upright cheeks, *b b*, which support at their upper end a strong cross beam, B, called the head; the beam, B, is perforated in the middle to receive an iron screw, D. E is a contrate-wheel, of ninety-six teeth, which has a female screw, to admit the male screw, D; the wheel is turned by a pinion of ten teeth, upon the axis of a large crank, *f*, which is turned round by one or two men, according to the power required: these men stand upon a stage, H, fastened to the upright cheeks, *b b*. The lower end of the screw, D, is square, and is keyed into a three-legged iron frame, *h*, bolted to the swinging-bed of the press, I; this is formed of several pieces of thick oak plank, strongly bolted together; the fixed bed, K, of the press is framed in the same manner, and supported on the bottom bed: *a a*, *k k*, are two upright beams, fastened at their lower ends to the fixed bed, the press, and at the upper ends are fastened to the frame of the stage, H, on which the men who turn the handle, *f*, stand: one of these beams, *k*, is fixed to the lower bed by a moveable key-bolt; at the upper end it turns on a bolt as a centre, so as to rise up, as shown in fig. 1: *l* is a rope going round a pulley, one end fastened to the beam, the other to a weight which counterbalances the beam.

The operation of the machine is begun by screwing the swinging bed of the press up as high as it will go, and turning up the bar, *k*: a bag, filled with hops, and sewed up, as before described, is then placed on the lower bed, K, and the bar, *k*, brought down and keyed fast, to keep the bag under the press; the man upon the stage, H, then turns the winch, *f*, and by the action of the pinion fixed upon its spindle, turns the wheel, E, and thus brings the screw and the swinging bed of the press down upon the bag, and compresses it into a very small space. A small cord is now passed through the spaces between the pieces of wood, forming the lower side of the swinging bed, and the upper side of the fixed bed, and reefed twice round the bag, and tied fast: the man at the handles now turns it back, and draws up the swinging bed to relieve the bag, the cord retaining it in its compressed state.

In 1798, the Society for the Encouragement of Arts, Manufactures, and Commerce, rewarded Mr. John Peak, of the New Road, near the Adam and Eve, London, with thirty guineas, for an improved packing press, shown in fig. 3, Plate Press, which is a front elevation of the machine, A A, the frame of the press; B B, the large screws, which, in this press, contrary to those in common use, are fixed and immoveable; C, a circular iron bar, extending beyond the sides of the press, and having thereon two worms or endless screws, E, E, which work in two toothed wheels, fixed to the nuts; by turning the winch, D, the nuts and bed are driven up and down the screws, as may be found necessary. F, a stage suspended from the bed, and on which the men stand who work the press; such a stage may, if found necessary, be fixed at the other end of the bar, another winch being put upon the square shoulder, G. The bed of this press must be formed of two pieces of strong wood, which are held together by screws and nuts passed through them, as shown at *h h h h*.

One very considerable advantage of this press is, that much time is saved by its being a double press; for it will very readily be perceived, that when the lower package has been sufficiently pressed, as the bed or presser is raised, (another package being thereon) the upper package begins to be pressed, as that one underneath is relieved, and so alternately, during the whole operation.

PRESSING, in the manufactures, is the violently squeezing a cloth, stuff, &c. to render it smooth and glossy. There are two methods of pressing, *viz.* cold or hot. As to the former, or cold pressing, after the stuff has been scoured, fulled, and shorn, it is folded square in equal plaits, and a skin of vellum, or pasteboard, put between each plait. Over the whole is laid a square wooden plank, and so put into the press; which is screwed down tight by means of a lever. After it has lain a sufficient time in the press, they take it out, removing the pasteboards, and lay it up to keep. Some only lay the stuff on a firm table, after plaiting and pasteboarding, cover the whole with a wooden plank, and load it with a proper weight. The method of pressing hot is this: when the stuff has received the above preparations, it is sprinkled a little with water, sometimes gum water, then plaited equally, and between each two plaits are put leaves of pasteboard; and between every sixth or seventh plait, as well as over the whole, an iron or brass plate well heated in a kind of furnace. This done, it is laid upon the press, and forcibly screwed down. Under this press are laid five, six, &c. pieces at the same time, all furnished with their pasteboards and iron plates. When the plates are well cold, the stuffs are taken out and stitched a little together to keep them in the plaits. This manner of pressing was only invented to cover the defects of the stuffs; and, accordingly, it has been frequently prohibited.

PRIMÆ *viæ*, among physicians, denote the whole alimentary duct; including the œsophagus, stomach, and intestines, with their appendages.

PRIMATES, in natural history, the first order of Mammalia in the Linnæan system. The animals in this order are furnished with fore-teeth, or cutting-teeth: the four above are parallel: two breasts on the chests. There are four genera, *viz.*

Homo	Simia
Lemur	Vespertilio.

PRIME, an appellation given to whatever is first in order, degree, or dignity, among several things of the same or like kind. Thus, we say, the prime minister, prime cost, &c. Prime is sometimes used to denote the same with decimal, or the tenth part of an unit. In weights it stands for the twenty-fourth part of a grain.

Prime *figure*, in geometry, one which cannot be divided into any other figures more simple than itself, as a triangle among planes, and the pyramid among solids.

Prime *numbers*, in arithmetic, are those which can be only measured by unity, or exactly divided without a remainder, 1 being the only aliquot part, as 3, 5, 7, 11, 13, &c.: they are sometimes called simple, or incomposite numbers. No even number is prime, because all even numbers are divisible by 2. Numbers endin 0 and 5, are not prime, because they are all divisible by 5, and those ending in 0 by 10 also

PRIME *of the moon*, is the new moon, when she first appears, which is about three days after the change.

PRIME *vertical*, is that vertical circle which passes through the poles of the meridian, or the east and west points of the horizon; whence dials projected on the plane of this circle are called prime vertical, or north and south dials.

PRIMING, or *Prime of a Gun*, is the gunpowder put into the pan or touch-hole of a piece, to give it fire thereby.—And this is the last thing done in charging. For pieces of ordnance they have a pointed iron rod, to pierce the cartridge through the touch-hole, called primer or priming-iron.

PRIMING, among painters, signifies the laying on of the first colour.

PRIMITIÆ, the first fruits gathered of the earth, whereof the ancients made presents to the gods. In our law, the primitiæ are one year's profits, after avoidance of every spiritual living, as rated in the King's books.

PRIMITIVE, in grammar, is a root or original word in a language, in contradistinction to derivative. Thus, *God* is a primitive, *godly* derivative, and *god-like* a compound.

PRIMULA, in botany, *primrose*, a genus of the Pentandria Monogynia class and order. Natural order of Preciæ. Lysimachiæ, Jussieu. Essential character: involucre of an umbellet; corolla tube cylindrical with a spreading mouth. There are twenty species.

PRIMUM *mobile*, in the Ptolemaic astronomy, the ninth or highest sphere of the heavens, whose centre is that of the universe.

PRINCE, in polity, a person invested with the supreme command of a state, independent of any other. Prince also denotes a person who is sovereign in his own territories, yet holds of some other as his superior; such are the princes of Germany, who, though absolute in their respective principalities, are bound to the Emperor in certain services. Prince also denotes the issue of princes, or those of the royal family. In France, they are called princes of the blood. In England, the King's children are called sons and and daughters of England: the eldest son is created Prince of Wales. The cadets are created Dukes or Earls, as the King pleases. And the title of all the children is royal highness: all subjects are to kneel when admitted to kiss their hand, and at table, out of the King's presence, they are served on the knee. It is high treason to violate the eldest daughter unmarried.

The Prince of Wales is born Duke of Cornwall, and immediately entitled to all the revenues belonging thereto. He is afterwards created Prince of Wales, by investiture with a cap, coronet, gold verge, and ring, and he holds it by patent. The title and principality were first given by Edward I. to his eldest son. While Normandy remained to England, he was styled Duke of Normandy; but since the union his title is Magnæ Britanniæ Princeps. He is reputed, in law, the same person with the King; to imagine his death, or violate his wife, is high treason.

PRINCIPAL, the chief and most necessary part of a thing. In commerce, principal is the capital of a sum due or lent, so called in opposition to interest. It also denotes the first fund put by partners into a common stock, by which it is distinguished from the calls or accessions afterwards required.

PRINCIPAL *point*, in perspective, is a point in the perspective plane, upon which a line drawn from the eye perpendicular to the plane falls. It is in the intersection of the horizontal and vertical plane, and called the point of sight, and point of the eye. See PERSPECTIVE.

PRINCIPAL *ray*, in perspective, that which passes perpendicularly from the spectator's eye to the perspective plane. See PERSPECTIVE.

PRINOS, in botany, *winter-berry*, a genus of the Hexandria Monogynia class and order. Natural order of Dumosæ.—Rhamni, Jussieu. Essential character: calyx six-cleft; corolla one-petalled, wheel-shaped; berry six-seeded. There are seven species.

PRINTERS, *marks of*. See PRINTING.

PRINTING, the art of making an impression upon one body by pressing it with another. This art, in some way or other, has been known in all ages. It has been done upon wax, upon plaster, upon iron, by the ancients; their seals, their rings, their money, prove it. It has been done with wooden blocks upon cotton and silk by the Indians. Printing, therefore, in this limited sense, was common to all nations. This art is now divided into four distinct branches: 1. Common, or letter-press printing. 2. Rolling-press printing. 3. Calico-printing. 4. Stereotype-printing.

Printing by letter-press is the most curious branch of the art, and demands the most particular notice. It has been often remarked, that as seven cities in Greece disputed for the birth of Homer, so three cities in Europe, Haerlem, Strasbourg, and Mentz, claim the honour of the invention of printing.

Without entering minutely into the disputes which have long agitated the minds of those who have felt a particular interest in this investigation, we state it as our opinion, that Guttemberg was the inventor of the art of printing by moveable types; that he began the art at Strasbourg, and perfected it at Mentz. In this opinion, the earliest writers who mention printing are all agreed.

That the first attempts at printing were made at Strasbourg is, we think, incontestably proved by the following circumstances John Guttemberg entered into a partnership with Andrew Drizehennius, John Riff, and Andrew Heilmann, all citizens of Strasbourg, binding himself to discover to them some important secrets, whereby they should make their fortunes. Each at first contributed eighty florins, and afterwards 125. The workshop was in the house of Andrew Dritzehen, who died. Guttemberg immediately sent his servant Beildeck to Nicholas, the brother of the deceased, to request him to suffer no one to enter the workshop, lest the secret should be discovered, and the *forms* stolen. But this had already been done. This theft, and the claim which Nicholas made to succeed to his brother's share, occasioned a law suit, and the evidence of the servant affords explicit and incontrovertible proof in favour of Guttemberg, as the first who practised the art of printing with moveable types. The document containing the account of this trial, &c. is dated 1439. It was published in the original German, with a Latin version, by Schopflin, in his "Vindiciæ Typographicæ." M. Lambinet, in his "Recherches Historiques sur l'Origine de l'Art de l'Imprimerie," published at Paris a few years ago, says, that the German is obscure, and that every one will interpret the equivocal words in favour of his own opinion. It is, however, manifest, that Guttemberg expressly ordered that the *forms* should be broken up, and the characters dispersed; a fact clearly proving, that the art of printing was at that time a secret, and that moreover it was performed with moveable types. Guttemberg, after having sunk what he and his associates had embarked in this speculation, returned to Mentz, where he was born, and succeeded better in a partnership with Fust.

The evidence in favour of Guttemberg appearing to us decisive, we shall not enter into any examination of the claims advanced by the other candidates for the honour of being the inventor of the art of letter-press printing. The names of those persons were, John Fust, of Mentz; John Mental of Strasbourg; and L. John Koster, of Haerlem. When the city of Mentz was taken by Adolphus, Count of Nassau, in 1462, Fust, and Schoeffer, servant and son-in-law to Fust, suffered materially with their fellow-townsmen.—Their associates and workmen dispersed to seek their fortunes, and the art was thus diffused over Europe. When it was first established at Paris, the copiers, finding their business so materially injured, presented a memorial of complaint to the parliament, and that tribunal, as superstitious as the people, who took the printers for conjurers, had their books seized and confiscated. Louis XI. who, villain as he was, was the friend and patron of letters, forbade the parliament to take any farther cognizance of the affair, and restored their property to the printers.

The art of printing now began to spread itself over a great part of Europe with astonishing rapidity. It was practised at Rome in the year 1467, and the year following it was introduced into England by Thomas Bourchier, Archbishop of Canterbury, who sent W. Turner, master of the robes, and W. Caxton, merchant, to the continent to learn the art. Turner and Caxton met with one Corseilles, an under-workman, whom they bribed with considerable presents and large promises, to come over to England, and instruct them in the art. This business having been accomplished, a press was set up at Oxford, which was afterwards removed to St. Albans, and after that to Westminster Abbey. The learned Dr. Conyers Middleton, and others, are inclined to doubt the truth of this part of the history of printing. It is certain, that Caxton did not return immediately to England, but continued some time on the continent, following the business of a printer. Indeed both the origin and the history of the first introduction of the art of printing into this country are involved in doubt and obscurity, and nothing has ever yet been published perfectly satisfactory on this subject. We will, therefore, proceed to an account of

THE METHOD OF PRINTING.

The workmen employed in this art are compositors and pressmen. The first are those persons whose business it is to range and dispose the letters into words, lines, pages, &c. The pressmen are those who, properly speaking, are the printers, as they take off the impressions from the letters after they are prepared for that purpose by the compositors. The types being provided for the compositor, he distributes each kind, or *sort*, by itself, into small cells or boxes, made in two wooden frames, called the *cases;* the upper-case and the lower-case. The cells in the upper-case are ninety-eight in number; those of the lower case are fifty-four.

The upper-case contains two alphabets of capitals; large, or full capitals, and small capitals. They also contain cells for the figures, the accented letters, the characters used in references to notes, &c.; and one cell, being a middle one in the bottom row, for the small letter k. The capitals in this case are disposed alphabetically.

The lower-case is appropriated to the small letters, the double letters, the points, parentheses, spaces, and quadrats. The boxes of the lower-case are of different sizes; the largest being for the letters most in use; but the arrangement is not in this instance alphabetical, those letters oftenest wanted being placed nearest to the compositor's hand. As there is nothing on the outside of the boxes to denote the letters they respectively contain, it is curious to observe the dexterity manifested by the compositor in finding and taking up the letters, as he wants them, from the different cells. Each case is placed in an inclined direction, that the compositor may reach the upper-case with ease.

The instrument in which the letters are set is called a composing-stick, which consists of a long plate of brass or iron, on the side of which arises a ledge, which runs the whole length of the plate, and serves to support the letters, the sides of which are to rest against it. Along this ledge is a row of holes, for introducing a screw to lengthen or shorten the line, by moving the sliders farther from, or nearer to, the shorter ledge at the end of the composing stick. Where marginal notes are required, the two sliding pieces are opened to a proper distance from each other. Before the compositor begins to compose, he puts a thin slip of brass plate, called a rule, cut to the length of the line, and of the same height as the letter, in the composing stick, parallel with the ledge, against which the letters are intended to bear. The compositor being thus furnished with an instrument suited to hold the letters as they are arranged into words, lines, &c. he places his copy on the upper-case, just before him, and holding the stick in his left hand, his thumb being over the slider, with the right takes up the letters, spaces, &c. one by one, and places them against the rule, while he supports them with his left thumb, by pressing them against the slider, the other hand being constantly employed in setting in other letters. Having in this manner composed a line, he takes the brass rule from behind it, and places it before the letters of which it is composed, and proceeds to compose another line in the same manner. But before he removes the brass rule, he notices whether the line ends with a complete word, or with an entire syllable of a word, including the hyphen that is put to denote the division, when a word is divided into syllables. If he finds that his words exactly fill the measure, he has nothing more to do with that line, but proceeds with the next. But if he finds the measure not entirely filled at the ending of a word or syllable, he puts in more spaces, diminishing the distances between the words, until the measure is full; and this operation, which is called *justifying*, is done in order that all the lines in the composing stick may be of equal length. Much depends upon exactness in *justifying;* and great care is taken by expert compositors that the lines are neither too closely wedged into the composing stick, nor yet loose and uneven.

The spaces are pieces of metal, of various thicknesses, exactly shaped like the shanks of the letters. They are used to regulate the distances between the words.

When the composing-stick has been filled with lines, being generally in number about ten or twelve, the compositor empties it on to a thin board, called a galley, being of an oblong shape, with a ledge on two sides, and a groove, to admit a false bottom. When the compositor has filled and emptied his stick until he has composed a page, he ties it up with a piece of pack-thread, and removes it from the galley, either to the imposing stone, or to such other safe and convenient place as he may think proper. And in this manner he proceeds until he has composed as many pages as are required to make a sheet, or, in some instances, a half-sheet. He then proceeds to arrange the pages on the imposing-stone, which is a very large oblong stone, of about five or six inches in thickness. The pages are so arranged, that, when they are printed, they may be folded so as to follow each other regularly. Great care, and some ingenuity, is requisite in the imposing of a sheet or half-sheet, particularly of works in sizes less than folio or quarto. In Stower's Printer's Grammar, a very excellent and copious work on the subject of printing, are given upwards of fifty schemes of imposition, of sheets of almost every possible size.

Having laid down or disposed the pages in right order on the imposing-stone, the compositor proceeds to what is called dressing the chases. The chase is a rectangular iron frame, of different dimensions, according to the size of the paper to be printed; having two cross pieces, of the same metal, called a long and short cross, mortised at each end so as to be taken out occasionally. By the different situations of these crosses the chase is fitted for different volumes; for folios, quartos, octavos, &c. To dress the chase, a set of furniture is necessary, consisting of small slips of wood of different dimensions. The first thing to be done, is to lay the chase over the pages; after this, that part of the furniture called gutter-sticks, are placed between the respective pages. Then another part of the furniture called reglets are placed along the sides of the crosses of the chase. The reglets are of such a thickness as will let the book have proper margins after it is bound. Having dressed the inside of the pages, the compositor proceeds to do the same with their outsides, by putting side-sticks and foot-sticks to them. Thus the pages being placed at proper distances, they are all untied and fastened together by small wooden wedges, called quoins. These small wedges, being firmly driven up the sides and feet of the pages, by means of a mallet, and a piece of hard wood called a shooting-stick, all the letters are fastened together. The work in this condition is called a form, and is ready for the pressman, who lays it upon the press, for the purpose of pulling a proof. When a proof is pulled, the form or forms are rubbed over with a brush, dipped in ley, made of pearl-ash and water; they are then carefully taken off the press, and the proof and forms delivered to the compositor's further care.

As it is impossible for the most careful compositor so to compose all his sheets as that they shall not require to be carefully read and corrected before they are finally worked-off, the next thing to be done is to put the proof, along with the copy from which it has been composed into the hands of the reader or corrector, whose business is to read over the whole proof two or three times with great care and attention, marking such errata in the margin of every page as he shall observe.

The corrections are always placed against the line in which the faults are found. There are different characters used to denote different corrections: thus ‿ is put to signify that a word is divided that ought to be in one, as *pe rson* instead of *person;* a mark resembling the Greek theta ϑ is put for *dele,* to intimate that something, as a point, letter, word, &c. dashed in that line, is to be taken out. If any thing is to be inserted, the place of insertion is marked with a caret, ʌ, and the thing to be inserted written in the margin. Where a space is wanting between two words, or letters, that are intended to be separated, a parallel line must be drawn where the separation ought to be, and a mark, somewhat resembling a flat in music ♯, placed in the margin. An inverted letter or word, is noticed by making a dash under it, and a mark, nearly resembling the *dele* character reversed.

Mr. Stower observes, that marking turned letters tries a corrector's skill in knowing the true formation of them; without which it would be better to mark them in the same manner as they do wrong letters, which is done by dashing out the wrong letter, and writing the right one in the margin, unless they are very sure that they can distinguish b, d, n, o, p, q, s, u, x, z, when they are turned, from the same letters with their nick the right way. Where a space rises up between two words, it is noticed by a cross + in the margin. When any thing is transposed, it is noted thus:

1 4 3 2
You merit your mistake

for *You mistake your merit;* and in the margin is added *tr.* for transposition.—Where a new paragraph is required, a line, in the shape of a crotchet, [is made, and the same mark placed in the margin; also where a paragraph ought not to have been made, a line is drawn from the broken-off matter to the next paragraph; and in the margin is written *No break.* If

Italic letters are to be changed for Roman, or *vice versa*, a line is drawn, thus ——, under the letters, and *Rom.* or *Ital.* is written in the margin. Where words have been struck out that are afterwards approved of, dots are marked under such words, and in the margin is written the word *stet*. Where the punctuation is required to be altered, the semicolon, colon, and period, are encircled in the margin. The comma and other points are marked as letters and words, viz. with a long oblique line immediately before them; which line is intended to separate the different corrections from each other, that occur in the same line. When letters of a different fount or size are improperly introduced into the page, they are noticed by a small dash drawn through them, and the letters *w f.* in the margin. There are some other marks used in correcting; such as √ for superior; where it is necessary to insert the apostrophe, the star, or other reference marks, and superior letters: *Cap.* for capital, *L. C.* for lower case, &c.

After a proof sheet has been read, and the errata thus noticed by the corrector, or, as he is more usually called, the reader, it is again put into the hands of the compositor, who proceeds to correct in the metal what has been marked for correction in the proof. He then unlocks the form on the imposing stone, by loosening the quoins or wedges which bound the letters together. He then casts his eye over one page of the proof, noticing what letters, &c. are required. Having gathered as many corrections, from the cases, between the thumb and fore-finger of his left hand, as he can conveniently hold, and an assortment of spaces, on a piece of paper, or in a small square box with partitions in it, he takes a sharp-pointed steel bodkin in his right hand.—Placing the point of the bodkin at one end of the line, and the fore-finger of his left hand against the other, he raises the whole line sufficiently high to afford him a clear view of the spacing. He then changes the faulty letters or words, and alters his spaces before he drops the line.

The first proof being corrected, another is pulled, to be again put into the hands of the reader, or sent to the author for examination. This proof being read and corrected as before, a *revise* is pulled, to see whether all the errors marked in the last proof are properly corrected. When the sheet is supposed to be correct, the forms are given to the pressman, whose business it is to work them off when they are so prepared and corrected; in doing which four things are required: paper, ink, balls, and a press. The paper is prepared for use by being dipped, a few sheets at a time, in water, and afterwards laid in a heap over each other; to make the water penetrate equally into every sheet, a thick deal board is laid upon the heap, on which is placed heavy weights, according to the size of the heap. The reason why the paper is to be wetted before it is in a fit state to be printed upon, is, that it may be made sufficiently soft to adhere closely to the surface of the letter, and take up a proper quantity of ink, that it may receive a fair and clear impression. It is also necessary to wet the paper, lest its stiff and harsh nature, when dry, should injure the face of the letters.

The ink used by printers has already been treated of, in the article Ink, which see. The manufacture of good common ink seems to be as yet but very imperfectly understood. That used in fine printing has been more attended to, and many of our best printers are now able to produce impressions in a great degree free from that offensive brown cast, which is to be observed in many books printed with what is called common ink.

The balls used in laying the ink on the forms, are a kind of wooden funnels, with handles, the cavities of which are stuffed with wool or hair, and covered over with a pelt, prepared for the purpose. One skin generally makes two proper sized balls. When the skin has been sufficiently soaked in urine, which will take about fourteen or fifteen hours, it is taken out and curried, by putting it round an iron, called a currying iron, or round some upright post; the pressman taking hold of each end of it, and drawing it with as much force as possible backwards and forwards, till it is rendered soft and pliable. He then cuts the skin exactly in two, puts them under his feet, and continues to tread them till they are so dry as to stick to the foot in treading. The skin is then laid on a board or flat stone, and stretched as much as possible by rubbing the ball-stock upon it. It is then nailed upon the ball-stock in plaits, about an inch wide, thrusting in as much wool as the cavity of the stock and the skin will conveniently hold. If, however, too much wool were to be put in, it would render the balls hard and difficult to work with. If too little wool is in the balls, they soon flap and wrap over into wrinkles, so as to prevent an equal distribution of the ink on their surface. When the balls are thus knocked up, as it is termed, they are dipped in urine, and scraped with a blunt knife, until they are perfectly clean; they are then dried with a clean sheet of stout paper, and patted with the hand until no moisture remains on the surface. The balls, when they are completed, have much the shape and appearance of a very large mallet, used by stone masons, except that their surface is much broader and rounder.

The press is a curious and complex machine: it consists of two upright beams, called cheeks; they are generally about six feet one inch long, eight inches and a half broad, and five inches thick, with a tenon at each end. The tenon at the upper end of the cheek is cut across the breadth, and enters the cap within half an inch of the top. The cap is a piece of solid timber, three feet long, eleven inches wide, and four inches thick. The lower tenon of the cheek enters the feet, which is a square wooden frame made very thick and strong. The head, which is moveable, is sustained by two iron bolts that pass through the cap. The spindle is an upright piece of iron, pointed with steel, having a male screw, which goes into the female one in the head about four inches. This spindle is so contrived, that when the pressman pulls a lever, which is attached to it, the pointed end of it works in a steel pan or cup, supplied with oil, which is fixed to an iron plate, let into the top of a broad thick piece of mahogany, with a perfectly plane surface, called the platten. This platten is made to rise and fall as the pressman pulls or lets go the lever or bar. When the platten falls, it presses upon a blanket, by which the paper is covered when it lies upon the form, from which the impression is intended to be taken. The form is laid upon a broad flat stone, or thick marble slab, which is let into a wooden frame, called the coffin, and which is made to move backwards or forwards, by the turning of a wince, or rounce. At the end of the coffin are three frames, two of which are called tympans, and the remaining one a frisket.

The tympans are square, and are made of three slips of very thin wood, and at the top a piece of iron, still thinner; that called the outer tympan is fastened with hinges to the coffin; they are both covered with parchment, and between the two are placed blankets, which are necessary to take off the impression of the letters upon the paper. The frisket is a square frame of thin iron, fastened with hinges to the tympan; it is covered with paper, cut in the necessary places, that the sheet, which is put between the frisket and the outer tympan, may receive the ink, and that nothing may hurt the margins. To regulate the margins, a sheet of paper is fastened upon this tympan, which is called the tympan sheet, and which ought to be changed whenever it becomes wet with the paper to be printed upon. On each side is fixed an iron point, which makes two holes in the sheet, which is to be placed on the same points when the impression is to be made on the other side. In preparing the press for working, or, as it is called by pressmen, making ready a form, great care and attention is requisite, that the printed sheets may be in proper register, *i. e.* that the lines on one side may exactly fall upon the backs of the other. That the impression may be equable, the parchment which covers the outer tympan is wetted till it is very soft; the blankets are then put in, and secured from slipping by the outer tympan. When the form is made ready, and every thing is prepared for working, one man beats the letters with the ink balls, another places a sheet of paper on the tympan sheet, turns down the frisket upon it, to keep the paper clean and prevent its slipping, then bringing the tympan upon the form, and turning the rounce, by which the carriage, holding the coffin, stone, and form, is moved, he brings the form, with the stone, &c. under the platten; pulls with the bar, by which the platten presses the blankets and paper close upon the letter, whereby half the form is printed, then easing the bar, he draws the form still forward, gives a second pull, and letting go the bar, turns back the carriage, &c. raises the tympans and frisket, takes out the printed sheet, and lays on a fresh one; and this is repeated till he has taken off the impression upon the full number of sheets of which the edition is to consist. One side of every sheet being thus printed, the form for the other side is laid on the press, and worked off in the same manner.

Mr. Stower very justly remarks, "that this, the common press, is constructed on the true principles of mechanism." It does not, however, he allows, produce an adequate impression from heavy works in small letter, without great labour and attention. It was therefore a great acquisition to gain an accession of power, with, at the same time, a diminution of labour.

This valuable acquisition in the art of printing owes its invention to that enlightened and patriotic statesman, the present Earl Stanhope. The iron press, invented by this nobleman, is capable of ten times the force of the common press, with, perhaps, a tenth of the labour. In working upon this press, nothing is left to the judgment of the pressman but the beating.

To describe the construction of the Stanhope press would not only much exceed our limits, but would require a considerable number of plates, as its internal construction cannot be sufficiently delineated by any general view of it. It is, however, a most compact and curious machine, and is an invention altogether worthy of the genius of the nobleman who first constructed it. A very minute account of the nature and construction of every part of this press is given in Mr. Stower's Grammar.

The Stanhopian principle has been applied in the construction of the common press, but we understand not with that success which was at first expected. The presses, however, so formed, and first made by Mr. Baker, are superior to the common press, and produce a more clear and strong impression, especially from light forms; though the sharpness, as well as smoothness of impression, produced by the Stanhope press, from forms of pearl and nonpareil letter, is not to be expected from the common presses constructed on the Stanhopian principle. See Engraving, and Calico Printing.

In an article of this nature, it would argue a want of taste or discernment to omit the mention of Mr. M'Creery's very elegant and beautiful poem, entitled "The Press," published as a specimen of typography. It is indeed a beautiful work, and does great credit both to the genius of the author as a poet, and to his care and talents as a printer. It is published by Messrs. Cadell and Davies, in the Strand.

Printing, *stereotype*. Perhaps it would not have been improper to have treated of stereotype printing even before that of common printing: for the first ideas of this art were certainly anterior to those of printing by moveable types.

The method of printing linen and paper for hangings has been known in the east from time immemorial. Printing from wooden blocks, by the Jesuits, has been practised above sixteen hundred years in China. According to this plan, when an author chuses to print his work, he has it fairly transcribed upon a thin and transparent paper. Each leaf is then reversed and fastened upon a smooth block of hard wood, upon which the engraver cuts the characters, in relief. There must be, therefore, a separate block for every page.

At the end of the fourteenth and beginning of the fifteenth century, the Italians, Germans, Flemings, and Dutch, began at the same time to engrave on wood and copper, but the previous advances had been gradual. The inscriptions, in relief, upon monuments and altars, in the cloisters and over church porches, served as models for block-printing. The letters upon painted windows greatly resemble those in the books of images. The invention of cards was an intermediate step. Bullet, in his "Recherches Historiques sur les Cartes à jouer," has proved from old chronicles, in particular from that of Petit-Jean de Sanitre, from edicts civil and ecclesiastical, and from the figures of the cards, that they were invented towards Charles the Fifth's reign, about the year 1376. By the shape of the crowns, and the sceptres with the *fleur de lis*, he infers that the French invented them. They soon were introduced into Spain, Italy, Germany, and England. The names of the suits seem rather to imply a Spanish or Italian origin. At first the cards were painted; about the year 1400 a method was devised of printing them from blocks. To this we may directly trace the art of printing. The books of images form the next step. These also were printed from wooden blocks; one side of the leaf only is impressed, and the corresponding text is placed below, beside, or proceeding from the mouth of the figure. Of these scarce books, M. Lambinet mentions seven: 1. Figuræ typicæ veteris atque antitypicæ novi testamenti. This is the work which in Germany is called the Bible of the Poor, because it was originally designed as an abridgment of the Bible for those who could not purchase the whole scriptures in manuscript, and who probably could not read. There is one copy of this work in the Bodleian Library, and another at Christ's College, Cambridge. 2. Historia S. Joannis Evangelistæ, ejusque visiones apocalypticæ. 3. Historia seu Providentia Virginis Mariæ, ex cautico cauticorum. 4. Ars moriendi. 5. Ars memorandi notabilis per figuras Evangilistarum. 6. Donatus, seu grammatica brevis in usum scholarum conscripta. It is not easy to conceive how this can be classed among the books of images. 7. Speculum humanæ salvationis. There is said to be an English translation of this work. Two other Books of images, the Tewrdanck, and the Triumpf-wagen, are posterior to the common use of printing. It is clear, therefore, from the cotton and silk printing of the Indians, the Chinese block-printing, and these books of images, and perhaps, also, from the bardic mode of writing, who cut their poems upon bars of wood, arranged like a grid-iron, and which they called carving a book, that the idea of stereotype printing is by no means of modern origin. That it was prior to the art of printing with moveable types there can be no doubt; since this latter mode of printing was first suggested by the Catholicon, which was printed with wooden tablets, in a series, and composed in forms. This mode of printing, except in China, where it is still practised, was laid aside soon after the invention of the common letter-press printing.

The history of the invention of modern stereotype is, like that of common printing, involved in some obscurity as to the name of the person, to whom justly belongs the honour of an invention so useful and curious. Mr. Andrew Tilloch, the worthy and ingenious editor of the Philosophical Magazine, has given the following extract, translated from Niewe Algemein Konst en Letter Bode, 1798, No. 232, which deserves particularly to be noticed. "Above a hundred years ago the Dutch were in possession of the art of printing with solid or fixed types, which in every respect was superior to that of Didot's stereotype. It may, however, be readily comprehended, that their letters were not cut in so elegant a manner, especially when we reflect on the progress which typography has made since that period. Samuel and J. Leuchtmans, booksellers at Leyden, have still in their possession the forms of a quarto Bible, which were constructed in this ingenious manner. Many thousand impressions were thrown off, which are in every body's hands, and the letters are still good.

"The inventor of this useful art was J. Vander Mey, father of the well-known painter of that name. About the end of the sixteenth century he resided at Leyden. With the assistance of Muller, the clergyman of the German congregation there, who carefully superintended the correction, he prepared and cast the plates for the above-mentioned quarto Bible. This Bible he published also in folio, with large margins, ornamented with figures; the forms of which are still in the hands of Elwe, bookseller at Amsterdam: also an English New Testament, and Schaaf's Syriac Dictionary; the forms of which were melted down: likewise a small Greek Testament, in 18mo.

"As far as is known, Vander Mey printed nothing else in this manner; and the art of preparing solid blocks was lost at his death, or at least was not afterwards employed." The Dutch editor supposes that the reason why Vander Mey's invention was dropped was, that, "though this process in itself is very advantageous, it is far more expensive than the usual method of printing, except in those cases where such works are to be printed as are indispensably necessary, and of standing worth." Mr. Tilloch, however, is of a directly contrary opinion.

In the year 1781 was printed, by and for J. Nichols, London, a very interesting pamphlet, entitled Biographical Memoirs of William Ged; including a particular account of his progress in the art of block-printing. The first part of the pamphlet was printed from a MS., dictated by Ged some time before his death; the second part was written by his daughter, for whose benefit the profits of the publication were intended; the third is a copy of proposals that had been published by Mr. Ged's son, in 1751, for reviving his father's art, and to the whole is added Mr. Mores's Narrative of Block Printing

It apears from this publication, that, in the year 1725, Mr. Ged began to prosecute plate-printing. In 1727, he entered into a contract with a person who had a little capital, but who, on conversing with some printer, got so intimidated, that, at the end of two years, he had laid out only twenty-two pounds. In 1729, he entered into a new contract with a Mr Fenner, Thomas James, a type-founder, and John James, the architect. Some time after, a privilege was obtained from the University of Cambridge, to print bibles and prayer-books; but it appears, that one of his partners was actually averse to the success of the plan, and engaged such people for the work as he thought most likely to spoil it. A straggling workman, who had wrought with them, informed Mr. Mores, that both bibles and common prayer-books had been printed; but that the compositors, when they corrected one fault, made purposely half a dozen more; and the pressmen, when the masters were absent, battered the letter in aid of the compositors. In consequence of these base proceedings, the books were suppressed by authority, and the plates sent to the King's printing-house, and from thence to Mr. Caslon's foundry. "After much ill usage," says Mr. Tilloch, "Ged, who appears to have been a person of great honesty and simplicity, returned to Edinburgh. His friends were anxious that a specimen of his art should be published, which was at last done by subscription. His son, James Ged, who had been apprenticed to a printer, with the consent of his master, set up the forms in the night-time, when the other compositors were gone, for his father to cast the plates from; by which means Sallust was finished in 1736." Mr. Tilloch has not only a copy of this work, but also "the plate of one of the pages." Besides Sallust, Mr. Tilloch has another work, printed some years after, from plates of Mr. Ged's manufacture. The book is The Life of God in the Soul of Man, printed on a writing pot, 12mo,. and with the following imprint: "Newcastle, printed and sold by John White, from plates made by William Ged, Goldsmith in Edinburgh, 1742."

Fifty years after the invention of plate-printing by Mr. Ged, Mr. Tilloch made a similar discovery, without having, at the time, any knowledge of Ged's invention. In perfecting the invention, Mr. Tilloch had the assistance and joint labour of Mr. Foulis, printer to the University of Glasgow. After great labour, and many experiments, these gentlemen "overcame every difficulty, and were able to produce plates, the impressions from which could not be distinguished from those taken from the types from which they were cast." "Though we had reason to fear," says Mr. Tilloch, "from what we [afterwards] found Ged had met with, that our efforts would experience a similar opposition, from prejudice and ignorance, we persevered in our object for a considerable time, and at last resolved to take out patents for England and Scotland, to secure ourselves, for the usual term, the benefits of our invention; for the discovery was still as much our own as if nothing similar had been practised before. Ged's knowledge of the art having died with his son, whose proposals for reviving it, published in 1751, not having been followed with success, he went to Jamaica, where he died. The patents were accordingly obtained; nay, they are even expired; and yet we hear people, who only began their stereotype labours yesterday, taking to themselves the merit of being the first inventors!" "Owing to circumstances of a private nature," not, however, connected with the stereotype art, the business was laid aside for a time; and Mr. Tilloch, having removed from Glasgow to London, the concern was dropped altogether; not, however, till several small volumes had been stereotyped and printed, under the direction of Messrs. Tilloch and Foulis.

Some time elapsed after this, when Didot, the celebrated French printer, applied the stereotype art to logarithmic tables, and afterwards to several of the Latin classics, and to various French publications. It has been said, by the French, that the merit of the invention properly belongs to Didot; but by what we have already laid before our readers, it is evident this cannot have been the case.

Some years after Mr. Tilloch had given up the prosecution of this art, Mr. Wilson, a printer of respectability in London, engaged with Earl Stanhope for the purpose of bringing it to perfection, and eventually to establish it in this country. His Lordship, it is said, received his instructions from Mr. Tilloch, and had afterwards the personal attendance of Mr. Foulis, for many months, at his seat at Chevening, where his Lordship was initiated in the practical part of the operation.

After two years application, Mr. Wilson announced to the public, that the genius and perseverance of Earl Stanhope, whom he styles "the Right Honourable Inventor," had overcome every difficulty; and that, accordingly, the various processes of the stereotype art had been so admirably contrived, combining the most beautiful simplicity with the most desirable economy, the *ne plus ultra* of perfection with that of cheapness, as to yield the best encouragement to the public for looking forward to the happy period, when an application of this valuable art to the manufacture of books would be the means of reducing the prices of all standard works at least thirty, and in many cases fifty, per cent.

In January, 1804, the stereotype art, (with the approbation of Lord Stanhope,) was offered by Mr. Wilson to the University of Cambridge, for their adoption and use in the printing of bibles, testaments, and prayer-books, upon certain terms and conditions highly advantageous to Mr. Wilson; for, with his Lordship's characteristic generosity, Earl Stanhope has uniformly declined to accept even the reimbursement of any part of the monies by him expended in the prosecution of this ingenious art. Some differences, however, arising between Mr. Wilson and the Syndics of the University, the contract was dissolved; and Mr. Wilson published his case in a stereotyped pamphlet, entitled "Arbitration between the University of Cambridge and Andrew Wilson."

That Mr. Wilson might make out his case more clearly, he has given a "Computation of the nonpareil bible,—showing the expenditure by both methods of printing, upon composition, reading, wear of type, and charges of composition; and upon paper, press-work, charges on press-work, and insurance." This computation is, of course, much in favour of the stereotype art; amounting, indeed, to nearly one half, or fifty per cent. saved by the new method. In addition to the saving attributed to stereotype printing, it is said that, as every page of the most extensive work has a separate plate, all the pages of the said work must be equally new and beautiful: which cannot be the case with single types, which are distributed and recomposed several times over in the course of a large work. The stereotype art also, it is said, possesses a security against error. This advantage is much insisted on by the friends of the art; but with what consistency, we confess, does not immediately appear: for, strange as it may seem, after all the care that we may naturally suppose was taken to render Mr. Wilson's pamphlet a model of stereotype perfection, it is still not without its errata. The pamphlet consists of about forty-four pages; and on the forty-first page, in a line containing only two monosyllables, there is an error: (*viz.*) *viod* for *void.* There are one or two other trifling inaccuracies in the pamphlet, which afford demonstrative proof that

> "Whoever thinks a faultless piece to see,
> Thinks what ne'er was, nor is, nor e'er shall be."

Indeed, as every work hitherto stereotyped clearly manifests, it is not possible that first editions of works should be more correct when stereotyped than when printed in the common way; and it ought not to be forgotten, that an error stereotyped in the first edition, is perpetuated through every subsequent edition. It is said, that stereotype plates admit of alteration: this, however, if carried to any extent, must be attended with a very considerable expense.

In short, we think that the stereotype art has much the advantage of common printing in standard books of very extensive circulation and constant demand, and wherein no alteration, as to plan or size, is allowed ever to take place; but for the common and most general purposes of the art of printing, the method by moveable types is incomparably the best.

The precise method adapted in stereotype printing being hitherto a secret known only to a few, our readers will perceive that we can only, as we have done, give a general history of the invention. The mode of stereotype printing is, however, generally, first to set up a page, for instance, in the common way, with moveable types; and when it is rendered as correct as the nature of the thing will admit, a cast is taken from it, and in this cast the metal for the stereotype plate is poured; and so for every page or sheet of a work intended to be stereotyped. When the plates are prepared, they are printed off at the Stanhope press; and it must be confessed, that the works hitherto published, that have been printed in this manner, are very beautiful, and to the full as correct as the best editions of books printed according to the common method. But as it does not appear that any actual saving can be obtained in the manufacture of books in general, the London publishers have not yet thought it worth their while to patronize and encourage this curious invention.

PRISM, in geometry, an oblong solid, contained under more than four planes, whose bases are equal, parallel, and alike situated. The prism is generated by the motion of a rectilinear figure, descending always parallel to itself, along a right line. If the describent be a triangle, the body is said to be a triangular prism; if square, a quadrangular one, &c.

From the genesis of the prism, it is evident it has two equal and opposite bases, and is terminated by as many parallelograms as the base consists of sides: and that all the sections of a prism parallel to its base are equal. Every triangular prism may be divided into three equal pyramids.

To measure the surface of any prism, find the area of each side, whether a triangle, parallelogram, or other rectilinear figure, as directed under these articles, and the sum of all these, taken together, is the whole superficies of the prism. The solid content of a given prism may be found thus: let the area of the base of the prism be measured, as directed under the article MENSURATION; and let this area be multiplied by the height of the prism, and the product will give the solid content of the prism.

PRISM, in dioptrics, a triangular glass-prism, much used in experiments about the nature of light and colours. See OPTICS.

PRISTIS, the *saw-fish*, in natural history, a genus of fishes of the order Cartilaginei. It may be with more propriety considered as a species of the squalus, or shark, and as such is regarded by Shaw. The saw-fish inhabits the Mediterranean, and was known to the Greeks and Romans by the name of pristis. It grows to the length of sixteen feet, and the general length of the snout is about one third of that of the whole fish. There are three varieties, in which the difference is confined to the size and the snout.

PRIVATEERS, in maritime affairs, a kind of private ships of war, fitted out by private persons at their own expense; who have leave granted them to keep what they can take from the enemy, allowing the Admiral his share.

PRIVY *council*, is the principal council belonging to the King, and is generally called, by way of eminence, the council. Privy Counsellors are made by the King's nomination, without either patent or grant; and, on taking the necessary oaths, they become immediately Privy Counsellors, during the life of the King that chooses them, but subject to removal at his discretion. No inconvenience now arises from the extension of the number of the Privy Council, as those only attend who are especially summoned for that particular occasion.

PRIZE, in maritime affairs, a vessel taken at sea from the enemies of a state, or from pirates; and that either by a man-of-war, a privateer, &c. having a commission for that purpose. Vessels are looked on as prize, if they fight under any other standard than that of the state from which they have their commission; if they have no charter-party, invoice, or bill of lading a-board; if loaded with effects belonging to the King's enemies, or with contraband goods. Those of the King's subjects recovered from the enemy, after remaining twenty-four hours in their hands, are deemed lawful prize. Vessels that refuse to strike may be constrained; and if they make resistance and fight, become lawful prize, if taken. If ships of war, the prizes are to be divided among the officers, seamen, &c. as his Majesty shall appoint by proclamation; but among privateers, the division is according to the agreement between the owners. By statute 13 George II, c. 4. judges and officers, failing of their duty, in respect to the condemnation of prizes, forfeit 500*l.* with full costs of suits; one moiety to the King, and the other to the informer.

PROBABILITY is nothing but the appearance of the agreement or disagreement of two ideas, by the intervention of proofs whose connection is not constant and immutable, or is not perceived to be so; but is, or appears for the most part to be so; and is enough to induce the mind to judge the proposition true or false, rather than the contrary.

Of probability there are degrees, from the neighbourhood of certainty and demonstration, quite down to improbability and unlikeness, even to the confines of impossibility; and also degrees of assent, from certain knowledge, and, what is next to it, full assurance and confidence, quite down to conjecture, doubt, distrust, and disbelief. That proposition then is probable, for which there are arguments, or proof, to make it pass or be received for true. Probability being then to supply the defect of our knowledge, is always conversant about a thing whereof we have no certainty, but only some inducements to receive it for true. The grounds of it are, in short, these two following: First, the conformity of any thing with our own knowledge, experience, or observation. Secondly, the testimony of others vouching their observation and experience. In the testimony of others, is to be considered, 1. the number; 2 the integrity; 3. the skill of the witnesses; 4. the design of the author, if it be a testimony cited out of a book; 5. the consistency of the parts and circumstances of the relation; 6. contrary testimonies. The mind, before it rationally assents or dissents to any probable proposition, ought to examine all the grounds of probability, and see how they make, more or less, for or against it; and, upon a due balancing the whole, reject or receive it, with a more or less firm assent, according to the preponderance of the greater grounds of probability on one side or the other.

PROBABILITY *of an event*, in the Doctrine of Chances, is the ratio of the number of chances by which the event may happen, to the number by which it may both happen and fail. So that, if there be constituted a fraction, of which the numerator is the number of chances for the events happening, and the denominator the number for both happening and failing, that fraction will properly express the value of the probability of the event's happening. Thus, if an event have 3 chances for happening, and 2 for failing, the sum of which being 5, the fraction $\frac{3}{5}$ will fitly represent the probability of its happening, and may be taken to be the measure of it. The same thing may be said of the probability of failing, which will likewise be measured by a fraction, whose numerator is the number of chances by which it may fail, and its denominator the whole number of chances both for its happening and failing: so the probability of the failing of the above event, which has 2 chances to fail, and 3 to happen, will be expressed or measured by the fraction $\frac{2}{5}$.

Hence, if there be added together the fractions which express the probability for both happening and failing, their sum will always be equal to unity, or 1; since the sum of their numerators will be equal to their common denominator. And since it is a certainty that an event will either happen or fail, it follows that a certainty, which may be considered as an infinitely great degree of probability, is fitly represented by unity. See Chances; Life, *duration of.*

PROBATE *of wills*, is the exhibiting and proving wills and testaments before the ecclesiastical judges, delegated by the bishop, who is ordinary of the place where the party dies.

By the stamp acts, a very heavy duty is now payable upon these instruments, and a man can entitle himself to personal property only by means of a probate; that is, by having proved the will.

PROBLEM, in logic, a proposition that neither appears absolutely true or false; and, consequently, may be asserted either in the affirmative or negative. A logical or dialectical problem, according to the school-men, consists of two parts; a subject, about which the doubt is raised; and a predicate, or attribute, which is the thing doubted, whether it be true of the subject or not. Problems may be divided into physical, ethical, and metaphysical; physical, when it is doubted whether such and such properties belong to certain natural bodies; ethical, when the doubt is, whether or not it be proper to do or omit certain actions; and metaphysical, when the doubt relates to spirits, &c.

Problem, in geometry, is a proposition wherein some operation or construction is required; as, to divide a line or angle, erect or let fall perpendiculars, &c. A problem is said to consist of three parts; the proposition, which expresses what is to be done; the solution, wherein the several steps whereby the thing required is to be effected are rehearsed in order; and, lastly, the demonstration, wherein is shown, that by doing the several things prescribed in the solution, the thing required is obtained.

Problem, in algebra, is a question or proposition which requires some unknown truth to be investigated, and the truth of the discovery demonstrated. So that a problem is to find a theorem.

Problem, *Kepler's*, in astronomy, is the determining a planet's place from the time; so called from Kepler, who first proposed it. It was this, to find the position of a right line, which passing through one of the foci of an ellipsis, shall cut off an area described by its motion, which shall be in any given proportion to the whole area of the ellipsis.

The proposer knew no way of solving the problem but by an indirect method; but Sir Isaac Newton, Dr. Keill, &c. have since solved it directly and geometrically, several ways.

Problem, *Deliacal*, or a problem for finding two mean proportionals between two given lines, in geometry, is the doubling of the cube; it was so called from the people of Delos, who, upon consulting the oracle for a remedy against a plague, were answered, that the plague should cease when Apollo's altar, which was in form of a cube, should be doubled. See Cube.

PROCEDENDO, is a writ which lies where a cause is removed out of an inferior to a superior court.

PROCELLARIA, the *petrel*, in natural history, a genus of birds of the order Anseres. Generic character: bill strait, but hooked at the end; nostrils generally contained in one tube, at the base of the bill; legs naked a little above the knee; back toe little more than a spur. There are twenty-three species, of which the following are the principal.

P. gigantea, or the giant petrel, is more than three feet long, and about seven wide. These birds are often seen sailing just above the water without moving their wings for a long time together, and, being particularly alert on the approach of storms, often fill the mariner with apprehension and alarm. They abound most in southern latitudes, and though their principal food is fish, devour also the putrid carcases of seals and whales.

P. capensis, or the pintado petrel, abounds about the coasts of the Cape of Good Hope. These birds are about the size of the kittiwake gull, and are often observed in such numbers that many hundreds have been taken in one night. They are often taken with a rod and line by a hook baited with lard. They frequently discharge oil from their nostrils on those who hold them, spurting it in their faces with great violence.

P. glacialis, or the fulmar petrel, weighs nearly a pound and a half, and is found in the northern coasts of this island, and thence even beyond Iceland and Greenland, where the natives use it for food, though its flesh is highly offensive to those not used to it. The fat is burnt in their lamps. These birds subsist chiefly on fish, but often banquet on the carcases of whales, particularly the fat parts, which they afterwards eject from their stomachs into the mouths of their young. They often spurt it in the faces of their enemies, and exhibit indeed no other mode of resistance. They are stated to be so amazingly fat, that, on being passed through the hands with great compression, the fat flows off like oil.

P. puffinus, or the shear water petrel, is smaller than the last. These birds are found in vast numbers in the Orkneys, where they are highly valued for their feathers as well as flesh. They are in some places salted and barrelled, especially in the Isle of Man. In Denmark they sometimes reside in rabbit burrows. See Aves, Plate XII. fig. 5.

P. pelagica, or the stormy petrel, is of the size of a swallow, and rarely seen but at sea; and in tempestuous weather, numbers are observed frequently following, as if for shelter, in the wakes of vessels. They dive sometimes for half an hour together, and live principally upon fish, but will eat a variety of offal thrown from ships. In the Ferro Islands they are so astonishingly fat, that the natives are stated to use them as candles after drawing a wick through their bodies. These are the birds so well known to seamen by the name of "Mother Carey's Chickens;" they are the smallest species of the genus, and are common on the sea coast of the United States. See Aves, Plate XII. fig. 6.

PROCESS, in law, is the manner of proceeding in every cause, being the writs and precepts that proceed, or go forth upon the original upon every action, being either original or judicial.

PROCKIA, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Rosaceæ, Jussieu. Essential character: calyx three-leaved, besides two-leaflets at the base; corolla none; berry five cornered, many seeded. There is but one species, *viz.* P. crucis.

PROCYON, in astronomy, a fixed star of the second magnitude in the constellation called canis minor.

PRODUCING, in geometry, signifies the drawing out a line further, till it have any assigned length.

PRODUCT, in arithmetic and geometry, the factum of two or more numbers, or lines, &c. into one another: thus $5 \times 4 = 20$, the product required. In lines it is always (and in numbers sometimes) called the rectangle between the two lines, or numbers, multiplied by one another.

PROFILE, in architecture, the draught of a building, fortification, &c. wherein are expressed the several heights, widths, and thicknesses, such as they would appear, were the building cut down perpendicularly from the roof to the foundation.

Profile also denotes the outline of a figure, building, member of architecture, &c. Hence profiling sometimes denotes designing or describing the member with a rule, compass, &c.

Profile, in sculpture and painting, denotes a head, portrait, &c. when represented sideways, or in a side view. On almost all medals, faces are represented in profile.

PROGNOSTICS, among physicians, signifies a judgment concerning the event of a disease, as whether it shall end in life or death, be short or long, mild or malignant, &c.

PROGRESSION, in mathematics, is either arithmetical or geometrical. Continued arithmetic proportion, where the terms do increase and decrease by equal differences, is called arithmetic progression.

thus $\left\{\begin{matrix} a, a + b\ a + 2b\ a + 3b, \text{\&c. increasing} \\ a, a - b\ a - 2b\ a - 3b, \text{\&c. decreasing} \end{matrix}\right\}$ by the difference d.

In numbers $\left\{\begin{matrix} 2, & 4, & 6, & 8, & 10, \text{\&c. increasing} \\ 10, & 8, & 6, & 4, & 2, \text{\&c. decreasing} \end{matrix}\right\}$ by the difference 2.

But since this progression is only a compound of two series, *viz.*

of $\left\{\begin{matrix} \text{Equals} & a, & a, & a, & a, & a, \\ \text{Arith. proportionals} & 0, & \pm b, & \pm 2b, & \pm 3b, & \pm 4b, \end{matrix}\right\}$ &c.

If 1, 3, 5, 7, 9, &c. a, $a + b$, $a + 2b$, $a + 3b$, &c. a, $a - b$, $a - 2b$, $a - 3b$, &c, are in arithmetical progression. Hence it is manifest, that if a be the first term, and $a + b$ the second, $a + 2b$ is the third, $a + 3b$ the fourth, &c. and $a + \overline{n-1}.b$ the n^{th} or last term.

"The sum of a series of quantities in arithmetical progression is found by multiplying the sum of the first and last terms by half the number of terms."

Let a be the first term, b the common difference, n the number of terms, and s the sum of the series: Then,

$$\underline{a\ + \overline{a+b}\ + \overline{a+2b} \ldots \overline{a + \overline{n-1}.b} = s}, \text{ or,}$$

$$\underline{\overline{a+\overline{n-1}.b} + \overline{a+\overline{n-2}.b} + \overline{a+\overline{n-3}.b} \ldots + a = s}.$$

Sum, $\overline{2a+\overline{n-1}.b} + \overline{2a+\overline{n-1}.b} + \overline{2a+\overline{n-1}.b}$ + &c. to n terms, $= 2s$,

$$\text{or, } \overline{2a + \overline{n-1}.b} \times n = 2s.$$

$$\text{and } s = \overline{2a + \overline{n-1}.b} \times \frac{n}{2}.$$

Any three of the quantities s, a, n, b, being given, the fourth may be found from the equation $s = \overline{2a + \overline{n-1}.b} \times \frac{n}{2}$.

Ex. 1. To find the sum of 18 terms of the series 1, 3, 5, 7, &c.

Here $a = 1$, $b = 2$, $n = 18$; therefore, $s = \overline{2 + 34} \times 9 = 324$.

Ex. 2. Required the sum of 9 terms of the series 11, 9, 7, 5, &c.

In this case $a = 11$, $b = -2$, $n = 9$; therefore $s = \overline{22 - 16} \times \frac{9}{2} = 6 \times \frac{9}{2} = 27$.

Ex. If the first term of an arithmetical progression be 14, and the sum of 8 terms be 28, what is the common difference?

$$\text{Since } \overline{2a + \overline{n-1}.b} \times \frac{n}{2} = s$$

$$2a + \overline{n-1}.b \times \frac{2s}{n}$$

$$\overline{n-1}.b = \frac{2s}{n} 2 - a = \frac{2s - 2an}{n};$$

therefore, $b = \frac{2s - 2an}{n.\overline{n-1}}$. In the case proposed, $s = 28$, $a = 14$, $n = 8$, therefore, $b = \frac{56 - 224}{8 \times 7} = \frac{7 - 28}{7} = -3$.

Hence, the series is 14, 11, 8, 5, &c.

Progression *geometrical*. Quantities are said to be in geometrical progression, or continual proportion, when the first is to the second, as the second to the third, and as the third to the fourth, &c. that is, when every succeeding term is a certain multiple, or part of the preceding term. If a be the first term, and ar the second, the series will be a, ar, ar^2, ar^3, ar^4, &c. For $a : ar :: ar : ar^2 :: ar^2 : ar^3$, &c.

The constant multiplier is called the common ratio, and it may be found by dividing the second term by the first.

"If quantities be in geometrical progression, their differences are in geometrical progression."

Let a, ar, ar^2 ar^3, ar^4, &c. be the quantities; their differences, $ar - a$, $ar^2 - ar$, $ar^3 - ar^2 - ar^4 - ar^3$, &c. form a geometrical progression, whose first term is $ar - a$, and common ratio r.

"Quantities in geometrical progression are proportional to their differences."

For $a : ar :: ar - a : ar^2 - ar :: ar^2 - ar : ar^3 - ar^2$, &c.

"In any geometrical progression, the first term is to the third, as the square of the first to the square of the second."

Let a, ar, ar^2, &c. be the progression; then $a : ar^2 :: a^2 : a^2r^2$.

Hence it appears, that the duplicate ratio of two quantities (Euc. Def. 10. 5.), is the ratio of their squares.

In the same manner it may be shown, that the first term is to the $\overline{n+1}^{th}$ term, as the first raised to the n^{th} power, to the second raised to the same power.

"If any terms be taken at equal intervals in a geometrical progression, they will be in geometrical progression."

Let a, $ar \ldots ar^n \ldots ar^{2n} \ldots ar^{3n} \ldots$ &c. be the progression, then a, ar^n, ar^{2n}, ar^{3n}, &c. are at the interval of n terms, and form a geometrical progression, whose common ratio is r^n.

"If the two extremes, and the number of terms in a geometrical progression be given, the means may be found."

Let a and b be the extremes, n the number of terms, and r the common ratio; then the progression is a, ar^2, ar^3........ ar^{n-1}; and since b is the last term, $ar^{n-1} = b$, and $r^{n-1} = \frac{b}{a}$; therefore $r = \overline{\frac{b}{a}}^{\frac{1}{n-1}}$; and r being thus known, the terms of the progression ar, ar^2, ar^3, &c. are known.

"To find the sum of a series of quantities in geometrial progression, subtract the first term from the product of the last term and common ratio, and divide the remainder by the difference between the common ratio and unity."

Let a be the first term, r the common ratio, n the number of terms, y the last term, and s the sum of the series:

Then $a + ar + ar^2 .... + ar^{n-2} + ar^{n-1} = s$; and multiplying both sides by r,

$$ar + ar^2 + ar^3 .... + ar^{n-1} + ar^n = rs$$

$$\text{Sub. } a + ar + ar^2 + ar^3 .... + ar^{n-1} \quad = s$$

$$\text{Rem. } -a + ar^n = rs - s = \overline{r-1} \times s$$

$$\text{or, } s = \frac{ar^n - a}{r-1} = \frac{ry - a}{r-1}.$$

From the equation $s = \frac{ry - a}{r-1}$, any three of the quantities, s, r, y, a, being given, the fourth may be found. When r is a proper fraction, as n increases, the value of r^n, or of ar^n, decreases, and when n is increased without limit, ar^n becomes less, with respect to a, than any magnitude that can be assigned; and therefore $s = \frac{-a}{r-1} = \frac{a}{1-r}$.

This quantity $\frac{a}{1-r}$, which we call the sum of the series, is the limit to which the sum of the terms approaches, but never actually attains; it is, however, the true representative of the series continued *sine fine*; for this series arises from the division of a by $1 - r$; and therefore $\frac{a}{1-r}$ may, without error, be substituted for it.

Ex. 1. To find the sum of 20 terms of the series, 1, 2, 4, 8, &c.

Here $a = 1$, $r = 2$, $n = 20$; therefore,

$$s = \frac{1 \times 2^{20} - 1.}{2 - 1} = 2^{20} - 1.$$

Ex. 2. Required the sum of 12, terms of the series 64, 16, 4, &c.

Here $a = 64$, $r = \frac{1}{4}$, $n = 12$, therefore, $s = \frac{\frac{64}{4^{12}} - 64}{\frac{1}{4} - 1} = \frac{64 \times 4^{12} - 64}{4^{12} - 4^{11}} = \frac{64}{4^{11}} \times \frac{4^{12} - 1}{4 - 1}$.

Ex. 3. Required the sum of 12 terms of the series, 1, — 3, 9, — 27, &c.

In this case, $a = 1$, $r = -3$, $n = 12$; therefore, $s = \frac{\overline{-3}|^{12} - 1}{-3 - 1} = -\frac{3^{12} - 1}{4}$

Ex. 4. To find the sum of the series $1 - \frac{1}{2} + \frac{1}{4} - \frac{1}{8} +$ &c. *in infinitum.*

Here $a = 1$, $r = -\frac{1}{2}$; therefore, (Art. 224),

$$s = \frac{1}{1 + \frac{1}{2}} = \frac{2}{3}.$$

It may be observed, in connection with this subject, that the recurring decimals are quantities in geometrical progression, where $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, &c. is the common ratio, according as one, two, three, &c, figures recur; and the vulgar fraction, corresponding to such a decimal, is found by summing the series.

Ex. 5. Required the vulgar fraction corresponding to the decimal .123123123, &c.

Let .123123,123, &c. $= s$; then multiply both sides by 1000; and 123.123123 123, &c. $= 1000s$, and by subtracting the former equation from the latter, $123 = 999s$; therefore $s = \frac{123}{999} = \frac{41}{333}$.

PROHIBITION, in law, is a writ properly issuing only out of the Court of King's Bench, being the King's prerogative writ; but, for the furtherance of justice, it may now also be had in some cases out of the Court of Chancery, Common Pleas, or Exchequer, directed to the judge and parties of a suit in an inferior court, commanding them to cease from the prosecution thereof, upon a suggestion, that either the cause originally, or some collateral matter arising therein, does not belong to that jurisdiction, but the cognizance of some other court. Upon the court being satisfied that the matter alleged by the suggestion is sufficient, the writ of prohibition immediately issues.

PROJECTILES.

PROJECTILES, are such bodies as, being put in a violent motion by any great force, are then cast off or let go from the place where they received their quantity of motion; as a stone thrown from a sling, an arrow from a bow, a bullet from a gun, &c. It is usually taken for granted, by those who treat of the motion of projectiles, that the force of gravity near the earth's surface is every where the same, and acts in parallel directions; and that the effect of the air's resistance upon very heavy bodies, such as bombs and cannon-balls, is too small to be taken into consideration.

Sir Isaac Newton has shown, that the gravity of bodies which are above the superficies of the earth, is reciprocally as the squares of their distances from its centre; but the theorems concerning the descent of heavy bodies, demonstrated by Gallileo, and Huygens, and others, are built upon this foundation, that the action of gravity is the same at all distances; and the consequences of this hypothesis are found to be very nearly agreeable to experience. For it is obvious, that the error arising from the supposition of gravity's acting uniformly, and in parallel lines, must be exceedingly small; because even the greatest distance of a projectile above the surface of the earth, is inconsiderable, in comparison of its distance from the centre, to which the gravitation tends. But then, on the other hand, it is very certain, that the resistance of the air to very swift motions, is much greater than it has been commonly represented. Nevertheless, (in the application of this doctrine to gunnery) if the amplitude of the projection, answering to one given elevation, be first found by experiment (which we suppose) the amplitudes in all other cases, where the elevations and velocities do not very much differ from the first, may be determined, to a sufficient degree of exactness, from the foregoing hypothesis; because, in all such cases, the effects of the resistance will be nearly as the amplitudes themselves; and were they accurately so, the proportions of the amplitudes, at different elevations, would then be the very same as in vacuo.

Now, in order to form a clear idea of the subject here proposed, the path of every projectile is to be considered as depending on two different forces; that is to say; on the impellant force, whereby the motion is first begun, (and would be continued in a right line) and on the force of gravity, by which the projectile, during the whole time of its flight, is continually urged downwards, and made to deviate more and more from its first direction. As whatever relates to the track and flight of a projectile, or ball, (neglecting the resistance of the air) is to be determined from the action of these two forces, it will be proper, before we proceed to consider their joint effects, to premise something concerning the nature of the motion produced by each, when supposed to act alone, independently of the other; to which end we have premised the two following lemmata.

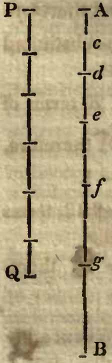
Lemma I. Every body, after the impressed force whereby it is put in motion ceases to act, continues to move uniformly in a right line; unless it be interrupted by some other force or impediment.

This is a law of nature, and has its demonstration from experience and matter of fact.

Corollary. It follows from hence, that a ball, after leaving the mouth of the piece, would continue to move along the line of its first direction, and describe spaces therein proportional to the times of their description, were it not for the action of gravity; whereby the direction is changed, and the motion interrupted.

Lemma II. The motion, or velocity, acquired by a ball, in freely descending from rest, by the force of an uniform gravity, is as the time of the descent; and the space fallen through, as the square of that time.

The first part of this lemma is extremely obvious: for since every motion is proportional to the force whereby it is generated, that generated by the force of an uniform gravity must be as the time of the descent; because the whole effort of such a force is proportional to the time of its action; that is, as the time of the descent.



To demonstrate that the distances descended are proportional to the squares of the times, let the time of falling through any proposed distance A B, be represented by the right line P Q; which conceive to be divided into an indefinite number of very small, equal particles, represented, each, by the symbol m; and let the distance descended in the first of them be A c; in the second $c\,d$; in the third $d\,e$; and so on.

Then the velocity acquired being always as the time from the beginning of the descent, it will, at the middle of the first of the said particles, be represented by one-half m; at the middle of the second, by $1\frac{1}{2}m$; at the middle of the third, by $3\frac{1}{2}m$, &c. which values constitute the series $\frac{m}{2}, \frac{3m}{2}, \frac{5m}{2}, \frac{7m}{2}, \frac{9m}{2}$, &c.

But since the velocity, at the middle of any one of the said particles of time, is an exact mean between the velocities of the two extremes thereof, the corresponding particle of the distance, A B, may be therefore considered as described with that mean velocity: and so, the spaces A c, $c\,d$, $d\,e$, $e\,f$, &c. being respectively equal to the above-mentioned quantities $\frac{m}{2}, \frac{3m}{2}, \frac{5m}{2}, \frac{7m}{2}$, &c. it follows, by the continual addition of these, that the space A c, A d, A e, A f, &c. fallen through from the beginning, will be expressed by $\frac{m}{2}, \frac{4m}{2}, \frac{9m}{2}, \frac{16m}{2}, \frac{25m}{2}$, &c. which are evidently to one another in proportion, as, 1, 4, 9, 16, 25, &c. that is, as the squares of the times. *Q. E. D.*

Corollary. Seeing the velocity acquired in any number (n) of the aforesaid equal particles of time (measured by the space that would be described in one single particle) is represented by (n) times m, or $n\,m$; it will therefore be, as one particle of time is to n such particles, so is $n\,m$, the said distance answering to the former time, to the distance, n^2m, corresponding to the latter, with the same celerity acquired at the end of the said n particles. Whence it appears that the space $\frac{n^2m}{2}$ (found above) through which the ball falls, in any given time n, is just the half of that (n^2m) which might be uniformly described with the last, or greatest celerity in the same time.

Scholium. It is found by experiment, that any heavy body, near the earth's surface (where the force of gravity may be considered as uniform) descends about 16 feet from rest, in the first second of time. Therefore, as the distances fallen through, are proved above to be in proportion as the squares of the time, it follows that, as the square of one second is to the square of any given number of seconds, so is 16 feet to the number of feet, a heavy body will freely descend in the said number of seconds. Whence the number of feet descended in any given time will be found, by multiplying the square of the number of seconds by 16. Thus the distance descended in 2, 3, 4, 5, &c. seconds, will appear to be 64, 144, 256, 400 feet, &c. respectively. Moreover, from hence, the time of the descent through any given distance will be obtained, by dividing the said distance in feet, by 16, and extracting the square root of the quotient; or, which comes to the same thing, by extracting the square root of the whole distance, and then taking one-half of that root for the number of seconds required. Thus, if the distance be supposed 2,640 feet; then, by either of the two ways, the time of the descent will come out 12.84, or 12.50 seconds.

It appears also (from the corol.) that the velocity per second (in feet) at the end of the fall, will be determined by multiplying the number of seconds in the fall by 32. Thus it is found that a ball, at the end of ten seconds, has acquired a velocity of 320 feet per second. After the same manner, by having any two of the four following quantities, *viz.* the force, the times, the velocity, and distance, the other two may be determined: for let the space freely descended by a ball, in the first second of time (which is as the accelerating force) be denoted by F; also let T denote the number of seconds wherein any distance, D, is descended; and let V be the velocity per second, at the end of the descent; then will

$$V = 2\,F\,T = 2\sqrt{F\,D} = \frac{2\,D}{T}$$

$$T = \sqrt{\frac{D}{F}} = \frac{V}{2\,F} = \frac{2\,D}{V}$$

$$D = F\,T\,T = \frac{V\,V}{4\,F} = \frac{T\,V}{2}$$

$$F = \frac{D}{T\,T} = \frac{V}{2\,T} = \frac{V\,V}{4\,D}$$

All which equations are very easily deduced from the two original ones, D = F T T, and V = 2 F T, already demonstrated; the former in the proposition itself, and the latter in the corollary to it; by which it appears that the measure of the velocity at the end of the first second is 2 F; whence the velocity (V) at the end of (T) seconds must consequently be expressed by 2 F × T or 2 F T.

Theorem 1. A projected body, whose line of direction is parallel to the plane of the horizon, describes by its fall a parabola. If the heavy body is thrown by any extrinsical force, as that of a gun, or the like, from the point A, (Plate Perspective, &c. fig. 7.) so that the direction of its projection is the horizontal line, A D, the path of this heavy body will be a semi-parabola. For if the air did not resist it, nor was it acted on by its gravity, the projectile would proceed with an equable motion, always in the same direction; and the times wherein the parts of space, A B, A C, A D, A E, were passed over, would be as the spaces A B, A C, A D, &c. respectively. Now if the force of gravity is supposed to take place, and to act in the same tenour, as if the heavy body were not impelled by any extrinsical force, that body would constantly decline from the right line, A E; and the spaces of descent, or the deviations from the horizontal line, A E, will be the same as if it had fallen perpendicularly. Wherefore, if the body, falling perpendicularly by the force of its gravity, passed over the space A K in the time A B descended through A L, in the time A C, and through A M in the time A D; the spaces, A K, A L, A M, will be as the squares of the times, that is, as the squares of the right lines, A B, A C, A D, &c. or K F, L G, M H. But since the impetus in the direction parallel to the horizon always remains the same (for the force of gravity, that only solicits the body downwards, is not in the least contrary to it); the body will be equally promoted forwards in the direction parallel to the plane of the horizon, as if there was no gravity at all. Wherefore, since in the time, A B, the body passes over a space equal to A B; but being compelled by the force of gravity, it declines from the right line, A B, through a space equal to A K; and B F being equal and parallel to A K, at the end of the time, A B, the body will be in F, so in the same manner, at the end of the time A E, the body will be in I; and the path of the projectile will be in the curve A F G H I; but because the squares of the right lines, K F, L G, M H, NI, are proportionable to the abscisses, A K, A L, A M, A N; the curve, A F G H I, will be a semi-parabola. The path, therefore, of a heavy body, projected according to the direction, A E, will be a semi-parabolical curve, *Q E D.*

Theorem 2. The curve line, that is described by a heavy body projected obliquely and upwards, according to any direction, is a parabola.

Let A F (fig. 8) be the direction of projection, any ways inclined to the horizon, gravity being supposed not to act, the moving body would always continue its motion in the same right line, and would describe the spaces A B, A C, A D, &c. proportional to the times. But by the action of gravity it is compelled continually to decline from the path A F, and to move in a curve, which will be a parabola. Let us suppose the heavy body falling perpendicularly in the time A B, through the space A Q, and in the time A C, through the space A R, &c. The spaces A Q, A R, A S, will be as the squares of the times, or as the squares of A B, A C, A D. It is manifest, from what was demonstrated in the last theorem, that if in the perpendicular B G, there is taken B M = A Q, and the parallelogram be completed, the place of the heavy body at the end of the time A B, will be M, and so of the rest; and all the deviations B M, &c. from the right line A F, arising from the times, will be equal to the spaces A Q, A R, A S, which are as the squares of the right lines A B, A C, A D. Through A draw the horizontal right line A P, meeting the path of the projectile in P. From P raise the perpendicular P E, meeting the line of direction in E; and by reason the triangles A B G, A C H, &c. are equiangular, the squares of the right lines A B, A C, &c. will be proportionable to the squares of A G, A H, &c. so that the deviations B M, C N, &c. will be proportionable to the squares of the right lines A G, A H, &c. Let the line L be a third proportional to E P and A P; and it will be (by 17 El. 6) $L \times EP = AP\,q$, but $AP\,q. : AG\,q. :: EP : BM :: L \times EP : L \times BM$; whence since it is $L \times EP = AP\,q.$ it will be $L \times BM = AG\,q.$ In like manner it will be $L \times CN = AH\,q$, &c. But because it is $BG : AG ::$ ($EP : AP ::$ by hypothesis) $AP : L$; it will be $L \times BG = AG \times AP = AG \times AG + AG \times GP = AG\,q. + AG \times GP$. But it has been shown that it is $L \times BM = AG\,q$, wherefore it will be $L \times BG - L \times BM = AG \times GP$, that is, $L \times MG = AG \times GP$. By the same way of reasoning it will be $L \times NH = AH \times HP$, &c. Wherefore the rectangle under M G and L, will be equal to the square of A G, which is the property of the parabola; and so the curve A M N O P K, wherein the projectile is moved, will be a parabola.

Cor. 1. Hence the right line L is the latus rectum or parameter of the parabola, that belongs to its axis.

Cor. 2. Let $AH = HP$, and it will be $L \times CN = AHq. = L \times NH$, whence it will be $NH = CN$; and consequently the right line A F, being the line of direction of the projectile, will be a tangent to the parabola.

Cor. 3. If a heavy body be projected downwards, in a direction oblique to the horizon; the path of the projectile will be a parabola.

Theorem 3. The impetus of a projected body in different parts of the parabola, are as the portions of the tangents intercepted between two right lines parallel to the axis; that is, the impetus of the body projected in the points A and B (fig. 9) to which A D, and B E are tangents, will be as C D and E B, the portions of the tangents intercepted between two right lines C B, and D E parallel to the axis.

We have here treated the path of a projected body as an exact parabola, though, from the resistance of the air, the line of a projectile is not exactly parabolical, but rather a kind of hyperbola; which, if considered and applied to practice, would render the computations far more operose, and the very small difference (as experience shows in heavy shot) would, in a great measure, lessen the elegancy of the demonstrations given by accounting for it; since the common rules are sufficiently exact, and easy for practice.

PROJECTION, in mechanics, the art of communicating motion to a body, from thence called projectile. In perspective, projection is the appearance or representation of an object on the perspective plane. The projection of the sphere is either orthographic, or stereographic.—The former, or orthographic, projection supposes the eye placed at an infinite distance; whereas, in the stereographic projection, it is supposed to be only 90 degrees distant from the primitive circle, or placed in its pole, and thence viewing the circles on the sphere. The primitive circle is that great circle which limits or bounds the representation or projection; and the place of the eye is called the projecting point.

PROLATE, in geometry, an epithet applied to a spheroid, produced by the revolution of a semi-ellipsis about its larger diameter.

PROLEGOMENA, in philology, certain preparatory observations or discourses prefixed to a book, &c. containing something necessary for the reader to be apprized of, to enable him the better to understand the book, or to enter deeper into the science, &c.

PROMISE, in law, is where, upon a valuable consideration, persons bind themselves by words to do or perform such a thing agreed on: it is in the nature of a verbal covenant, and wants only the solemnity of writing and sealing to make it absolutely the same. Yet, for the breach of it the remedy is different; for, instead of an action of covenant, there lies only an action upon the case, the damages whereof are to be estimated and determined by the jury. If there is no consideration, it is void, and it is called a nude compact, or, in Latin a *nudum pactum*.

PROMISSORY *note*. See Bills *of Exchange*.

PRONOUN, *pronomen*, in grammar, a declinable part of speech, which, being put instead of a noun, points out some person or thing. See Grammar.

PRONUNCIATION, in grammar, the manner of articulating or sounding the words of a language. Pronunciation makes much the most difficult part of a written grammar; in regard that a book expressing itself to the eyes, in a matter that wholly concerns the ears, seems next akin to that of teaching the blind to distinguish colours; hence it is, that there is no part so defective in grammar as that of the pronunciation, as the writer has frequently no term whereby to give the reader an idea of the sound he would express; for want of a proper term, therefore he substitutes a vicious and precarious one. To give a just idea of the pronunciation of a language, it seems necessary to fix as nearly as possible all the several sounds employed in the pronunciation of that language.

Pronunciation is also used for the fifth and last part of rhetoric, which consists in varying and regulating the voice agreeably to the matter and words, so as most effectually to persuade and touch the hearers. It is much the same with what is otherwise called emphasis.

This emphasis is a considerable stress or force of voice, laid upon that word in a sentence by which the sense of the whole is regulated: thus, suppose you were asked, "are you determined to walk this day to London?" If the emphasis be placed on the word *you*, the answer may be, "yes, I go myself;" or, "no, I shall send my son." Again, if it be placed on the word *walk*, the answer is, "yes, I am;" or, "no, I shall ride:" if on the words *to-day*, then the answer is, "yes;" or, "no, I shall go to-morrow:" and, lastly, if the emphasis be placed on the word *London*, the answer may be, "no, I shall go to Richmond only."

Quintilian advises his pupils to study the principles of pronunciation under a comedian. There are three things which come under the pronunciation, viz. the memory, voice, and gesture.

PROOF, in arithmetic, an operation whereby the truth and justness of a calculation is examined and ascertained. The proper proof is always by the contrary rule: thus subtraction is the proof of addition, and multiplication of division; and *vice versa.*

PROOF, in military affairs, is a trial whether the piece will stand the quantity of powder allotted for that purpose.

PROPAGO, in botany, properly a slip, layer, or cutting of a vine or other tree.

PROPORTION. When two quantities are compared one with another, in respect of their greatness or smallness, the comparison is called ratio, reason, rate, or proportion; but when more than two quantities are compared, then the comparison is more usually called the proportion that they have to one another. The words ratio and proportion are frequently used promiscuously. When two quantities only are compared, the former term is called the antecedent, and the latter the consequent. The relation of two homogeneous quantities one to another, may be considered either, 1. By how much the one exceeds the other, which is called their difference. Thus 5 exceeds 3 by the difference 2. Or, 2. What part or parts one is of another, which is called ratio. Thus the ratio of 6 to 3 is $\frac{6}{3}=\frac{2}{1}$, or double; and the ratio of 3 to 6 is $\frac{3}{6}=\frac{1}{2}$, or subduple.

When two differences are equal, the terms that compose them are said to be arithmetically proportional. Thus, suppose the term to be a and b, their difference d. If a be the last term, then $a+d=b$. And if a be the greatest, then $a-d=b$.

But when two ratios are equal, the terms that compose them are said to be geometrically proportional. For suppose a and b to be the terms of any ratio; if a be the least term, put $r=\frac{b}{a}$, then $ar=b$ by equal multiplication: but if b be the least term, put $r=\frac{a}{b}$, then $br=a$ by equal multiplication, and $\frac{a}{r}=b$ by equal division.

Thus the ratio of two quantities, or of two numbers, in geometrical proportion, is found by dividing the antecedent by the consequent, and the quotient is the exponent or denominator of the ratio.

If, when four quantities are considered, you find that the first hath as much greatness or smallness in respect to the second, as the third hath in respect to the fourth: those four quantities are called proportionals, and are thus expressed:

As $\left\{\begin{matrix} A : B :: C : D \\ 8 : 2 :: 16 : 4 \end{matrix}\right\}$ that is, as A=8 contains B=2 four times, so C=16 contains D=4, four times; and, therefore, A has the same ratio to B as C has to D; and, consequently, these four quantities having equal ratios, are proportionals.

Proportion consists of three terms at least, whereof the second supplies the place of two.

When three magnitudes, A, B, C, are proportional, the first, A, has a duplicate ratio to the third, C, of that it hath to the second, B: but when four magnitudes, A, B, C, D, are proportional, the first, A, has a triplicate ratio to the fourth, D, of what it has to the second, B; and so always in order one more, as the proportion shall be extended.

Duplicate ratio is thus expressed, $\frac{A}{C}=\frac{A}{B}$ twice; that is, the ratio of A to C is duplicate of the ratio of A to B. For let A=2, B=4, C=8: then the ratio of 2 to 8 is duplicate of the ratio of 2=A to B=4, or as the square of 2 to the square of 4.

Triplicate ratio is thus expressed, $\frac{A}{D}=\frac{A}{B}$ thrice; that is, the ratio of A again = 2, to D = 16, is triplicate of the ratio of A = 2 to B = 4, or as 8 the cube of 2, to 64 the cube of 4. Wherefore duplicate ratio is the proportion of squares, and triplicate that of cubes.

And the ratio of 2 to 8 is compounded of the ratio of that of 2 to 4, and of 4 to 8. From what has been said of the nature of ratio and proportion, the six ways of arguing, which are often used by mathematicians, will evidently follow.

1. Alternate proportion is the comparing of antecedent to antecedent, and consequent to consequent. As if

$\left\{\begin{matrix} A : B :: C : D \\ 2 : 4 :: 8 : 16 \end{matrix}\right\}$ therefore alternately, or by permutation, as

$$\left\{\begin{matrix} A : C :: B : D \\ 2 : 8 :: 4 : 16 \end{matrix}\right\}$$

2. Inverse ratio, is when the consequent is taken as the antecedent, and so compar-

ed to the antecedent as the consequent. As A : B :: C : D; therefore inversely as

$$\begin{Bmatrix} B : A :: D : C \\ 4 : 2 :: 16 : 8 \end{Bmatrix}$$

3. Compound ratio, is when the antecedent and consequent, taken both as one, are compared to the consequent itself. As A : B :: C : D; therefore by composition, as A + B : B :: C + D : D : in numbers, as 2 + 4 = 6, is to 4, so is 8 + 16 = 24, to 16.

4. Divided ratio, is when the excess wherein the antecedent exceedeth the consequent is compared to the consequent. As A : B :: C : D; therefore by division, A—B : B :: C—D : D in numbers, as 16 : 8 :: 12 : 6; therefore as 16—8=8, is to 8, so is 12—6=6 to 6.

When of several quantities the difference or quotient of the first and second is the same with that of the second and third, they are said to be in a continued arithmetic or geometric proportion.

$$\text{Thus} \begin{Bmatrix} a, a+d, a+2d, a+3d, a+4d \\ a, a-d, a-2d, a-3d, a-4d \end{Bmatrix}$$

&c. is a series of continued arithmetical proportionals, whose common difference is d.

$$\text{And} \begin{Bmatrix} a, ar, arr, arrr, arrrr, ar^5 \\ a, \frac{a}{r}, \frac{a}{rr}, \frac{a}{rrr}, \frac{a}{rrrr}, \frac{a}{r^5} \end{Bmatrix}$$

&c. is a series of continued geometric proportionals, whose common multiplier is $\frac{r}{1}$ or $\frac{1}{r}$, or whose ratio is that of 1 to r, or r to 1.

PROPORTION *of figures.* To find the proportion that one rectangle hath to another, both length and breadth must be considered. For rectangles are to each other, as the products of their respective lengths multiplied by their breadths.—Thus, if there be two rectangles, the former of which hath its length five feet, and its breadth three; and the latter hath its length eight feet, and its breadth four.—Then the rectangles will be to each other as 3 × 5 (= 15), is to 4 × 8 (= 32); that is, as 15 : 32, so that all the rectangles are to one another in a ratio compounded of that of their sides.

When rectangles have their sides proportionable, so that $\frac{A\ B}{8} :: \frac{E\ H}{4} :: \frac{A\ D}{4} : \frac{E\ F}{2}$, then is the rectangle A, to the rectangle B, in a duplicate proportion to the ratio of the sides. For the ratio of A to B, is compounded of the ratio of A B to E H, and of the ratio of A D to E F. And therefore the proportion of A to B, being compounded of equal ratios, must be duplicate of the ratio of their sides to each other; that is, duplicate of the ratio of A B : E H, or of A D : E F.

Hence all triangles, parallelograms, prisms, parallelopipeds, pyramids, cones, and cylinders, are to one another respectively compared, in a proportion compounded of that of their heights and bases. All triangles, and parallelograms, pyramids, prisms, and parallelopipeds; also all cones and cylinders, each kind compared among themselves; if they have equal altitudes, are in the same proportion as their bases; if they have equal bases, are as their heights.

For the bases, or heights, will severally be common efficients or multipliers; and therefore must make the products be in the same proportion as the multiplicand was before.

Thus, if the equal altitude of any two triangles, parallelopipeds, cones, &c. be called A, and their unequal bases B and D: then it will be as B : D : : A B : A D.

PROPORTION, *harmonic*, is when three terms are so disposed, that as the difference of the first and second : the difference of the second and third :: first : third; and they are said to be harmonically proportional. Thus, 10, 15, 30, are harmonically proportional. For as the difference of 10 and 15, is to the difference of 15 and 30, so is 10 to 30. Also, 12, 6, 4, are harmonically proportional; for 12 — 6 : 6 — 4 : : 12 : 4. So $h^2 + 3hn + 2n^2$, $b^2 + 2hn$, $h^2 + hn$, are harmonically proportional. For $hn + 2n^2 : hn :: h^2 + 3hn + 2n^2 : h^2 + hn$.—Whence, if the two first terms of an harmonic proportion be given, the third is readily found.

For if A, B, C, be harmonically proportional. Then A — B : B — C : : A : C, and A C — B C = A B — A C. Therefore A B = 2 A — B × C, and B C = 2 C — B × A. Consequently $C = \frac{AB}{2A - B}$, and $A = \frac{BC}{2C - B}$. Again, when four terms are so disposed, that as the difference of the 1st and 2d : the difference of the 3d and 4th : : 1st : 4th, they are also harmonically proportional. As 10, 16, 24, 60; for as 10 — 16 : 24 — 60 : : 10 : 60. Whence, if the three first terms of such an harmonic proportional be given, the 4th is easily found.

For if a, b, c, d, be harmonic proportionals, then $a - b : c - d :: a : d$; and $a\,d - b\,d = a\,c - a\,d$, therefore $d =$

$\frac{a\,c}{2\,a - b}$, and $a = \frac{b\,d}{2\,d - c}$.

If the terms of an harmonic proportion be continued, then it is called an harmonic progression. Thus, supposing

$\left\{ \begin{array}{l} h, \text{ to be the 2d term,} \\ d, \text{ the difference of the 1st and 2d,} \end{array} \right\}$

and that the 1st exceeds the 2d. The progression will be

$h + d,\ h,\ \frac{h^2 + h\,d}{h + 2\,d},\ \frac{h^2 + h\,d}{h + 3\,d},\ \frac{h^2 + h\,d}{h + 4\,d},\ \frac{h^2 + h\,d}{h + 5\,a}$, &c. Whence, if out of a rank of harmonic proportionals, there be taken any series of equidistant terms, that series will be harmonically proportional.— And this kind of proportion has several other properties common with arithmetic and geometric proportions.

When three terms are so disposed, that the difference of the 1st and 2d : difference of the 2d and 3d :: 3d : 1st, they are said to be in a contra-harmonic proportion. Thus, 6, 5, 3, and 12, 10, 4, are contra-harmonics. For 6 — 5 : 5 — 3 :: 3 : 6; and 12 — 10 : 10 — 4 :: 4 : 12. Or, supposing h greater than n, if the 2d term be greater than the 1st:

Then $h\,n + n^2$, $h^2 + n^2$, $h^2 + h\,n$, are contra-harmonics, for $h\,n - h^2 : n - h\,n :: h^2 + h\,n : h\,n + n^2$.

But if the 1st term exceeds the 2d, then $h^2 + h\,n$, $h^2 + n^2$, $h\,n + n^2$, are contra-harmonics. For $h\,n^2 - n^2 : h^2 - h\,n :: h\,n + n^2 : h^2 + h\,n$.

PROPOSITION, in logic, part of an argument wherein some quality, either negative or positive, is attributed to a subject, as "God is just." While the comparing of our ideas is considered merely as the act of the mind, assembling them together, and joining or disjoining them according to the result of its perceptions, this operation is called judgment. But when these judgments are expressed in words, they then bear the name of propositions. Hence a proposition is a sentence expressing some judgment of the mind, whereby two or more ideas are affirmed to agree or disagree: and as our judgments include at least two ideas, one of which is affirmed or denied of the other; so a proposition must have terms corresponding to these ideas. The idea of which we affirm or deny, and of course the term expressing that idea, is called the subject of the proposition; and the idea affirmed or denied, as also the term answering to it, is called its predicate; thus in the proposition, God is omnipotent, God is the subject, it being of him that we affirm omnipotence: and omnipotent is the predicate, because we affirm the idea expressed by that word to belong to God.

Proposition, in mathematics, is either some truth advanced, and shown to be such by demonstration, or some operation proposed and its solution shown. If the proposition be deduced from several theoretical definitions compared together, it is called a theorem; if from a praxis, or series of operations, it is called a problem.

Proposition, in poetry, the first part of a poem wherein the author proposes briefly, and in general, what he is to say in the body of his work. It should comprehend only the matter of the poem, that is the action and the persons that act. Horace prescribes modesty and simplicity in the proposition, and would not have the poet promise too much, nor raise in the reader too great ideas of what he is going to relate.

PROSERPINACA, in botany, a genus of the Triandria Trigynia class and order. Natural order of Inundatæ. Hydrocharides, Jussieu. Essential character: calyx three parted, superior: corolla none; drupe with a three celled nut. There is but one species, *viz.* P. palustris, a native of Virginia in marshes.

PROSODY, that part of grammar which treats of the quantities and accents of syllables, and the manner of making verses. The English prosody turns chiefly on two things, numbers and rhyme.

PROSONOMASIA, a figure in rhetoric, whereby allusion is made to the likeness of a sound in several names or words.

PROSOPIS, in botany, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx bell-shaped, five-toothed; stigma simple; legume linear, many-seeded. There is but one species, *viz.* P. spicigera; it is a native of most parts of the Coromandel coast, flowering during the cold season; the pod of this tree is the only part used; it is nearly an inch in circumference, and from six to twelve inches long; when ripe, it is brown and smooth, containing besides the seeds, a large quantity of a brown mealy substance, which the natives eat; it has a sweetish agreeable taste.

PROSOPOPŒIA, a figure in rhetoric, whereby we raise qualities, or things inanimate, into persons. This figure is divided into two parts: 1. when good and bad qualities, accidents, and things inanimate, are introduced as living and rational beings; as the following verses of Milton:

——— Now gentle gales,
Fanning their odoriferous wings, dispense
Native perfumes; and whisper whence they stole
Those balmy spoils.———

The second part of this figure is when we give a voice to inanimate things, and make rocks, woods, rivers, buildings, &c. express the passions of rational creatures, as in the following lines of Spencer.

She foul blasphemous speeches forth did cast,
And bitter curses, horrible to tell,
That ev'n the temple, wherein she was placed,
Did quake to hear, and nigh asunder burst!

PROSTATÆ. See Anatomy.

PROTEA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Aggregatæ. Protea, Jussieu. Essential character: corolla four cleft or four-petalled; anthers linear, inserted into the petals below the tip; calyx proper, none; nut one-seeded, superior. There are sixty-four species; these are all shrubs, and natives of the Cape of Good Hope.

PROTECTION *of parliament*. See Arrest and Privilege.

PROTEST, in law, is where one openly affirms, that he does either not at all, or but conditionally, yield his consent to any act, or to the proceeding of a judge in court, wherein his jurisdiction is doubtful, or to answer upon his oath further than by law he is bound. It is also that act, by which the holder of a foreign bill of exchange declares that such bill is dishonoured. Further, it is that act of a master, on his arrival, with his ship from parts beyond the seas, to save him and his owners harmless and indemnified from any damage sustained in the goods of her lading, on account of storms. See Bills of Exchange and Insurance.

PROTESTANTS, a term now applied to all christians who in any country or of any sect dissent from the principles and discipline of the church of Rome. This name was first given to the following princes of the German Empire; John, Elector of Saxony; George, Elector of Brandenburg, for Franconia; Ernest and Francis, Dukes of Lunenburg, the Landgrave of Hesse, and the Prince of Anhalt. These princes, being seconded by thirteen imperial towns, *viz.* Strasbourg, Ulm, Nuremberg, Constance, Rottingen, Windseim, Memmingen, Nortlingen, Lindau, Kempten, Heilbron, Wissemberg, and St. Gall, solemnly *protested* against the decree of the Emperor Charles the Fifth, and the diet of Spires, by which it had been decreed to prohibit any further innovations in religion. This Protest was made in the year 1529; from which time all who have renounced, or never agreed to, the doctrines of the Romish church have been denominated Protestants. This class of christians consequently includes the Huguenots in France, the Refugees in Holland, the Presbyterians in Scotland, as well as the Episcopalians and Nonconformists in England; together with a numerous body of christians in America. The principal denominations of Protestants in England, are the Episcopalians or church of England, the Presbyterians, the Independents, and the Baptists, general and particular. These, however, have divided themselves into innumerable sects and parties; the principal of which are denominated Arians and Socinians, or, more properly speaking, Unitarians, Sabellians, Calvinists, Sublapsarians and Supralapsarians, Arminians, Baxterians, Antinomians, Brownists, Pædobaptists, Quakers, Methodists, Universalists, Sabbaterians, Moravians, Sandemanians, and Swedenborgians. Concerning these, and other christian sects, the reader will find very impartial accounts, drawn up in a popular and perspicuous manner, and accompanied with many pious and sensible reflections on the nature and extent of christian candour, in the Rev. J. Evans's "Sketch of the Denominations of the Christian World," eleventh edition. But for more elaborate accounts of the christian sects, the reader is referred to Dr Rees's Cyclopedia; the theological, as, indeed, every other department of which is conducted in a manner every way worthy the literature of a country where the genuine principles of religious liberty are clearly understood, and extensively encouraged. The sects and parties into which the Protestant religion is divided, have furnished the Roman Catholics, on some occasions, with matter of triumph; asserting that the Protestant faith is deficient in the first mark or characteristic of a true church, *viz.* that of unity; and unbelievers have not neglected to avail themselves of this circumstance to vilify the christian religion altogether; as affording no sufficient data for religious truth, but engendering only strife, animosity, division, and bloodshed: and, it must be confessed, that when the enemies of the Protestant faith behold the rancour, the bigotry, and the malice of many sectaries, and particularly of those sects which are the most numerous and popular, they have but too much ground for their triumphs. When the spirit of Chillingworth shall have influenced the hearts, and directed the lives of all Protestants, their professions will be as consistent as their leading principles are rational and scriptural. That author addressing himself to a Romish writer, speaks of the religion of Protestants in the following terms. "Know then, Sir, that when I say the religion of Protestants is in prudence to be preferred before yours; as, on the one side, I do not understand by your religion the doctrine of Bellarmine or Baronius, or any other private man amongst you, nor the doctrine of the Sorbonne, or of the Jesuits, or of the Dominicans, or of any other particular company among you; but that wherein you all agree, the doctrine of the Council of Trent; so accordingly, on the other side, by the religion of Protestants I do not understand the doctrine of Luther, or Calvin, or Melancthon; nor the confession of Augsburg or Geneva; nor the catechism of Heidelberg, nor the articles of the church of England—no, nor the harmony of Protestant confessions; but that wherein they all agree, and which they all subscribe with a greater harmony, as a perfect rule of faith and action, that is, THE BIBLE! The Bible, I say, the Bible only, is the religion of Protestants. Whatsoever else they believe besides it, and the plain, irrefragable, indubitable consequences of it, well may they hold it as a matter of opinion; but as a matter of faith and religion, neither can they with coherence to their own grounds, believe it themselves, nor require belief of it of others, without most high and most schismatical presumption. I, for my part, after a long (and I verily believe and hope) impartial search of the true way to eternal happiness, do profess plainly, that I cannot find any rest for the sole of my foot, but upon this rock only. I see plainly, and with my own eyes, that there are popes against popes, and councils against councils; some fathers against other fathers, and some fathers against themselves; a consent of fathers of one age against consent of fathers of another age; traditive interpretations of scripture are pretended, but there are few or none to be found: no tradition but that of scripture can derive itself from the fountain; but may be plainly proved either to have been brought in in such an age after Christ, or that in such an age it was not in. In a word, there is no sufficient certainty but that of scripture only, for any considering man to build upon. This, therefore, and this only, I have reason to believe. This I will profess; according to this I will live; and for this, if there be occasion, I will not only willingly but even gladly, lose my life; though I should be sorry that christians should take it from me. Propose me any thing out of the book, and require whether I believe it or no, and seem it never so incomprehensible to human reason, I will subscribe it with hand and heart, as knowing no demonstration can be stronger than this: God hath said so, therefore it is true. In other things I will take no man's liberty of judging from him, neither shall any man take mine from me. I will think no man the worse man, nor the worse christian; I will love no man the less for differing in opinion from me. And what measure I mete to others, I expect from them again. I am fully assured that God does not, and therefore men ought not, to require any more of any man than this: to believe the scripture to be God's word; to endeavour to find the true sense of it, and to live according to it"

Such are the genuine principles of Protestantism; such the spirit by which all christians ought to be actuated. Those men, who, calling themselves Protestants, are of a contrary spirit (and it is a lamentable fact that their number is daily increasing) are a disgrace to their profession, and bring dishonour on the common cause of christianity. Their devotion is enthusiasm, and their zeal madness; while their increasing number portends one of the greatest of all public calamities; threatening to rekindle the latent embers of persecution,—again to light up those fires which the united efforts of reason, philosophy, and the principles of rational religion have conspired to extinguish for ever. See ARMINIANS, PRESBYTERIANS, PURITANS, REFORMATION, and ROMAN CATHOLICS.

PROTESTATION is a form in pleading, when one does not directly affirm or deny any thing that is alleged by another, or which he himself alleges.

PROTRACTOR is the name of an instrument used for protracting or laying down on paper the angles of a field, or other figure. The protractor is a small semi-circle of brass, or other solid matter, the limb or circumference of which is nicely divided into one hundred and eighty degrees: it serves not only to draw angles on paper, or any plane, but also to examine the extent of those already laid down. For this last purpose, let the small point in the centre of the protractor be placed above the angular point, and let the side coincide with one of the sides that contain the angle proposed; then the number of degrees cut off by the other side, computing on the protractor, will show the quantity of the angle that was to be measured. See MENSURATION.

Protractors are now more usually made in the form of a parallelogram, and properly graduated at the upper edge. See MATHEMATICAL *Instruments*.

PROVIDENCE, the conduct and direction of the several parts of the universe, by a superior intelligent being.

PROVINCE, in law, means the circuit of an Archbishop's jurisdiction, which is subdivided into bishoprics. The ecclesiastical division of this kingdom is into two provinces; *viz.* Canterbury and York. Provincial constitutions, in this kingdom, were decrees made in the provincial synods, held under divers Archbishops of Canterbury.

PROVISO, in law, is a condition inserted in a deed, upon the observance of which the validity of the deed depends.

PROVOST *marshal*, an officer of the King's navy, who has charge of the King's prisoners taken at sea.

PROVOST, or PREVOT, in the King's stables; his office is to attend at court, and hold the King's stirrup, when he mounts his horse, &c. There are four provosts of this kind, each of whom attends in his turn monthly.

PROW, in navigation, denotes the head or fore-part of a ship, particularly in a galley, being that which is opposite to the poop or stern. In the middle of the prow is the beak that cuts the water, on the top of which is commonly some figure or hieroglyphic. The prow is lower than the poop, and contains fewer decks.

PRUNELLA, in botany, *self-heal*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ, or Labiatæ. Essential character: filaments forked, with an anther on one of the forks; stigma bifid. There are three species.

PRUNELLA, *sal*, in pharmacy, a preparation of purified saltpetre, called also crystal mineral, made in this manner: having melted any quantity of saltpetre, cast a little flower of sulphur upon it, and when that is burnt throw on more; and continue to do so till the nitre flow as clear as rock-water. Then with a clean iron or brass ladle take it out, and, putting it into moulds till coagulated, preserve it for use.

PRUNING, in gardening and agriculture, is the lopping off the superfluous branches of trees, in order to make them bear better fruit, grow higher, or appear more regular. Pruning, though an operation of very general use, is nevertheless rightly understood by few; nor can it be learned by rote, or, indeed, wholly by books, but requires a strict observation of the different manners of growth of the several sorts of fruit-trees; the proper method of doing which cannot be known, without carefully observing how each kind is naturally disposed to produce its fruit; for some do this on the same year's wood, as vines; others, for the most part, upon the former year's wood, as peaches, nectarines, &c. and others, upon spurs which are produced upon wood of three, four, &c. to fifteen or twenty years old, as pears, plumbs, cherries, &c. therefore, in order to the right management of fruit-trees, provision should always be made to have a sufficient quantity of bearing wood in every part of the trees, and at the same time there should not be a superfluity of useless branches, which would exhaust the strength of the trees, and cause them to decay in a few years. The reasons for pruning of fruit-trees are, 1. To preserve them longer in a vigorous bearing-state; 2. To render them more beautiful; and, 3. To cause the fruit to be larger and better tasted.

PRUNUS, in botany, *bird cherry-tree*, a genus of the Icosandria Monogynia class and order. Natural order of Pomaceæ. Rosaceæ, Jussieu. Essential character: calyx five-cleft, inferior; petals five; drupe with a nut, having the sutures prominent There are thirty-three species.

PRUSSIAN *blue*. A rich pigment has been known for a considerable time unthe name of Prussian blue. It is prepared by drying blood, and mixing three parts of the dried residuum with two parts of the potash of commerce, and calcining the mixture in a crucible by a red heat: it is then boiled in successive portions of water, which are afterwards mixed together, and concentrated by evaporation. A solution is prepared of one part of sulphate of iron, and two parts of alum, and to this the liquor obtained from the calcined blood and alkali is added, as long as any precipitate is formed. This precipitate is of a green colour, but by washing it with a little dilute muriatic acid, it becomes of a dark rich blue colour. This forms the Prussian blue of commerce. The property of forming the colour depends on a peculiar principle combined with the alkali; that in the formation of the Prussian blue, this is transferred to the iron, and that it may be again abstracted from it, by boiling the blue in an alkaline solution; the properties of the alkali are thus changed, and it acquires the power of again forming the precipitate of Prussian blue from a solution of sulphate of iron. The reason the precipitate is thrown down green is, that the alkali is not entirely saturated with the colouring principle; the excess of alkali throws down, therefore, a portion of yellow oxide of iron from the sulphate, which mingling with the blue precipitate, renders it green, and the muriatic acid gives the deep blue colour, by dissolving, and of course removing this oxide. See Prussic *acid*.

PRUSSIATES, in chemistry, salts formed with the prussic acid. These salts have not been attentively examined, on account of their want of permanency, unless they are united with some metallic oxide; but the prussiate of potash and iron, which is a triple salt, has been used by chemists as the best combination of prussic acid for detecting the existence of iron. In chemistry and mineralogy this is a very important substance, as it is capable of indicating whether most metallic substances be present in any solution whatever, and of pointing out the particular metal, and of ascertaining its quantity. This is done by precipitating the metals from their solution, in consequence of the insoluble compound which it forms with them. The colour of the precipitate indicates the particular metal, while its quantity enables us to judge of the proportion of metallic oxide contained in any solution. This salt has obtained, at different times, the names of Prussian alkali, phlogisticated alkali, Prussian test, &c. This salt, though of great importance as a test, is of no use whatever, if it be not quite pure. There are two ways in which this test may be rendered impure, besides the introduction of foreign ingredients, which it is needless to mention, because it is obvious that it must be guarded against. 1. There may be a superabundance of alkali present, or, which is the same thing, there may be mixed with the Prussian test a quantity of pure alkali; or, 2. There may be contained in it a quantity of yellow prussiate of iron, for which prussiate of potash has also a considerable affinity. If the Prussian test contain a superabundance of alkali, two inconveniences follow. This superabundant quantity will precipitate those earthy salts which are liable to contain an excess of acid, and which are only soluble by that excess. Hence alumina and barytes will be precipitated. Another inconvenience arising from the superabundance of alkali in the Prussian test is, that it gradually decomposes the blue prussiate which the test contains, and converts it into a yellow prussiate. In what manner it does this will be understood, after what has been said, without any explanation. On the other hand, when the Prussian alkali contains a quantity of yellow prussiate of iron, as great inconveniences follow. This yellow prussiate has an affinity for prussic acid, which, though inferior to that of the potash, is still considerable; and, on the other hand, the potash has a stronger affinity for every other acid than for the prussic. When, therefore, the test is exposed to the air, the carbonic acid, which the atmosphere always contains, assisted by the affinity between the yellow prussiate and the prussic acid, decomposes the prussiate of potash in the test, and the yellow prussiate is precipitated in the form of Prussian blue, and every other acid produces the same effect. A test of this kind would indicate the presence of iron in every mixture which contains an acid (for a precipitation of Prussian blue would appear), and could not therefore be employed with any confidence.

PRUSSIC *acid*, in chemistry and the arts, is one of the most important of the acids. It was discovered by accident, about the beginning of the last century, by Diesbach, a chemist of Berlin. This gentleman, wishing to precipitate a decoction of cochineal with an alkali, got some potash, on which he had distilled several times his animal oil, and as there was some sulphate of iron in the decoction, the liquor instantly exhibited a beautiful blue in the place of a red precipitate. Hence he saw the method of producing the same substance at pleasure, and it soon became an object of commerce, and obtained the name of Prussian blue, from the place where it was discovered. This substance is now formed, chiefly, during the decomposition of animal substances in high temperatures. Three parts of blood, evaporated to dryness in an iron dish, are to be mixed with one part of subcarbonate of potash, (common pearlash) and calcined in a crucible, which should be only two-thirds filled by the materials, and covered with a lid. The calcination must be continued, with a moderate heat, as long as a blue flame issues from the crucible; and when it becomes faint, and likely to be extinguished, the process must be stopped. Throw the mass, when cold, into ten or twelve parts of water; allow it to soak a few hours, and then boil them together in an iron kettle. Filter the liquor, and continue pouring hot water on the mass as long as it acquires any taste. To this solution, add one composed of two-parts of alum and one of sulphate of iron, in eight or ten of boiling water, and continue the mixture as long as any effervescence and precipitation ensues. Wash the precipitate several times with boiling water. It will have a green colour; but, on the addition of a quantity of muriatic acid, equal to twice that of the sulphate of iron which has been used, it will assume a beautiful blue colour. Wash it again with water, and dry it in a gentle heat. In this state it is the pigment, called Prussian blue, which consists of a mixture of prussiate of iron with alumine. From prussiate of iron, the prussic acid may be separated by the following process: mix two ounces of red oxide of mercury, prepared by nitric acid, with four ounces of finely powdered Prussian blue, and boil the mixture with twelve ounces of water in a glass vessel, shaking frequently.—Filter the solution, which is a prussiate of mercury, while hot, and when cool, add to it, in a bottle, two ounces of iron filings, and six or seven drachms of sulphuric acid; shake these together, decant the clear liquor into a retort, and distil off one-fourth of the liquor. The distilled liquor is the prussic acid, which combines with alkalies and earths, and has many of the properties belonging to the other acids. It has a sweetish taste, and a smell resembling that of bitter almonds; it does not redden blue vegetable colours. It precipitates sulphurets, and curdles soap. It separates alumine from nitric acid. Oxygenized muriatic acid entirely decomposes it. It does not appear to have a strong affinity for alkalies, nor does it take them from carbonic acid, for no effervescence arises on adding it to a solution of alkaline carbonates; on the contrary, its combinations with alkalies and earths are decomposed by exposure to carbonic acid, even when highly diluted, as in atmospheric air. It readily combines, however, with pure alkalies, destroys their alkaline properties, and forms crystallizable salts. It does not precipitate iron blue, but green, and this green precipitate is soluble in acids The rays of light render the green precipitate blue, as does also the addition of metallic iron, or sulphurous acid.

PSIDIUM, in botany, *guava*, a genus of the Icosandria Monogynia class and order. Natural order of Hesperidæ. Myrti, Jussieu. Essential character: calyx five-cleft superior; petals five; berry one-celled, many-seeded. There are eight species, natives of the East and West Indies.

PSITTACUS, the *parrot*, in natural history, a genus of birds of the order Picæ. Generic character: bill hooked, upper mandible moveable; nostrils round in the base of the bill, and sometimes covered with a cere; tongue fleshy, broad, and blunt at the end; head large, crown flat: toes formed for climbing. These abound within the tropics, and live on seeds and fruits in their natural state, but in confinement will eat both flesh and fish. They often appear in flocks, yet are in such cases generally somewhat separated into pairs. They are noisy, mimetic, singularly capable of articulating human sounds, extremely docile, and long lived. They breed in the hollows of trees, without constructing any nest, and use their feet as hands to convey food to their mouths.—Latham notices one hundred and thirty-three species, and Gmelin no fewer than one hundred and sixty-nine. The general division is regulated by the evenness or unevenness of the tails. The following are the principal species.

P. macao, or the red and blue maccaw, is as large as a capon, and inhabits South America. With its bill it breaks a peach-stone with the most perfect ease. These birds lay their eggs in decayed trees, and often enlarge the hollow for this purpose with their bills. They are used for food in vast numbers in Cayenne. They are, in common with many species, exposed to fits when confined.

P. rufirostris, or the long-tailed green parrakeet, is of the size of a blackbird, extremely clamorous, and highly imitative. These birds are seen in large flocks, and alighting on certain trees, can with difficulty be distinguished, in consequence of the similar colour of their plumage to that of the leaves. They inhabit various parts of America, are used for food, and are extremely fat. The above have tails uneven at the end.

P. Melucceusis, or the Molucca cockatoo, inhabits the Moluccas, is about fifteen inches long, and is regarded by Buffon as one of the most docile and interesting birds of the tribe.

P. pullarius, or the red-headed Guinea parrakeet, is of the size of a lark, and is extremely common in many parts of Africa. These birds are peculiarly distinguished by their mutual affection. They are exported from Africa in considerable numbers, for their beauty and attachment, and not on account of any power of articulation or enchantment of melody, their sounds being harsh and grating. Few, however, survive the voyage. They are kept in cages, in pairs, and the attentions of the male to the female are highly tender, elegant, and interesting. He extricates the seeds from their husks, and presents them to her in this prepared state, and appears restless and miserable on the slightest separation. Indeed, the attachment is reciprocal, the sadness of one always producing distress in the other; and the death of either involving the survivor, generally, in fatal as well as fruitless grief.

P. Carolinensis, the Carolina parrot, is about thirteen inches long, yellowish-green, head and fore part of the neck yellow; front, cheeks, and edge of the shoulders rufous; bill and orbits whitish; feet pale flesh colour, claws black; greater wing-coverts and primaries yellow, with a tinge of green; shafts of most of the feathers black. Tail long, cuneiform; knees and vent fulvous. Inhabits the southern parts of the United States, as far north as Maryland, but on the rivers Mississippi and Ohio, it is of frequent occurrence much farther northwardly. It is the only species found in the United States.

PSOPHIA, the *trumpeter*, in natural history, a genus of birds of the order Grallæ. Generic character: bill cylindrical, conic, convex; nostrils oval, sunk, and pervious; tongue cartilaginous, flat, and fringed at the tip; feet four-toed and cleft.—Latham mentions only one species, viz. P. crepitans, or the gold-breasted trumpeter, is of the size of a large fowl, and very high on its legs, and abounds in South America, especially in the country of the Amazons. It is remarkable for emitting from its lungs a noise very similar to the sound of a child's trumpet, and, being easily domesticated, will often follow the person to whose care it is committed, through the streets, making this singular noise. It may be fed on bread and fish. It runs fast, aided by the expansion of its wings. When confined with poultry, it often annoys both common fowls and turkeys, and, indeed, occasionally destroys them. It will follow the negroes in the West Indies, and catch at their legs, not unfrequently producing blood. Their flesh is esteemed a considerable delicacy.

PSORALEA, in botany, a genus of the Diadelphia Decandria class and order.—Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx besprinkled with callous dots, the same length with the legume, which has only one seed in it. There are thirty-three species, chiefly natives of the Cape of Good Hope.

PSYCHOTRIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: calyx five-toothed, crowning; corolla tubular; berry globular; seeds two, hemispherical, grooved. There are thirty-nine species.

PTELEA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Terebintaceæ, Jussieu. Essential character: calyx four-parted, inferior; corolla four-petalled; stigmas two; fruit with a roundish membrane, having one seed in the middle. There is but one species, viz. P. trifoliata, three-leaved ptelea, or shrubby trefoil, a native of North America.

PTERIS, in botany, a genus of the Cryptogamia Filices class and order. Natural order of Filices or Ferns. Generic character: fructifications in an uninterrupted marginal line; involucre from the margin of the frond turned in, uninterrupted, separating on the inner side. There are thirty-four species.

PTEROCARPUS, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Luguminosæ. Essential character: calyx five-toothed; capsule sickle-shaped, leafy, varicose; seeds few, solitary. There are six species, found chiefly in South America and the West Indies.

PTERONIA, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Discoidæ. Cinarocephalæ, Jussieu. Essential character: receptacle with many-parted bristles; down subplumose; calyx imbricate. There are eighteen species, all found at the Cape of Good Hope.

PTEROSPERMUM, in botany, a genus of the Monadelphia Dodecandria class and order. Essential character: calyx single, five-parted; corolla five-petalled; filaments fifteen, with five ligules, one between every three filaments; capsule five-celled, with the cells two-valved; seeds many, winged. There are two species, *viz.* P. suberifolium and P. acerifolium, both natives of the East Indies.

PTEROTRACHEA, in natural history, a genus of the Vermes Mollusca class and order. Generic character: body detached, gelatinous, with a moveable fin at the abdomen or tail; two eyes placed within the head. There are four species.

PTINUS, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ filiform, the last joints larger; thorax nearly round, not margined, receiving the head. There are about forty species, divided into sections: A. feelers clavate, lip entire. B. feelers filiform, lip bifid. Of the former section is P. pulsator, or death watch, which is of a dusky colour, with irregular grey brown spots. This insect is found in various parts of Europe in old wooden furniture, makes a peculiar ticking with the fore part of its head, resembling the beating with the nail upon a table; this is done in several distinct strokes in the night time, and has been considered by the common people as prophetic of some fatal occurrence in the family, but is nothing more than the call of one sex to the other. This must not be confounded with a much smaller insect of a very different genus, which makes a sound like the ticking of a watch, and continues for a long time without intermission. This belongs to a different order, and is the Termes pulsatorium of Linnæus. But the real death-watch of vulgar superstition is the ptinus. P. pertinax is brown, immaculate; thorax compressed. It inhabits Europe, and is very destructive to wooden furniture and books. When touched, it draws in its head and legs, and becomes immoveable. An insect strongly allied to this species inhabits the United States, and has generally been considered as the same, but from some of its characters we should suppose it to be specifically distinct.

PTOLEMAIC, or PTOLEMÆAN *system of astronomy*, is that invented by Claudius Ptolemy. This hypothesis supposes the earth immoveably fixed in the centre, not of the world only, but also of the universe: and that the sun, the moon, the planets, and stars all move about it from east to west, once in twenty-four hours, in the order following, *viz.* the Moon next to the Earth, then Mercury, Venus, the Sun, Mars, Jupiter, Saturn, the fixed stars, the first and second crystalline heavens, and above all the fiction of their *primum mobile.* This system, or hypothesis, was first invented and adhered to, chiefly because it seemed to correspond with the sensible appearances of the celestial motions.

PTOLEMY (CLAUDIUS), in biography, a very celebrated geographer, astronomer, and mathematician, among the ancients, was born at Pelusium, in Egypt, about the seventeenth year of the Christian era, and died, it has been said, in the seventy-eighth year of his age, and in the year of Christ 147. He taught astronomy at Alexandria, in Egypt, where he made many astronomical observations, and composed his other works. It is certain that he flourished in the reigns of Marcus Antoninus and Adrian; for it is noted in his Canon, that Antoninus Pius reigned twenty-three years, which shows that he himself survived him: he also tells us in one place, that he made a great many observations upon the fixed stars at Alexandria, in the second year of Antoninus Pius; and in another, that he observed an eclipse of the moon in the ninth year of Adrian; from which it is reasonable to conclude, that this astronomer's observations upon the heavens were many of them made between the year 125 and 140.

Ptolemy has always been reckoned the prince of astronomers among the ancients, and in his works has left us an entire body of that science. He has preserved and transmitted to us the observations and principal discoveries of the ancients, and at the same time augmented and enriched them with his own. He corrected Hipparchus's catalogue of the fixed stars; and formed tables, by which the motions of the sun, moon, and planets might be calculated and regulated. He was, indeed, the first who collected the scattered and detached observations of the ancients, and digested them into a system, which he set forth in his "Μεγαλη Συνταξις, sive Magna Constructio," divided into thirteen books. He adopts and exhibits here the ancient system of the world, which placed the earth in the centre of the universe; and this has been called, from him, the Ptolemaic System, to distinguish it from those of Copernicus and Tycho Brahe.

About the year 827, this work was translated by the Arabians into their language, in which it was called "Almagestum," by order of one of their kings; and from Arabic into Latin, about 1230, by the encouragement of the Emperor Frederic II. There were also other versions from the Arabic into Latin; and a manuscript of one done by Girardus Cremonensis, who flourished about the middle of the fourteeth century, Fabricius says, is still extant in the library of All Souls College, in Oxford. The Greek text of this work began to be read in Europe in the fifteenth century, and was first published by Simon Grynæus, at Basil, 1538, in folio, with the eleven books of Commentaries by Theon, who flourished at Alexandria in the reign of the elder Theodosius. In 1541, it was reprinted at Basil, with a Latin version by George Trapezond; and again at the same place in 1551, with the addition of other works of Ptolemy, and Latin versions by Camerarius. We learn from Kepler, that this last edition was used by Tycho.

Of this principal work of the ancient astronomers, it may not be improper to give here a more particular account. In general it may be observed, that the work is founded upon the hypothesis of the earth's being at rest in the centre of the universe, and that the heavenly bodies, the stars and planets, all move round it in solid orbs, whose motions are all directed by one, which Ptolemy calls the *primum mobile*, or First Mover, of which he discourses at large. But, to be more particular, this great work is divided into thirteen books.

In the first book, Ptolemy shows that the earth is in the centre of those orbs, and of the universe itself, as he understood it; he represents the earth as of a spherical figure, and but as a point in comparison of the rest of the heavenly bodies: he treats concerning the several circles of the earth, and their distances from the equator; as also of the right and oblique ascension of the heavenly bodies in a right sphere.

In the second book he treats of the habitable parts of the earth; of the elevation of the pole in an oblique sphere, and the various angles which the several circles make with the horizon, according to the different latitude of places; also of the phenomena of the heavenly bodies depending on the same.

In the third book he treats of the quantity of the year, and of the unequal motion of the sun through the zodiac: he here gives the method of computing the mean motion of the sun, with tables of the same; and likewise treats of the inequality of days and nights.

In the fourth book he treats of the lunar motions, and their various phenomena; he gives tables for finding the moon's mean motions, with her latitude and longitude; he discourses largely concerning lunar epicycles; and by comparing the times of a great number of eclipses mentioned by Hipparcus, Calippus, and others, he has computed the places of the sun and moon, according to their mean motions, from the first year of Nabonazar, king of Egypt, to his own time.

In the fifth book he treats of the instrument called the astrolabe; he treats also of the eccentricity of the lunar orbit, and the inequality of the moon's motion according to her distance from the sun; he also gives tables and an universal canon for the inequality of the lunar motions: he then treats of the different aspects or phases of the moon, and gives a computation of the diameter of the sun and moon, with the magnitude of the sun, moon, and earth, compared together; he states also the different measures of the distance of the sun and moon, according as they are determined by ancient mathematicians and philosophers.

In the sixth book he treats of the conjunctions and oppositions of the sun and moon, with tables for computing the mean time when they happen; of the boundaries of solar and lunar eclipses; of the tables and methods of computing the eclipses of the sun and moon, with many other particulars.

In the seventh book he treats of the fixed stars, and shows the methods of describing them, in their various constellations, on the surface of an artificial sphere or globe; he rectifies the places of the stars to his own time, and shows how different those places were then, from what they had been in the times of Timocharis, Hipparcus, Aristillus, Calippus, and others: he then lays down a catalogue of the stars in each of the northern constellations, with their latitude, longitude, and magnitudes.

In the eighth book he gives a like catalogue of the stars in the constellations of the southern hemisphere, and in the twelve signs or constellations of the zodiac. This is the first catalogue of the stars now extant, and forms the most valuable part of Ptolemy's works. He then treats of the galaxy, or milky-way; also of the planetary aspects, with the rising and setting of the sun, moon, and stars.

In the ninth book he treats of the order of the sun, moon, and planets, with the periodical revolutions of the five planets; then he gives tables of the mean motions, beginning with the theory of Mercury, and showing its various phenomena with respect to the earth.

The tenth book begins with the theory of the planet Venus, treating of its greatest distance from the sun; of its epicycle, eccentricity, and periodical motions; it then treats of the same particulars in the planet Mars.

The eleventh book treats of the same circumstances in the theory of the planets Jupiter and Saturn. It also corrects all the planetary motions, from observations made from the time of Nabonazar to his own.

The twelfth book treats of the retrogressive motion of the several planets, giving also tables of their stations, and of the greatest distances of Venus and Mercury from the sun.

The thirteenth book treats of the several hypotheses of the latitude of the five planets; of the greatest latitude or inclination of the orbits of the five planets, which are computed and disposed in tables; of the rising and setting of the planets, with tables of them. Then follows a conclusion or winding-up of the whole work.

This great work of Ptolemy will always be valuable, on account of the observations he gives of the places of the stars and planets in former times, and according to ancient philosophers and astronomers, that were then extant; but principally on account of the large and curious catalogue of the stars, which being compared with their places at present, we thence deduce the true quantity of their slow progressive motion, according to the order of the signs, or of the precession of the equinoxes.

Another great and important work of Ptolemy was, his Geography, in seven books; in which, with his usual sagacity, he searches out and marks the situation of places according to their latitudes and longitudes; and he was the first that did so. Though this work must needs fall far short of perfection, through the want of necessary observations, yet it is of considerable merit, and has been very useful to modern geographers. Cellarius, indeed, suspects, and he was a very competent judge, that Ptolemy did not use all the care and application which the nature of his work required; and his reason is, that the author delivers himself with the same fluency and appearance of certainty, concerning things and places at the remotest distance, which it was impossible he could know any thing of, that he does concerning those which lay the nearest to him, and fall the most under his cognizance. Salmasius had before made some remarks to the same purpose upon this work of Ptolemy. The Greek text of this work was first published by itself at Basil, in 1533, in quarto: afterwards with a Latin version, and notes, by Gerard Mercator, at Amsterdam, 1605; which last edition was reprinted at the same place, 1618, in folio, with neat geographical tables, by Bertius.

Other works of Ptolemy, though less considerable than these two, are still extant. As, "Libri quatuor de Judiciis Astrorum," upon the first two books of which Cardan wrote a commentary; "Fructus Librorum suorum," a kind of supplement to the former work; "Recentio Chronologica Regum;" this, with another work of Ptolemy, "De Hypothesibus Planetarum," was published in 1620, 4to., by John Bainbridge, the Savilian Professor of Astronomy at Oxford, and Scaliger, Petavius, Dodwell, and the other chronological writers, have made great use of it; "Apparentiæ Stellarum Inerrantium;" this was published at Paris by Petavius, with a Latin version, 1630, in folio; but from a mutilated copy, the defects of which have since been supplied from a perfect one, which Sir Henry Saville had communicated to Archbishop Usher, by Fabricius, in the third volume of his Bibliotheca Græea; "Elementarum Harmonicarum libri tres," published in Greek and Latin, with a commentary, by Porphyry, the philosopher, by Dr. Wallis, at Oxford, 1682, in 4to.; and afterwards reprinted there, and inserted in the third volume of Wallis's works, 1699, in folio.

Mabillon exhibits, in his German Travels, an effigy of Ptolemy looking at the stars through an optical tube; which effigy, he says, he found in a manuscript of the thirteenth century, made by Conradus, a monk. Hence, some have fancied, that the use of the telescope was known to Conradus. But this is only matter of mere conjecture, there being no facts or testimonies, nor even probablities, to support such an opinion.

It is likely that the tube was nothing more than a plain open one, employed to strengthen and defend the eyesight, when looking at particular stars, by excluding adventitious rays from other stars and objects, a contrivance which no observer of the heavens can ever be supposed to have been without.

PUBES. See ANATOMY.

PUBES, in botany, *hair* or *down;* a general term, expressive of all the hairy and glandulous appearances on the surface of plants. They are supposed to serve the double purpose of defensive weapons, and vessels of secretion. Different species of hairs have obtained different names; some are visible to the naked eye, while others are rendered visible only by the help of glasses; they are of different forms; in leguminous plants they are usually cylindric; in the mallow tribe, terminated in a point; in agrimony, shaped like a fish hook; in the nettle, awl-shaped and jointed; and in some compound flowers, they end in two crooked points.

PUBLIC *worship.* By law all contemners of public worship shall be, *ipso facto*, excommunicated; and if any person shall disturb a preacher in his sermon by word or deed, he shall be apprehended and carried before a justice, who shall commit him to gaol for three months.

PUDDING *stone*, in chemistry, a term invented by English lapidaries to designate one particular mineral aggregate, consisting of oblong and rounded pebbles of flint, about the size of almonds, imbedded in a hard siliceous cement. The pebbles are usually black, and the cement a light yellowish brown. It is capable of receiving a very high polish, and is used in ornamental works. It is found chiefly in Essex. The French mineralogists have naturalized the term, *poudingue*, and have applied it to all rounded stones imbedded in a cement, so as to make it nearly synonimous to the English "rubble-stone."

PUGIL, in physic, &c. such a quantity of flowers, seeds, or the like, as may be taken up between the thumb and two fore-fingers.

PUISNE, younger, junior; as, a puisne judge.

PULEX, in natural history, the *flea*, a genus of insects of the order aptera. Generic character: mouth without jaws or feelers, with a long inflected proboscis, covered at the base with two ovate laminæ; the sheath two-valved, five-jointed, and concealing a single bristle; lip rounded and fringed with reflected prickles; antennæ projecting, moniliform; two eyes; abdomen compressed; six legs formed for leaping. There are two species, *viz.* P. irritans, the common flea: and P. penetrans, or chigger.

The common flea is remarkable for undergoing the several changes experienced by the greater part of the insect race of other tribes, being produced from an egg in the form of a minute larva, which changes to a chrysalis, in order to give birth to the perfect animal. The egg is small, oval, and white, and from this in a few days is hatched the larva, which is destitute of feet, beset with hairs, and furnished at the head with a pair of short antennæ, and at the tail with a pair of slightly curved forks. The larvæ in about ten days arrive at their full growth, when they cease to feed, and casting their skin, change into the state of a chrysalis, which is of a white colour, and of an oval shape, with a slightly pointed extremity, and exhibits the immature limbs of the included insect. After remaining in the chrysalis state about a fortnight, the complete insect emerges, in its perfect form. The singularity most worthy of notice in the flea is the situation of the first pair of legs, which are placed beneath the head. The eyes are large, round, and black: the male is smaller than the female, with the back rather sinking than convex, as it always is in the female.

P. penetrans, or chigger, is a native of South America and the West India islands: it is said to be exceedingly troublesome in the sugar colonies, penetrating into the skin of the inhabitants, where it lodges its eggs, and causes malignant, and sometimes fatal ulcers.

PULLEY, in mechanics, one of the mechanical powers, called by seamen a tackle. See MECHANICS.

PULMONARIA, in botany, *lung-wort*, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Calyx prismatic five-cornered; corolla, funnel form, with an open throat. There are five species, of which P. officinalis, common lung-wort, has a perennial fibrous root, lower leaves rough, about six inches long and two and a half broad, of a dark green on their upper side, marked with many broad whitish spots, pale underneath; stalks almost a foot in height, having several smaller leaves on them, standing alternately; the flowers are produced in small bunches at the top of the stalks; calyx tubulous, hairy, as long as the tube of the corolla; brims of the petal spread open, shaped like a cup, red, purple and blue in the same bunch. Woodville observes, that the name pulmonaria, seems to have arisen rather from the speckled appearance of the leaves, resembling that of the lungs, than from any intrinsic quality, which experience has discovered to be useful in pulmonary complaints.

PULSE, in the animal œconomy, denotes the beating or throbbing of the heart and arteries.

PULTENÆA, in botany, so named in honour of William Pulteney, M. D. a genus of the Decandria Monogynia class and order. Generic character: calyx, five-toothed, with an appendage on each side; corolla, papilionaceous; the wings shorter than the standard; legume of one cell, with two seeds. There are six species, all natives of New Holland.

PULVERISATION, an operation, commonly employed in the apothecary's shop, by means of pestles and mortars. The bottom of the mortars should be concave; and their sides should neither be so inclined as not to allow the substances operated on to fall to the bottom between each stroke of the pestle, nor so perpendicular as to collect it too much together, and to retard the operation. The materials of which the pestles and mortars are formed, should resist both the mechanical and chemical action of the substances for which they are used. Wood, iron, marble, siliceous stones, porcelain and glass, are all very properly employed; but copper, and metals containing copper, are to be avoided, especially where the article operated upon has a tendency to corrode the metal.

PUMICE, in mineralogy, is of a greyish white colour: it occurs in mass and disseminated, being always more or less carious. It is glistening, with a silky lustre; its fracture is fibrous, its fragments are sharp edged; it is opaque, sometimes a little translucent on the edges; it is rather soft, but its particles in powder are very hard: it is fusible without addition before the blow-pipe into a white enamel; it is regarded as a volcanic product, and is wrought in considerable quarries in the Lipari islands, which are almost entirely composed of this mineral. It is found also in Sicily and Iceland. It is composed of

Silica	77.5
Alumina	17.5
Oxide of iron	1.75
	96.75
Loss	3.25
	100

This mineral is employed in the arts for grinding down metals, glass, ivory, &c. previously to polishing. It is likewise used in smoothing leather, and many other purposes of the like kind.

PUMP, in hydraulics, a machine formed on the model of a syringe, for raising of water. See HYDRAULICS.

PUMP *air*. See PNEUMATICS.

PUMP *chain*, consists of a long chain, equipped with a sufficient number of valves, at proper distances, which working upon two wheels, one above and the other below, passes downward through a wooden tube, and returns upward through another. It is managed by a long winch or roller, whereon several men may be employed at once, and thus it discharges, in a limited time, a much greater quantity of water than the common pump, and with less fatigue and inconvenience to the labourers. This machine was formerly exposed to several disagreeable accidents, by nature of its then construction. The chain was of too complicated a fabric, and the sprokel wheels, employed to wind it up from the ship's bottom, were deficient in a very material circumstance, *viz.* some contrivance to prevent the chain from sliding or jerking back upon the surface of the wheel, which frequently happened when the valves were charged with a considerable weight of water, or when the pump was violently worked. The links were evidently too short, and the unmechanical manner in which they were connected exposed them to a great friction in passing round the wheels. Hence they were sometimes apt to break or burst asunder in very dangerous situations, when it was extremely difficult, and sometimes impracticable to repair the chain. Of late, however, some considerable improvements have been made by Mr. Cole, under the direction of Captain Bentinck. The chain of this machine is more simple and mechanical, and less exposed to danger. It appears to have been first applied to the pump by Mr. Mylne, to exhaust the water from the caissons at Blackfriar's Bridge. It was thence transferred to the marine by Captain Bentinck, after having received some material additions to answer that service. The principal superiority of this pump to the former is, 1. That the chain is more simple and easily worked, and consequently less exposed to injuries by friction. 2. That the chain is secured upon the wheel, and thereby prevented from jerking back when charged with a column of water. 3. That it may be easily taken up and repaired when broken or choked with ballast, &c. And, 4 That it discharges a much greater quantity of water with an inferior number of men. This has been proved by experience, when two men (instead of four) discharged a tun of water in fifty-five seconds.

PUNCH, an instrument of iron or steel, used in several arts for the piercing or stamping holes in plates of metals, &c. being so contrived as not only to perforate, but to cut out and take away the piece. The punch is a principal instrument of the metal button-makers, wafer-makers, patch-makers, shoe-makers, &c.

PUNCHEON, a little block or piece of steel, on one end whereof is some figure, letter, or mark, engraven either in creux or relievo, impressions whereof are taken on metal, or some other matter, by striking it with a hammer on the end not engraved. There are various kinds of these puncheons used in the mechanical arts: such for instance are those of the goldsmiths, cutlers, pewterers, &c. The puncheon, in coining, is a piece of iron steeled, whereon the engraver has cut in relievo the several figures, arms, effigy, inscription, &c. that are to be in the matrices, wherewith the species are to be marked. Minters distinguish three kinds of puncheons, according to the three kinds of matrices to be made; that of the effigy, that of the cross, or arms, and that of the legend, or inscription. The first includes the whole portrait in relievo: the second are small, each only containing a piece of the cross or arms; for instance, a fleur-de-lys, an harp, a coronet, &c. by the assemblage of all which the entire matrice i formed. The puncheons of the legend only contain each one letter, and serve equally for the legend on the effigy side and the cross side.

Puncheon is also used for several iron-tools of various sizes and figures, used by the engravers in creux on metals. Seal-gravers particularly use a great number for the several pieces of arms, &c. to be engraven, and many stamp the whole seal from a single puncheon.

Puncheon is also a common name for all those iron instruments used by stone-cutters, sculptors, blacksmiths, &c. for the cutting, inciding or piercing their several matters. Those of sculptors and statuaries serve for the repairing of statues when taken out of the moulds; the locksmiths use the greatest variety of puncheons; some for piercing hot, others for piercing cold; some flat, some square, some round, others oval, each to pierce holes of its respective figure in the several parts of locks.

Puncheon, in carpentry, is a piece of timber placed upright between two posts, whose bearing is too great, serving, together with them, to sustain some large weights. This term is also used for a piece of timber raised upright, under the ridge of a building, wherein the little forces, &c. are jointed.

Puncheon, is also used for the arbor, or principal part of a machine, whereon it turns vertically, as that of a crane, &c.

Puncheon is also a measure for liquids, containing an hogshead and one third, or eighty-four gallons.

PUNCTUATION, the art of dividing a written composition into sentences, or parts of sentences, by points or stops, for the purpose of marking the different pauses which the sense requires.

The comma (,) represents the shortest pause; the semicolon (;) a pause double that of the comma; the colon (:) double that of the semicolon; and the period (.) double that of the colon. The precise duration of these pauses must depend on the degree of slowness or rapidity observed in reading; but the proportion between them should be ever invariable.

In order to determine clearly the application of the points, it is necessary to distinguish between a simple sentence and a compound sentence. A simple sentence contains only one finite verb: as, "Virtue refines the affections." A compound sentence has more than one finite verb expressed or implied, and therefore consists of two or more simple sentences connected together: as, "Virtue refines the affections; but vice debases them."

The comma is used to mark the pauses which occur in a simple sentence; the semicolon and the colon divide a compound sentence into the members which compose it; and the period is placed at the end of a sentence, to denote that it is complete, and unconnected with that which follows.

In a simple sentence, when two or more words of the same sort, or belonging to the same part of speech, occur, they are parted by a comma: as, "Husband, wife, and children;" "open, generous, sincere;" "to read, mark, learn;" "to live soberly, righteously, and godly," &c.

Where the connection of the different parts of a simple sentence is interrupted by necessary adjuncts, either to the subject or to the verb, the separation is generally marked by a comma: as, "To rouse mankind, when sunk in ignorance or superstition, and to encounter the rage of bigotry, armed with power, required the utmost vehemence of zeal, and a temper daring to excess."

The semicolon is used for dividing a compound sentence, and hence it occurs most generally in cases where the comma has preceded, and a greater pause is necessary: as, "Tribulation worketh patience; and patience, experience; and experience, hope." "He knew how to conciliate the most enterprising spirit, with the coolest moderation; the most obstinate perseverance, with the easiest flexibility; the most severe justice, with the greatest lenity: the greatest rigour in command, with the greatest affability of deportment; the highest capacity and inclination for science, with the most shining talents for action." In each of these examples the first clause forms a complete sentence, and what is expressed in it is understood in those which follow.

The colon divides a compound sentence into parts less connected than those which are separated by a semicolon. It may be properly applied in the three following cases:

1. When a member of a sentence is complete in itself, but is followed by some supplemental remark, or further illustration of the subject: as, "The knowledge of nature is only half the task of a poet: he must be acquainted likewise with all the modes of life."

2. When several semicolons have preceded: as, "Those who propagate evil reports frequently invent them; and it is no breach of charity to suppose this to be always the case; because no man who spreads detraction would scruple to produce it: and he who should diffuse poisons in a brook would scarce be acquitted of a malicious design, though he should allege that he received it of another who is doing the same elsewhere."

3. Where an example, a quotation, or a speech is introduced: as, "He was often heard to say: 'I have done with the world."

The period is employed to separate sentences which are not connected in construction; but it may be sometimes admitted, though they are joined by a copulative or disjunctive conjunction: as, "In passing judgment upon the characters of men, we ought to try them by the principles and maxims of their own age, and not by those of another. For, although virtue and vice are at all times the same, manners and customs vary continually."

Besides the points which mark the pauses in discourse, there are others, which denote a different modulation of voice in correspondence to the sense. These are,

The interrogation point . . ?
The exclamation point . . . !
The parenthesis . . . . (

The interrogation and exclamation points are sufficiently explained by their names: they are indeterminate as to their duration, and may in that respect be equivalent to a semicolon, a colon, or a period, as the sense requires. They generally mark an elevation of the voice.

The parenthesis is a clause introduced into the body of a sentence without affecting the construction. It marks a moderate depression of the voice, and may be marked with every point which the sense would require, if the parenthetical characters were omitted. It ought to terminate with the same kind of stop which the member has that precedes it; and to contain that stop within the parenthetical marks: as, "He found them asleep again; (for their eyes were heavy;) neither knew they what to answer him."

PUNICA, in botany, a genus of the Icosandria Monogynia class and order. Natural order of Pumaceæ. Myrti, Jussieu. Essential character: calyx five-cleft, superior; petals five; pome many-celled, many-seeded. There are two species; *viz.* P. granatum, common pomegranate tree, and P. nana, dwarf pomegranate tree; with several varieties, which are cultivated rather for the beauty of their scarlet-coloured flowers than for the fruit, which seldom arrives to any perfection in this country, so as to render it valuable.

PUR *auter vie,* where lands, &c. are held by another's life. See ESTATE.

PURCHASE, signifies the buying or acquisition of lands or tenements with money, or by deed or agreement; and not obtaining it by descent, or hereditary right.

PURITANS, a name given to the Protestant exiles who returned to England upon the accession of Queen Elizabeth.

These exiles were no sooner come to their native country, than they set about to carry on the work of reformation, even further than it had been done by the ecclesiastical laws of Elizabeth. This princess, with those that had weathered the storm at home, were only for restoring King Edward's liturgy; but the majority of the exiles were for the worship and discipline of the foreign churches, and refused to conform to the usages of the old establishment, declaiming loudly against the popish habits and ceremonies. For a time the Queen connived at their non-conformity; but no sooner did she find herself firmly established on the throne, than she gave the Puritans, as the reforming exiles were reproachfully called, a specimen of her proud spirit, and the nation a proof of her secret attachment to the principles and many of the ceremonies of the Romish faith. A Puritan, at that time, was a man of severe morals, a Calvinist in doctrine, and a non-conformist to the ceremonies and discipline of the church. As they did not avowedly separate from the church, they seem to have acted, in this particular, somewhat like the Wesleyan Methodists of the present day.

The aversion which Queen Elizabeth conceived against the Puritans induced her to act against them in the most cruel and rigid manner. "For," says Neal, "besides the ordinary courts of the bishops, her Majesty erected a new tribunal, called the High Commission, which suspended and deprived men of their livings, not by the verdict of twelve men upon oath, but by the sovereign determination of three commissioners of her Majesty's own nomination, founded not upon the statute laws of the realm, but upon the bottomless deep of the canon law; and instead of producing witnesses in open court to prove the charge, they assumed a power of administering an oath *ex officio*, whereby the prisoner was obliged to answer all questions the court should put to him, though never so prejudicial to his own defence; if he refused to swear, he was imprisoned for contempt; and if he took the oath, he was convicted upon his own confession." Such are the ingenious intricacies which a spirit of intolerance can invent to puzzle and embarrass its victims!

Having already, in some degree, anticipated the history of the Puritans, in the article PRESBYTERIANS, it is almost unnecessary to enlarge in this place.

Mr. Hume, whom no one will accuse of an unwarrantable prejudice for the principles of civil and religious liberty, observes, when speaking of the conduct of Elizabeth, "so absolute was the authority of the crown, that the precious spark of liberty had been kindled, and was preserved by the Puritans alone, and it was to this sect, whose principles appear so frivolous, and habits so ridiculous, that the English owe the whole freedom of their constitution." When it is considered who it is that thus speaks of the Puritans, and when it is also considered what is meant by "the whole freedom of the English constitution," it will be thought that we, of the present day, are debtors, of no small magnitude, to the zeal and perseverance of the ancient Puritans.

It must, however, be granted, that when the persecutions carried on against the Puritans, during the reign of Elizabeth and the Stuarts, had driven the Puritans once more to seek refuge abroad, they now, in their turn, persecuted others who dissented from them. Those who formed the colony of Massachusett's Bay, having never relinquished the principle of a national church establishment, were less tolerant than those who settled at Plymouth, at Rhode Island, and at Providence plantations. The consequence was, they did not fail to discover that their sufferings and trials had not fully taught them the lessons of christian forbearance and universal toleration. Happily for the peace and security of mankind, those lessons are now better understood; and little remains of the offensive parts of Puritanism, besides what is to be found in the genius of high Calvinism, still unhappily possessing the minds of some of the sectaries of our own time. We may, however, fairly hope that the time is fast approaching, when the true principles of liberty shall be not only acknowledged, but fully acted upon; and the spirit of enthusiasm and bigotry known only to be execrated, and remembered only to be avoided. See Dr. Toulmin's edition of Neal's History of the Puritans, and Palmer's Nonconformist's Memorial; two works of considerable merit, and fraught with information, on the history and principles of the Puritans. See also the articles, NON-CONFORMISTS, PRESBYTERIANS, PROTESTANTS, and REFORMATION.

PURLUE, or PURLIEU, signifies all that ground near any forest, which, being made forest by King Henry II. Richard I. and King John, was afterwards, by perambulations and grants of Henry III. severed again from the same, and made purlieu; that is to say, pure and free from the laws of the forest.

Purlue *man*, or Purlieu *man*, a person who has ground within the purlieu, and is qualified to hunt within the same, though under certain restrictions.

By a statute of Charles II. no man may keep greyhounds within the purlieu, or elsewhere within England and Wales, unless he have a free warrant, or be lord of a manor, or such a freehold as is seized in his own right, or in right of his wife, of lands, tenements, or hereditaments, of the clear yearly value of 40*l.* over and above all the charges of reprises of such estate of inheritance; or of lands, tenements, &c. in his own right, or in the right of his wife, for the term of life or lives, of the yearly value of 80*l.* over and above all charges and reprises; or that is worth, in goods or chattels, 400*l.* Others, that are not thus qualified, and yet have land in the purlieus, if they find beasts of the forest in their own ground, within the purlieu, may chase them out with little dogs, though not with greyhounds.

PURPLE. See Dyeing.

PURPURE, Pourpre, or Purple, in heraldry, according to some, is one of the five colours of armories, compounded of gules and azure, bordering on violet, and, according to others, of a great deal of red and a little black. But it was excluded by the ancient heralds as only an imperfect colour. In the coats of noblemen, it is called amethyst; and, in those of princes, mercury. It is represented in engraving by diagonal lines, drawn from the sinister chief to the dexter base point.

PURSER, an officer aboard a man of war, who receives her victuals from the victualler, sees that it be well stowed, and keeps an account of what he every day delivered to the steward. He also keeps a list of the ship's company, and sets down exactly the day of each man's admission, in order to regulate the quantity of provisions to be delivered out, and that the paymaster or treasurer of the navy may issue out the disbursements, and pay off the men, according to his book.

PUS, in medicine. What is called healthy pus is about the consistence of cream, and of a yellowish-white colour, an insipid taste, and when it is cold, without smell. It produces no change on vegetable blues. When pus is exposed to a moderate heat, it dries and assumes the appearance of horn. By distillation it gives out water in considerable proportion, ammonia and some gaseous substance, and an empyreumatic oil; a shining coaly matter remains behind, the ashes of which, after being burnt, afforded some traces of iron. The following tests have been given to distinguish pus from mucus, which is of considerable importance in cases where the formation of pus is suspected in the lungs. 1. Pus is soluble in sulphuric acid, and precipitated by water; mucus swims. 2. Pus may be diffused through water, diluted sulphuric acid, and brine; but mucus is not. 3. Pus is soluble in alkaline solutions, and is precipitated by water; but this is not the case with mucus. These are the properties of pus when it is secreted from a sore which is said to be in good condition, or in a disposition to heal. Its properties are very different in what are called ill-conditioned sores. In these cases, the matter secreted is thin, fetid, and acrid. Matter secreted by cancerous sores, which has been examined, converts the syrup of violets to a green colour; and from this matter sulphurated hydrogen gas is separated by means of sulphuric acid. This gas is supposed to exist in combination with ammonia.

PUTAMINEÆ, in botany, the name of the twenty-fifth order in Linnæus's Fragments of a Natural Method; the fleshy seed-vessel of which is frequently covered with a hard, woody shell: among the genera of this, are the capparis, caper-bush; and the crescentia, calabash-tree. Most of the plants of this order are acrid and penetrating, and yield, by burning, large quantities of alkali. The flower-buds of the caper-bush, preserved with vinegar, furnish the pickle well known by the name of capers. The calabash-tree is large and spreading, like an apple-tree: the fruit, when largest, is capable of holding, when the pulp is cleared out, about two gallons of water, and is used in the West Indies, as drinking cups, punch-bowls, and other articles of household furniture.

PUTREFACTION, is that spontaneous process of decomposition which takes place in all the soft parts of animals, and some vegetables, by which they are finally disorganized, and resolved into a variety of gaseous and volatile substances which mix with the atmosphere. See Physiology.

PUTTING *in fear*. See Robbery.

PUTTOCKS, or Puttock *shrouds*, in a ship, are small shrouds which go from the shrouds of the main-mast, fore-mast, and mizen-mast, to the top-mast shrouds; and if there be any top-gallant masts, there are puttocks to go from the top-mast shrouds into these. These puttocks are at the bottom seized to a staff, or to some rope which is seized to a plate of iron, or to a dead man's eyes, to which the laniards of the fore-mast shrouds do come.

PUTTY, in the arts, is a substance used in polishing metals, precious stones, and glass; it is also the base of most of the opaque enamels. It is made by calcining equal parts of tin and lead. Glazier's putty was probably composed of this true putty and oil; but what they now use is a mixture of whiting and linseed oil, which has the property of becoming very hard and durable by exposure to the air.

PUZZOLANA, or Pozzulana, a kind of earth found about Puteoli, Baiæ, and Cumæ, in the kingdom of Naples. It is thrown out from the burning mouths of volcanoes, in the form of ashes; sometimes in such large quantities, and with so great violence, that whole provinces have been covered with it at a considerable distance. Puzzolana is of a grey, brown, or blackish colour; of a loose, granular, or dusty and rough, porous or spongy texture, resembling a clay hardened by fire, and then reduced to a gross powder. It has various heterogeneous substances mixed with it. Its specific gravity is from 2.5 to 2.8; and it is, in some degree, magnetic: it scarcely effervesces with acids, though partially soluble in them. It easily melts *per se*; but its most distinguishing property is, that it hardens very suddenly when mixed with one-third of its weight of lime and water; and forms a cement which is more durable in water than any other. According to Bergman's analysis, 100 parts of it contain from 55 to 60 of siliceous earth, 20 of argillaceous, 5 or 6 of calcareous, and from 15 to 20 of iron. Its effects, however, in cement may perhaps depend only on the iron, which has been reduced into a particular substance by means of subterraneous fires; evident signs of which are observable in the places where it is obtained.

PYRAMID, in architecture: this form we derive from the Egyptians, a people who conceived and executed unparalleled works, which are, however, more remarkable for their strength and durability than elegance of otuline, and beauty of execution. According to Herodotus, the people alluded to considered the pyramidal form as emblematic of human life, the broad base representing the commencement, and the gradation, to a point, the termination of our existence in the present state; hence they used it for sepulchral purposes: it would be absurd to contradict this assertion, as the period of their erection is too remote for enquiry, with any probable success; but there is another obvious reason for the adoption of the shape, which of all others is most decidedly calculated to resist the operations of time. Admitting a monarch to have conceived an idea of rendering his tomb almost everlasting, it was impossible to invent an outline less liable to injury from the assaults of wind and rain, and the very disposition of the stones made it impossible that it should fall even through the operations of an earthquake, besides the immense extent of their bases, and the solidity of the workmanship made it highly improbable that his successors, or the people, would be at the trouble and expense of destroying it through disrespect to his memory; this circumstance, perhaps, united with the former consideration, were sufficient inducements for the selection of the pyramid for monuments.

Some authors derive the word from the Greek for wheat and its receptacle, and those assert that pyramids were originally built by the Patriarch Joseph as granaries; others derive it from the word πυρ, fire, thinking that the pyramidal shape resembles the ascent of flame.

There are several pyramids in Egypt, but those at Gizeh are the most gigantic; and the most enormous, or the great pyramid, is situated near Memphis. Herodotus says he was informed the latter covered the remains of Cheops, and another adjoining those of his brother Cephrenes, who succeeded him; the first only having inner galleries, or passages. Although much dependence cannot be placed upon the further accounts of this ancient writer, it seems highly probable that 100,000 men may have been constantly employed, for 20 years, in erecting the immense pile, and that Cheops became detested by the people, who were thus taken from more useful employments, as well as by the bulk of the population, who found the taxes demanded of them appropriated to a purpose utterly unproductive of future advantage.

When M. Savary visited the pyramids of Gizeh, the country was under the government of its present natives, whose kiaschif, or governor, for the above district, exacted a small tribute from travellers, and in return provided them with an escort, as a protection against the Arabs, who seized every opportunity to plunder them. The gentleman just mentioned, accompanied by some friends, and the guards furnished by the kiaschif, departed from Gizeh at an hour after midnight, and were soon after gratified with a view of the two greatest pyramids, on the summits of which the moon shone with full splendour; as they approached them, they assumed the appearance of vast pointed rocks, penetrating the clouds. At half an hour past three in the morning, the company prepared to enter the passages of the great pyramid, by taking off great part of their clothing, and each taking a lighted torch in his hands, thus prepared, they began a long descent, which, at last, became so much contracted, that the party were compelled to crawl upon their hands and knees; this terminating, they commenced an ascent nearly under the same uncomfortable circumstances, except that they proceeded on their knees, and made use of their hands against the sides to facilitate their progress, and this mode of getting forward was necessary, as the stone at the bottom of the passage did not afford sufficient level for a firm step; when in this dismal gallery they were so imprudent as to discharge a pistol, the report of which long echoed and re-echoed through the place, and alarmed numbers of bats, who darted against them and extinguished some of their torches. Succeeding in their efforts, they arrived at the upper termination of the second passage, where they passed through a very small door into a large oblong apartment, entirely composed of granite, seven enormous blocks of which formed the ceiling.

At one extremity of this apartment M. Savary saw an empty marble sarcophagus, composed of one piece, but without a lid, and fragments of earthen vases lay scattered over the floor of the room; they also visited a second chamber, situated beneath that just described, and of smaller dimensions, which contained the entrance of a conduit, then filled with rubbish. Satisfied with the progress they had made, the party descended by the passage already noticed, and with some difficulty avoided a deep and dangerous well on their left hands; on their arrival in the open air, each person observed that his companions were pale and exhausted by the heat they endured, when immured within the frightful abyss they had just explored.

After having rested their weary limbs, and recovered their strength and spirits, the party began to ascend the exterior of the pyramid, which consists, according to their enumeration, of above 200 gradations of stone, varying from two to four feet in height. This operation, fatiguing and severely laborious, occupied an hour; but, on their reaching the summit, they had the satisfaction of seeing, that the rays of the approaching sun were darted on the points of Mokaltam, and not long after they beheld it rise from behind that mountain; the landscape, thus illuminated, they perceived, with infinite pleasure, the Nile and the adjoining fruitful fields, Gizeh, Grand Cairo, and part of the Delta, forming a striking contrast with the remainder of the view, composed of sterile hills and wide-spreading sands, with the intervening pyramids of Sakkara, three leagues from their then situation.

Fully sated with the rich prospect before them, they cut their names on the upper stones of the pyramid, and descended with the utmost caution, as this was a far more dangerous undertaking than the ascent; having reached the base in safety, they paced around it, and contemplated the rugged mass with terror, which strongly resembles a vast pile of detached rocks when near it, but at a distance, the inequalities are lost, and the sides appear plain surfaces. The form of this immense monument prevents an accurate measurement of its dimensions, without severe labour and imminent danger; consequently, those authors who give them, may have judged from mere conjecture. Herodotus mentions its reputed height, in his time, to have been 800 feet, and the width of each side of the base the same; Strabo made it 625 feet; but Diodorus reduces it to 600; modern observers have agreed with Strabo, and some of those bring it below Diodorus; if, however, an average may be permitted of these various accounts, that will amount to more than 500 feet.

One cause of the difference between the assumed heights is, that the pyramid is measured or observed on different sides; the north-east angle is most frequently ascended, being the least damaged, but this part is exposed to the deserts of Libya, whence vast quantities of sand are driven by the wind against it, and the number of visible gradations are diminished by its accumulation; it is, therefore, evident, that all admeasurements should be made at the opposite angle, where it is probable the rise in the earth has been less considerable; and yet, to arrive at any degree of accuracy, that should be ascertained by digging. Strabo mentions, that the stone which closed the entrance to the apartments within the pyramid, was situated nearly half way up one of the sides; were this the fact, a very great rise in the neighbouring earth must have occurred, as it now appears to be not more than 100 feet from the base. Herodotus informs us, that the great and next pyramid, in size, were covered with white marble; and Diodorus and Pliny supposed, they were wholly formed of that rich material; enough still remains on both to confirm the truth of the former assertion, which has escaped the labours of the Arabs, to whose indefatigable researches, to discover supposed treasures within, we are indebted for the finding the entrance to the passage, and that the pyramid was intended as a sepulchral monument for the Egyptian princes.

Denon, who accompanied the ever-memorable expedition from France to Egypt, is the last visiter of the pyramids, and to him we are obliged for the following particulars of their present state.

General Buonaparte had determined to examine the great pyramids of Gizeh, and ordered an escort of near 300 men. Denon had the address to become one of the party, and they proceeded on the undertaking rather late in the day, owing to the difficulty of assembling the persons who composed it. Boats were procured to convey them, and they passed through the inundating trenches of the Nile to the boundary of the desert, within half a league of the pyramids. As they approached them, Denon perceived that their sloping and angular forms had the effect of reducing their real height, which the eye was thus prevented from measuring with accuracy; besides, as there are no other objects in their vicinity, by which a comparison can be made, the mind is led to think of nature's grandest production, the mountain, and in consequence, the pyramid shrinks into insignificance. This impression was, however, very soon effaced, for as Denon advanced, he saw an 100 persons assembled near the base, the deception instantly vanished, a comparison was formed, and the stupendous pile assumed all its appropriate majesty.

The party ascended a small heap of rubbish and sand, the probable remains of the trench of the first of these edifices which presents itself, and now conducting to the opening through which it may be reached; this aperture, said by Denon to be about 60 feet from the base, is hidden by a general facing of stone, forming the third or inner enclosure to the solitary entrenchment surrounding the pyramid. Large stones are laid horizontally on the sides of the entrance, and above those are others of enormous size, fitted at the ends so as to lean against each other, by this means rendering their fall or derangement impossible, through the superincumbent weight. Hence commences the first gallery, with a direction towards the centre and base of the monument; this gallery is now greatly clogged with the drifted sand of the desert, and the rubbish originally made by the efforts to explore the secrets of the edifice, it is consequently difficult of access. "At the extremity of this gallery," says Denon, "two large blocks of granite are met with, which form a second partition to this mysterious passage." The interruption made by those in the progress of past research was such, that various fruitless attempts have been made to surmount the impediment, and some have even had the folly to cut into the solid mass composing the pyramid, "but this proving unsuccessful, they have returned some way, have passed round two blocks of stone, climbed over them, and thus discovered a second gallery, of so steep an ascent, that it has been necessary to hew steps in the ground in order to mount it. This gallery leads to a kind of landing-place, in which is a hole, usually called the well, which is the opening to an horizontal gallery, leading to a chamber known by the name of the queen's chamber, without ornament, cornice, or any inscription whatever.

"Returning to the landing-place, an aperture, in a perpendicular direction, leads to the principal gallery, and this terminates in a second landing-place, where a third and last partition is situated; as this is constructed with a greater degree of architectural care and propriety than the rest of the building, it may be inferred that the Egyptians considered it proper to guard the immediate deposit of their dead with peculiar attention.

"Lastly comes the royal chamber, containing the sarcophagus, a narrow sanctuary, which is the sole end and object of an edifice so stupendous, so collossal."

We have thus enabled the reader to compare the two latest accounts of the pyramids of Egypt, and it will be found that though they differ in the method of description, that each author has been correct in stating the facts relating to them. Denon concludes his detail with several just and severe observations on the pride of those by whose order they were erected, and the barbarous ignorance and stupidity which governed those who obeyed its dictates; and yet, strange as it may appear, it becomes necessary to mention a pyramid erected by the very Frenchmen, who, having visited Egypt, and witnessed the effects of ancient despotism, perversely imitated the devotion of its inhabitants to a military idol, who has wofully convinced the world how little that devotion is deserved.

The pyramid alluded to is situated in Holland, was designed by the chief of the battalion of engineers of the French army there, is 110 French feet high, exclusive of an obelisk on the summit, which is 42 feet more; and the sides have four inscriptions, three adulatory, and the last to the following purport: "This pyramid was raised to the august Emperor of the French, Napoleon the First, by the troops encamped in the plain of Zeyst, being a part of the French and Batavian army, commanded by the Commander in Chief, Marmont." As 30,000 men assisted in this undertaking, it was completed in 32 days, in the year 12, by their computation.

Pyramid, in geometry, a solid, standing on a triangular, square, or polygonal basis, and terminating in a point at the top; or, according to Euclid, it is a solid figure, consisting of several triangles, whose bases are all in the same plane, and have one common vertex.

Hence the superficies of a given pyramid is easily found by measuring these triangles separately; for their sum added to the area of the base is the surface of the pyramid required. It is no less easy to find the solid content of a given pyramid; for the area of the base being found, let it be multiplied by the third part of the height of the pyramid, or the third part of the base by the height, and the product will give the solid content, as is demonstrated by Euclid, lib. 12. prop. 7. If the solid content of a frustrum of a pyramid is required, first let the solid content of the whole pyramid be found; from which subtract the solid content of the part that is wanting, and the solid content of the frustrum, or broken pyramid, will remain. Every pyramid is equal to one third of its circumscribing prism, or that has the same base and height; that is, the solid content of the prism is equal to one third of the prism For supposing the base a square, then does the pyramid consist of an infinite number of such squares, whose sides, or roots, are continually increasing in arithmetical progression, beginning at the vertex or point, its base being the greatest term, and its perpendicular height the number of all the terms: but the last term multiplied into the number of terms will be triple the sum of all the series, equal the solid content of the pyramid.

All pyramids are in a ratio compounded of their bases and altitudes; so that if their bases be equal, they are in proportion to their altitudes; and *vice versa.* Equal pyramids reciprocate their bases and altitudes; that is, the altitude of one is to that of the other, as the base of the one is to that of the other.

PYRITES. Iron, in combination with sulphur, forms a mineral substance, which has been long known under the name of Pyrites, and which is very extensively diffused. It occurs massive, disseminated, and frequently crystallized: the forms of its crystals are various, but the most common is the cube regular, or modified by truncation of the angles or edges, or accumination of three planes on the angles: the octaedron, dodecaedron, and icosaedron, also sometimes occur.

Its colour is brass-yellow, varying a little in the shade, and the lustre is always fully metallic: it is opaque. The fracture is uneven. It is brittle; its hardness is such as to strike fire with steel; its specific gravity is from 4.6 to 4.8. By friction it exhales a sulphurous smell. This odour is strong when it is heated before the blow-pipe; it gives at the same time a blue flame; and at length a globule of a brownish colour. It is soluble in nitric acid, with the disengagement of red vapours. It is not sensibly magnetic. Various analyses of it have been given: according to those executed by Mr. Hatchet, it consists of

Sulphur	52
Iron	48
	100

Besides this, which may be named common Pyrites, there are some others which may be regarded as varieties of the species, and which differ principally in structure, or in the form under which they occur. The striated or radiated pyrites presents a striated fracture, the striæ being generally diverging.

It is rather more liable to tarnish than the preceding, and decomposes more readily in a humid atmosphere. According to Mr. Hatchet's analysis, it consists of

Sulphur	54
Iron	46
	100

The capillary pyrites occurs in delicate capillary crystals, grouped, parallel, diverging or interwoven, slightly flexible, having a metallic lustre, and a colour passing from yellow to steel-grey. There is, lastly, the hepatic pyrites, so named from the liver-brown colour which it assumes from exposure to the air. In the fresh fracture its colour is pale brass-yellow, inclining to steel-grey. It occurs massive, of various imitative forms, and crystallized in six-sided prisms, or six-sided pyramids: it has less lustre than the others, and is more subject to decomposition. What has been named magnetic pyrites, distinguished, as the name implies, by its magnetic quality, of which the others are destitute, has been considered as forming a distinct species. Its colour is deeper, being intermediate between brass-yellow and copper-red, and approaching even to brown, often tarnished: its lustre is also inferior, but is still metallic. It occurs only massive or disseminated. Its fracture is compact: it is hard and brittle: its specific gravity is 4.5. It appears from Mr. Hatchet's analysis of it to differ from the other iron pyrites, in containing a larger proportion of metal, to which, no doubt, its quality of being attracted by the magnet is owing.

PYROLA, in botany, *winter-green*, a genus of the Decandria Monogynia class and order. Natural order of Bicornes. Ericæ, Jussieu. Essential character: calyx five parted; petals five; capsule superior, five-celled, opening at the corners, many-seeded; anthers with two pores. There are six species, natives of the North of Europe.

PYROLIGNOUS and PYROTARTAROUS *acids*. When wood is distilled in close vessels, it always yields more or less of an acid juice: the same remark applies to the salt called tartar. These liquids were distinguished by the name of pyrolignous and pyrotartarous acids: but they are now known to be only the acetic disguised by the presence of a peculiar oil.

PYROMETER, an instrument for measuring the expansion of bodies by heat. The whole art in forming an instrument, adapted to this purpose, is so as to render it capable of showing very small expansions of solid bodies. Different instruments have been invented for this purpose; of the greater number of which it is scarcely necessary to give a detailed account. The difficulty of contriving an unexceptionable instrument of this kind has arisen partly from the difficulty of finding a substance not liable to be altered by a high temperature, and which shall suffer a change of volume sufficiently perceptible to be accurately measured; and partly from that of finding a measure, which shall not itself be affected by the high temperature, and be, at the same time, sufficiently delicate.

The pyrometer, in which, perhaps, these difficulties have been most effectually surmounted, and which has come into most general use, is that invented by the late Mr. Wedgwood. The pure earth, named alumina, and the different earths, (the clays) in which it predominates, have the singular property of not expanding, but of contracting by heat. This contraction begins to become evident, when the clay is raised to a red heat, it continues to proceed until it vitrifies, and the total contraction, in pure clays, exceeds considerably one-fourth part of the volume in every direction. It occurred to Mr. Wedgwood, that from this property it might be employed in the construction of a pyrometer. The contraction that the clay suffers is permanent, or it does not return to its former dimensions when cold. The degree of contraction it has suffered, therefore, can be ascertained without any source of fallacy, and will indicate the extreme of temperature to which it has been exposed.

This pyrometer consists of a gauge, composed of two straight pieces of brass, twenty-four inches long, divided into inches and tenths, and fixed in a brass plate, so as to converge; the space between them, at the one extremity, being five-tenths of an inch, and at the other three-tenths. The pyrometrical pieces of clay are small cylinders, flattened on one side, made in a mould, so as to be adapted exactly to the wider end. It is evident that, in exposing one of these pieces to a high temperature, the contraction it has suffered may be measured, by the length to which it can be slid into the converging groove or gauge.

The utility of this instrument, it was obvious, would be much increased by connecting it with the mercurial thermometer, and by ascertaining the proportion between the degrees of each; and this was done by Mr. Wedgwood. The scale of his pyrometer commences at red-heat fully visible in day-light. The mercurial thermometer cannot easily measure any temperature above 500° or 550°; and hence, between the termination of the scale in the one, and its commencement in the other, there is a range of temperature requiring to be measured. This Mr Wedgwood did, by the expansions of a square piece of silver, measured in a gauge of earthen-ware, constructed in the same way as his pyrometer; and by the same method, he found out the proportion between each degree of his scale, and that of any of the usual thermometrical scales. Each degree of his pyrometer he found to be equal to 130° of Fahrenheit. The commencement of his scale, or the point marked 0, corresponds with 1077½° of Fahrenheit's scale. From these data, it is easy to reduce either to the other, through their whole range. The scale of Wedgwood includes an extent of temperature equal to about 32,000° of Fahrenheit, or 54 times as much as that between the freezing and boiling points of mercury. Its commencement, as has been stated, is at 1077½° of Fahrenheit, or red-heat fully visible in day-light; its extremity is 240°; but the highest heat that he measured with it is 160°, or 21,877° of Fahrenheit; being the temperature of a small air-furnace, and 30° degrees of his scale above the point at which cast-iron melts.

Guyton has proposed a pyrometer for measuring high temperatures, in which platina, a metal not fusible even at very intense heats, is employed as the measure of expansion. A rod or plate of this metal is placed horizontally in a groove framed in a mass of hardened white clay; one extremity of the rod is supported on the mass which terminates the groove; the other presses against a bended lever of platina, the longest arm of which forms an index to a graduated arc. The expansion, which the rod of metal suffers from exposure to heat, is indicated by the change of position in this index. The mass of clay, being highly baked, will not introduce any important error from its contraction; and the expansion, which it may suffer during the exposure to heat, will affect only the small distance between the axis of motion of the index, and the point of contact of the plate, so as rather to diminish the effect than to increase it. Platina, having the important advantage of not melting by any heat we have to measure, and of not suffering any chemical change from it, is well adapted to the construction of a pyrometer.

Besides these, various metallic pyrometers have been invented, capable of measuring low temperatures, by the expansion being multiplied by the aid of wheels, levers, or other mechanical contrivances, or being magnified by microscopes. Such are the pyrometers of Muschenbroeck; that described by Ferguson; one invented by Mr. Ellicot, with which he measured the expansions of various metals; one by Mr. Smeaton, and applied to the same purpose; Mr. Ramsden's, superior to the preceding ones in delicacy and accuracy; Mr. Crichton's, in which advantage is taken of the difference of expansion between a rod of zinc and a rod of iron, to give a curvature to the bar composed of the united rods, proportioned to the temperature to which they are raised; by which bending motion is given to an index, that, at its other extrimity, where the scale is marked, describes a considerable space; and, lastly, one by Regnier, on a principle somewhat similar, of which a report is presented to the French National Institute. The strict accuracy of these instruments may, from the nature of their construction, be regarded as doubtful. It has been found, by Ellicot's pyrometer, that the expansion of bars of different metals, by the same degree of heat, is as follows:

Gold.	Silver.	Brass.	Copper.	Iron.	Steel.	Lead.
73	103	95	89	60	56	149

PYROMUCOUS *acid.* When sugar and other sweet tasted substances are distilled, among other products there is always a notable quantity of an acid liquid. This acid, when rectified, obtained the names of syrupus acid, and afterwards pyromucous acid. It is now known from the recent experiments of Fourcroy and Vauquelin, that this acid is nothing else than the acetic, holding in solution a portion of empyreumatic oil.

PYROPE, in mineralogy, a species of

the Flint genus. Its colour is dark blood red, which, when held between the eye and the light, falls strongly into yellow. It occurs in angular grains, which are imbedded, but never crystallized; it is completely transparent and hard; specific gravity about 3.8. It is composed of

Silica	40.00
Alumina	28.50
Magnesia	10.00
Lime	3.50
Oxide of iron	16.50
—— manganese	0.25
	98.75
Loss	1.25
	100

It is found in many parts of Germany; also in Fifeshire in Scotland, in the sand of the sea-shore. It is employed in almost every kind of jewellery, and generally set in gold foil. The very small grains are powdered, and used in the stead of emery in cutting softer stones. This was formerly considered as a variety of the garnet, and denominated the Bohemian Garnet, from its occurring in that country in great beauty and perfection. Werner has given the title to a distinct species, on account of its colour, transparency, and want of crystallization.

PYROPHORUS, in chemistry, a compound substance, which takes fire on the admission of the atmospheric air. It is prepared by exposing to heat in an iron pot, three parts of alum, with one part of flour; the mixture liquefies, and is to be stirred constantly till the whole becomes grey, and easily reducible to powder while hot.

The coarse powder is put into a coated phial, so as nearly to fill it; the mouth of the phial is stopped with a small plug of clay, and is placed in a crucible, and surrounded with sand up to the neck. The crucible is heated to redness, until a blue flame appears at the mouth of the phial; when this has continued ten minutes, the crucible is removed from the fire, and the phial, when sufficiently cold, is accurately stopped. This substance inflames in atmospheric air; in a moist atmosphere, the inflammation is much more speedy, and in a dry air it can scarcely take place. It burns also very brilliantly in oxygen gas, in nitrous gas, and in oxymuriatic acid gas; and is inflamed by the sulphuric and nitric acids. See ALUM.

PYROSTRIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Generic character: calyx very small, four-toothed; corolla bell-shaped, five-cleft, tomentose in the throat; stamina four; pistils one; stigma capitate; pericarpium drupe, pear shaped, inferior, small, eight-streaked; nuts eight, one-seeded. There is but one species, *viz.* P. salicifolia, a native of the island of Mauritius.

PYROTECHNY, is, properly speaking, the science which teaches the management and application of fire in divers operations; but in a more limited sense, and as it is commonly used, it refers chiefly to the composition, structure, and use of artificial fire-works. The ingredients are, 1. saltpetre, purified for the purpose: 2. sulphur, and 3. charcoal. Gunpowder is likewise used in the composition of fire-works, being first ground, or, as it is technically termed, mealed. Camphor and gum-benzoin are employed as ingredients in odoriferous fire-works. The proportions of the materials differ very much in different fire-works, and the utmost care and precaution are necessary in the working them to a state fit for use, and then in the mixing. In this work we cannot enter on the subject with a sufficient degree of minuteness to teach the method of making of fire-works, and shall therefore content ourselves with a brief notice of the proportions of the materials in some of the more common, and more interesting articles in use.

The charges for sky-rockets are made of saltpetre, four pounds; brimstone, one pound; and charcoal one pound and a half; or by another direction, saltpetre, four pounds; brimstone, one pound and a half; charcoal, twelve ounces; and meal powder, two ounces. These proportions vary again according to the size of the rocket; in rockets of four ounces, mealed-powder, saltpetre, and charcoal, are used in the proportions of 10 : 2 and 1; but in very large rockets the proportions are, saltpetre, four; mealed-powder and sulphur, one each. When stars are wanted, camphor, alcohol, antimony, and other ingredients are required, according as the stars are to be blue, white, &c. In some cases gold and silver rain is required; then brass-dust, steel-dust, saw-dust, &c. enter into the composition; hence the varieties may be almost indefinite. With respect to colour, sulphur gives a blue, camphor a white or pale colour, saltpetre a clear white yellow, sal-ammoniac a green, antimony a reddish, rosin a copper colour. These materials require preparation before they are fit for use; and before a person can be qualified for the business of fire-work making, he must understand the method of making the moulds, cases, &c. and be acquainted with the instruments used in the art, their dimensions and materials. To discuss the several topics connected with the business would require a space very much larger than could be afforded in this work; we shall therefore content ourselves with this notice, referring our readers to distinct treatises on the subject, which are to be found in the English and French language.

PYRUS, in botany, a genus of the Icosandria Pentagynia class and order. Natural order of Pomaceæ. Rosaceæ, Jussieu. Essential character: calyx five-cleft; petals five; pome inferior, five-celled, many-seeded. There are thirteen species, with many varieties. The P. communis, common pear-tree, grows to a lofty height, with upright branches, the twigs or branchlets hanging down; leaves elliptical, obtuse, serate; the younger ones clothed with a deciduous cotton underneath and along the edge; stipules linear; flowers in terminating villose corymbs; corolla snow-white; pome produced at the base; hard and acerb, in the wild state, with five cells in the middle, each two-valved, containing two seeds. The wood of the pear is light, smooth, and compact; it is used by turners, also for joiners' tools, for picture frames to be stained black; the leaves afford a yellow dye, and may be used to give a green to blued cloths: the juice of the fruit fermented is called Perry. The P. malus, common apple-tree, is very spreading, with the branches and twigs irregular and twisting, more horizontal than in the pear; leaves ovate, serrate, the younger ones pubescent underneath; stipules linear; flowers in terminating sessile, villose, umbels; corollas white inside, and finely tinged with red on the outside; fruit roundish, umbilicate at the base, acid. The wood of the wild apple is tolerably hard; it turns very clean, and when made into cogs for wheels acquires a polish, and lasts a long time; the bark affords a yellow dye; the acid juice of the fruit is called verjuice; it is much used in recent sprains, and in other cases, as an astringent or repellent. For a full description of the numerous varieties of pears and apples, the reader is referred to Martyn's edition of Millar's "Gardener's and Botanist's Dictionary."

PYTHAGORAS, in biography, one of the greatest philosophers of antiquity, was born about the forty-seventh Olympiad, or 590 years before Christ. His father's principal residence was at Samos; but being a travelling merchant, his son Pythagoras was born at Sidon, in Syria; but soon returning home, our philosopher was brought up at Samos, where he was educated in a manner that was answerable to the great hopes that were conceived of him. He was called "the youth with a fine head of hair;" and from the great qualities that soon appeared in him, he was regarded as a good genius sent into the world for the benefit of mankind.

Samos, however, afforded no philosophers capable of satisfying his thirst for knowledge; and therefore, at eighteen years of age, he resolved to travel in quest of them elsewhere. The fame of Pherecydes drew him first to the island of Syros; from hence he went to Miletus, where he conversed with Thales. He then travelled to Phœnicia, and stayed some time at Sidon, the place of his birth; and from hence he passed into Egypt, where Thales and Solon had been before him.

Having spent twenty-five years in Egypt, to acquire all the learning and knowledge he could procure in that country, with the same view he travelled through Chaldea, and visited Babylon. Returning after some time, he went to Crete; and from hence to Sparta, to be instructed in the laws of Minos and Lycurgus. He then returned to Samos; which, finding under the tyranny of Polycrates, he quitted again, and visited the several countries of Greece. Passing through Peloponnesus, he stopped at Pholius, where Leo then reigned; and in his conversation with that prince, he spoke with so much eloquence and wisdom, that Leo was at once ravished and surprised.

From Peloponnesus he went into Italy, and passed some time at Heraclea and at Tarentum; but made his chief residence at Croton; where, after reforming the manners of the citizens by preaching, and establishing the city by wise and prudent counsels, he opened a school, to display the treasures of wisdom and learning he possessed. It is not to be wondered that he was soon attended by a crowd of disciples, who repaired to him from different parts of Greece and Italy.

He gave his scholars the rules of the Egyptian priests, and made them pass through the austerities which he himself had endured. He at first enjoined them a five years' silence in the school, during which they were only to hear; after which leave was given them to start questions, and to propose doubts, under the caution, however, to say, "not a little in many words, but much in a few." Having gone through their probation, they were obliged, before they were admitted, to bring all their fortune into the common stock, which was managed by persons chosen on purpose, and called œconomists, and the whole community had all things in common.

The necessity of concealing their mysteries induced the Egyptians to make use of three sorts of styles, or ways of expressing their thoughts; the simple, the hieroglyphical, and the symbolical. In the simple, they spoke plainly and intelligibly, as in common conversation; in the hieroglyphical, they concealed their thoughts under certain images and characters; and in the symbolical, they explained them by short expressions, which, under a sense plain and simple, included another wholly figurative. Pythagoras borrowed these three different ways from the Egyptians in all the instructions he gave; but chiefly imitated the symbolical style; which he thought very proper to inculcate the greatest and most important truths; for a symbol, by its double sense, the proper and the figurative, teaches two things at once; and nothing pleases the mind more than the double image it represents to our view. In this manner Pythagoras delivered many excellent things concerning God, and the human soul, and a great variety of precepts, relating to the conduct of life, political as well as civil; he made also some considerable discoveries and advances in the arts and sciences. Thus, among the works ascribed to him, there are not only books of physic and books of morality, like that contained in what are called his "Golden Verses," but treatises on politics and theology. All these works are lost; but the vastness of his mind appears from the wonderful things he performed. He delivered, as antiquity relates, several cities of Italy and Sicily from the yoke of slavery; he appeased seditions in others; and he softened the manners, and brought to temper the most savage and unruly spirits of several people and tyrants. Phalaris, the tyrant of Sicily, it is said, was the only one who could withstand the remonstrances of Pythagoras; and he, it seems, was so enraged at his discourses, that he ordered him to be put to death. But though the lectures of the philosopher could make no impression on the tyrant, yet they were sufficient to reanimate the Sicilians, and to put them upon a bold action. In short, Phalaris was killed the same day that he had fixed for the death of the philosopher.

Pythagoras had a great veneration for marriage; and therefore himself married at Croton a daughter of one of the chief men of that city, by whom he had two sons and a daughter. One of the sons succeeded his father in the school, and became the master of Empedocles. The daughter, named Damo, was distinguished both by her learning and her virtues, and wrote an excellent commentary upon Homer. It is related, that Pythagoras had given her some of his writings, with express commands not to impart them to any but those of his own family; to which Damo was so scrupulously obedient, that even when she was reduced to extreme poverty, she refused a great sum of money for them.

From the country in which Pythagoras thus settled and gave his instructions, his society of disciples was called the Italic sect of philosophers, and their reputation continued for some ages afterwards, when the Academy and the Lycæum united to obscure and swallow up the Italic sect.

Pythagoras's disciples regarded the words of their master as the oracles of a god; his authority alone, though unsupported by reason, passed with them for reason itself; they looked upon him as the most perfect image of God among men. His house was called the temple of Ceres, and his court yard the temple of the Muses: and when he went into towns, it was said he went thither, "not to teach men, but to heal them."

Pythagoras was persecuted by bad men in the last years of his life, and some say he was killed in a tumult raised by them against him; but according to others, he died a natural death at 90 years of age, about 497 years before Christ.

Beside the high respect and veneration the world has always had for Pythagoras, on account of the excellence of his wisdom, his morality, his theology, and politics, he was renowned as learned in all the sciences, and a considerable inventor of many things in them; as arithmetic, geometry, astronomy, music, &c. In arithmetic, the common multiplication table is, to this day, still called Pythagoras's table. In geometry, it is said, he invented many theorems, particularly these three :—1. Only three polygons, or regular plane figures, can fill up the space about a point; *viz.* the equilateral triangle, the square, and the hexagon. 2. The sum of the three angles of every triangle is equal to two right angles. 3. In any right-angled triangle the square on the longest side is equal to both the squares on the two shorter sides. For the discovery of this last theorem, some authors say, he offered to the gods a hecatomb, or a sacrifice of a hundred oxen. Plutarch, however, says it was only one ox; and even that is questioned by Cicero, as inconsistent with his doctrine, which forbade bloody sacrifices. The more accurate, therefore, say, he sacrificed an ox made of flour, or of clay, and Plutarch even doubts whether such sacrifice, whatever it was, was made for the said theorem, or for that concerning the parabola, which it was said Pythagoras also found out.

In astronomy his inventions were many and great. It is reported, that he discovered, or maintained, the true system of the world, which places the sun in the centre, and makes all the planets revolve about him: from him it is to this day called the old, or Pythagorean system; and is the same as that lately revived by Copernicus. He first discovered that Lucifer and Hesperus were but one and the same, being the planet Venus, though formerly thought to be two different stars. The invention of the obliquity of the zodiac, is likewise ascribed to him. He first gave to the world the name Kosmos, from the order and beauty of all things comprehended in it; asserting, that it was made according to musical proportion: for as he held that the sun, by him and his followers termed the fiery globe of unity, was seated in the midst of the universe, and the earth and planets moving around him, so he held, that the seven planets had an harmonious motion, and their distances from the sun corresponded to the musical intervals or divisions of the monochord.

Pythagoras and his followers held the transmigration of souls, making them successively occupy one body after another; on which account they abstained from flesh, and lived chiefly on vegetables.

PYTHAGOREANS, a sect of ancient philosophers, so denominated from their being the followers of Pythagoras of Samos. See PYTHAGORAS.

Q.

Q, Or q, the sixteenth letter, and twelfth consonant, of our alphabet, but is not to be found either in the Greek, old Latin, or Saxon alphabets; and, indeed, some would entirely exclude it, pretending that k ought to be used wherever this occurs. However, as it is formed in the voice in a different manner, it is undoubtedly a distinct letter; for, in expressing this sound the cheeks are contracted, and the lips, particularly the under one, are put into a cannular form, for the passage of the breath.

The q is never sounded alone, but in conjunction with u, as in *quality, question, quite, quote,* &c. and never ends any English word.

As a numeral, Q stands for 500; and with a dash over it, thus, $\bar{Q}$, for 500,000.

Used as an abbreviature, q. signifies quantity, or quantum: thus, among physicians, q. pl. is quantum placet, *i. e.* as much as you please of a thing; and q. s. quantum sufficit, *i. e.* as much as is necessary. Q. E. D. among mathematicians, is quod erat demonstradum, *i. e.* which was to be demonstrated; and Q. E. F. quod erat faciendum, *i. e.* which was to be done. Q. D. among grammarians, is quasi dictum, *i. e.* as if it were said.

QUACK, a medical impostor, who "for the good of the public," and "by the blessing of God," undertakes, with his powders, potions, or balsam, to cure "all disorders." Thus, ignorance and blasphemy unite in picking the pockets and ruining the constitution of thousands o credulous people in this and other countries. The pretension to infallibility in any one medicine, as a cure for any one disorder, is next to absurd; much more ridiculous is it then to suppose, that any medicine will remove all kinds of complaints.

Every medicine possesses active properties, or it does not. If it be active, it must be dangerous to apply it, indiscriminately, to persons of every age, and without regard to their habits of living. An active medicine, which might be very useful in strengthening a debilitated constitution, would be highly injurious if exhibited in an acute rheumatism, or other inflammatory disorder, and *vice versa;* consequently, an application of the same remedy in all cases can hardly fail of being fatal in some. Should the medicine be inactive, which happily is often the case, it can be of no other utility than to work upon the patient's imagination, and amuse him while his pocket is picked. See MEDICAL DICT.

QUADRANGLE, in geometry, the same with a quadrilateral figure, or one consisting of four sides and four angles. To the class of quadrangles belong the square, parallelogram, trapesium, rhombus, and rhomboides. A square is a regular quadrangle; a trapesium an irregular one.

QUADRANS, the quarter or fourth part of any thing, particularly the *as*, or pound.

QUADRANT, denotes a mathematical instrument, of great service in astronomy, and, consequently, in navigation, for taking the altitudes of the sun and stars; as also for taking angles in surveying. Those chiefly in use, are Adams's, Cole's, Gunter's, Hadley's, Sutton's, or Collins's, the horodictical, the sinical, the astronomical, and the common surveying quadrant.—Many of these are made of wood, generally ebony, mounted with ivory; but such are subject to warp, which occasions those made of brass to be preferred, for very hot or very cold climates; though their expansion and contraction, under various temperaments, is some drawback on their merits: however, that being the lesser evil, and scarcely ever amounting to more than two or three seconds in the whole arch of the quadrant, cannot be considered as any great defect.

Although these instruments are generally termed quadrants, they are, in truth, but octants, since they occupy but one-eighth of a circumference; but as each of the 45° they contain on the arch actually measures two, while taking the observation, they do not receive their designation improperly. We have another description of this instrument, called the sextant, which has 60° marked on its arch, and includes 120° in real measurement. This is peculiarly calculated for the observation of various celestial bodies, so as to ascertain their distances at any particular moment: this often could not be effected by an instrument which embraced only 90°; whereas, we rarely find any two planets suitable to the purposes of navigation, at so great a distance as 120°.

The manner in which the quadrant is held, relieves it from the effect of the vessel's motion; although, in the first instance, some difficulty may occur in suiting the body to the rolling, or pitching, of a vessel; yet, in a very short time, the operator will become so habituated, as to overcome that trifling impediment.

Hadley's quadrant (or his sextant) is the only instrument, hitherto known, on which the mariner can depend for a correct observation. It may be called the "portable observatory." The first idea of this machine originated with the celebrated Dr. Hooke; it was completed by Sir Isaac Newton, and first offered to the public by Mr. Hadley; however, it has undergone many changes since that time. The great perfection it exhibits, with respect to the accuracy of the angles it defines, is considerably enhanced by the facility with which it may be rectified; so that errors may be avoided: a matter of supreme importance, when we consider the rough usage to which the instrument is subject; and, that an error of one degree in the index makes two in the observation.

Description of Hadley's Quadrant. (Fig. 1. Plate XIII. Miscel.) shows the quadrant, as usually constructed. The following parts compose the instrument. B C, the arc of 45°: A D, the index, moving on a pivot, under the centre of the index-glass, E; which glass is in the exact direction of the index, and stands at right angles upon it. F, the fore-horizon-glass, which receives the reflection from the index-glass. G, the back-horizon-glass. The former stands parallel with the leg, A C; the latter at right angles thereto. K, is a pivot, on which three dark glasses, or screens, move, so that any one, or more, may be placed between the index-glass and the horizon-glass, to diminish the lustre of the reflected planet. H and I, the vanes, or sights. The arc, B C, is called the limb, or quadrantal arc; what is beyond 0, is the arc of excess: the residue of the arc usually is graduated up as far as 100°.

A large portion of the lower part of the index is open, so as to show the gradations on the arc: the lower edge is chamfered, that it may come close down to them, and is there divided into smaller portions: this scale is called the nonius, and shows the smaller divisions in a more correct and obvious manner than could be done by the quadrantal arc, on which each degree is subdivided into no more than three equal parts, of 20′ each. Now the nonius, being divided into 21 equal parts, shows at what portions of the arc the index cuts the division of 20 minutes; therefore it shows every minute.

THE USE OF HADLEY'S QUADRANT.

For the Fore-Observation. Bring the index close to the bottom, so that the middle of the Vernier's scale, or nonius, stand against 0 degrees. Hold the plane of the instrument vertical, with the arch downwards; look through the right-hand hole in the vane, and direct the sight through the transparent part of the horizon-glass, to observe the horizon. If the horizon-line, seen both in the quick-silvered part, and through the transparent part, should coincide, or make one straight line, then is the glass adjusted; but if one of the horizon-lines should stand above the other, slacken the screw in the middle of the lever, backwards or forwards, as there may be occasion, until the lines coincide: fasten the screw in the middle of the lever, and all is ready for use.

To take the Sun's Altitude. Fix the screens above the horizon-glass, using either or both of them, according to the strength of the sun's rays, by turning one or both the frames of those glasses close against the plane or face of the instrument; then your face being turned towards the sun, hold the quadrant by the braces, or by either radius, as is found most convenient, so as to be in a vertical position, with the arch downwards. Put the eye close to the right-hand-hole in the vane, look at the horizon through the transparent part of the horizon-glass, at the same time sliding the index with the left hand, until the image of the sun, seen in the quicksilvered part, falls in with the edge of the horizon, taking either the upper or the under edge of the solar image. Swing your body gently from side to side; and when the edge of the sun is observed not to cut, but to touch the horizon-line like a tangent, the observation is made. Then will the degrees on the arch, reckoning from the end next your body, give the altitude of that edge of the sun which was brought to the horizon. If the lower edge was observed, then sixteen minutes, added to the said degrees, gives the altitude of the sun's centre; but if the upper edge was used, the sixteen minutes must be subtracted.

To take the Altitude of a Star. Look directly up at the star, through the vane, and transparent part of the glass; the index being close to the button: then will the image of the star, by refraction, be seen in the silvered part, right against the star seen through the other part. Move the index forward, and, as the image descends, let the quadrant descend also, to keep it in the silvered part, till it comes down in a line with the horizon, seen through the transparent part, and the observation is made.

To make an Artificial Horizon. Often, when the atmosphere is clear above, the horizon is so laden with vapours, as to prevent an observation being taken. In such case, an artificial horizon is to be made thus: fill into any vessel, having a diameter of about three inches, and about half an inch deep, from one to two pounds of quicksilver, on which lay a metal speculum, or a piece of plain glass, whose diameter may be about one-third of an inch less than that of the surface of quicksilver: in this the image of the sun may be seen distinctly. Sling the vessel so that it may remain level, and take an observation with a stained glass, which will subdue the great brilliancy of the reflection. The observation thus taken, will be as correct as if taken by means of the natural horizon.

As refraction causes each ray of light to assume a curved direction, all objects, when observed, especially by means of instruments, appear with an excess of altitude beyond their actual height. The refractions, to be deducted, follow:

A TABLE OF THE REFRACTION OF THE HEAVENLY BODIES,

TO BE SUBTRACTED FROM THE OBSERVED LATITUDE.

Elevation of the Eye above the Sea, in feet.	Dip of the Horizon of the Sea.	Apparent Altitude.	Refraction.	Apparent Altitude.	Refraction.	Apparent Altitude.	Refraction.	Apparent Altitude	Refraction.	Apparent Altitude.	Refraction.
		0–1	1–11	0–1	1–11	0–1	1–11	0–1	1–11	0–1	1–11
1	0′.57″	0	33. 0	4–50	10.11	10–30	5. 0	26–0	1–56	59.0	0–34
2	1.21	5	32.10	5– 0	9.54	10–45	4.53	27	1–51	60	33
3	1.39	10	31.22	5–10	9.38	11– 0	4.47	28	1–41	61	32
4	1.55	15	30.35	5–20	9.23	11–15	4.40	29	1–40	62	30
5	2. 8	20	29.50	5–30	9. 8	11–30	4.34	30	1–38	63	29
6	2.20	30	28.22	5–40	8.54	11–45	4.29	31	1–35	64	28
7	2.31	32	28. 5	5–50	8.41	12– 0	4.23	32	1–31	65	26
8	2.42	36	27.30	6– 0	8.28	12–20	4.16	33	1–28	66	25
9	2.52	40	27. 0	6–10	8.15	12–40	4. 9	34	1–24	67	24
10	3. 1	50	25.42	6–20	8. 3	13– 0	4. 3	35	1–21	68	23
12	3.18	1– 0	24.29	6–30	7.51	13–20	3.57	36	1–28	69	22
14	3.24	1–10	23.20	6–40	7.40	13–40	3.51	37	1–16	70	21
16	3.49	1–20	22.15	6–50	7.30	14– 0	3.45	38	1–13	71	19
18	4. 3	1–30	21.15	7– 0	7.20	14–20	3.40	39	1–10	72	18
20	4.16	1–40	20.18	7–10	7.11	14–40	3.35	40	1– 8	73	17
22	4.28	1–50	19.25	7–20	7. 2	15– 0	3.30	41	1– 5	74	16
24	4.40	2– 0	18.35	7–30	6.53	15–30	3.24	42	1– 3	75	15
26	4.52	2–10	17.48	7–40	6.45	16– 0	3.17	43	1– 1	76	14
28	5. 3	2–20	17. 4	7–50	6.37	16–30	3.10	44	59	77	13
30	5.14	2–30	16.24	8– 0	6.29	17– 0	3. 4	45	57	78	12
35	5.39	2–40	15.45	8–10	6.22	17–30	2.59	46	55	79	11
40	6. 2	2–50	15. 9	8–20	6.15	18– 0	2.54	47	53	80	10
45	6.24	3– 0	14.36	8–30	6. 8	18–30	2 49	48	51	81	9
50	6.44	3–10	14. 4	8–40	6. 1	19– 0	2.44	49	49	82	8
60	7.23	3–20	13.34	8–50	5.55	19–30	2.39	50	48	83	7
70	7.59	3–30	13. 6	9– 0	5.48	20– 0	2.35	51	46	84	6
80	8.32	3–40	12.40	9–10	5.42	20–30	2.31	52	44	85	5
90	9. 3	3–50	12.15	9–20	5 36	21– 0	2.27	53	43	86	4
100	9.33	4– 0	11.51	9–30	5.31	21–30	2.24	54	41	87	3
		4–10	11.29	9–40	5.25	22– 0	2.20	55	40	88	2
			11. 8	9–50	5.20	23– 0	2.14	56	38	89	1
			10.48	10– 0	5.15	24– 0	2. 7	57	37	90	0
			10.29	10–15	5. 7	25– 0	2. 2	58	35		

The latitude of any place is its distance from the equator, either north or south, and never can exceed ninety degrees. It is found by taking the altitude of the sun, or star, above the horizon, with a quadrant, when on the meridian (*i. e.* due north, or south) of the place of observation. The meridian altitude, corrected for the dip of the horizon, and refraction, and sixteen minutes, the sun's semidiameter added thereto, gives the altitude of his centre, which, being subtracted from 90°, gives the zenith-distance, or the number of degrees the centre of the object is from the point over your head; with which, and knowing how far the object is to the north or south of the equator, which is is called its declination, the latitude is found by the meridian altitude of any celestial object, as follows:

1. If the object be south when observed, call the zenith-distance, south; and *vice versa*. Then, if the zenith-distance, and the declination, be of contrary names, (that is, if the sun, or star, comes to the meridian in the north, and has south declination, or *per contra*), the zenith-distance, added to the declination, gives the latitude of the place of observation; the designation will be north, or south, according as the declination may be.

2 When the zenith-distance, and the declination, are of the same name, that is, when the sun, or star comes to the meridian in the north, and has north declination; or *per contra;* then subtract the lesser from the greater; and the remainder is the latitude.

This general rule decides whether it be north or south. When the declination is greater than the zenith distance, the latitude is of the same name with the declination; but if less, the latitude is on the opposite side of the equator. For further particulars, see LATITUDE.

QUADRANT *of altitude*, is a thin piece of metal, in general applied to the globe, and marked with the degrees, from 0 to 90°: when laid upon the meridian of any place, it shows its latitude or distance from the equator.

QUADRANT *of a circle*, or the fourth part of its circumference, is contained under two radii standing at right angles. The quadrant contains ninety degrees, and is the parent of various lines of the greatest utility in many branches of the mathematics, such as the lines of chords, of sines, of latitude, &c. See MATHEMATICAL *instruments*, and DIALLING.

QUADRANTS, *gunner's*, are made in various manners, some of them having levels; but the most simple construction, with which we are acquainted, is that made with a staff about a foot in length, having on one side a quadrant, which, by means of a pendulum of metal, shows the exact angle made by the chase, or bore. The staff being put into the muzzle of a mortar, or howitzer, so as to lay, in contact, evenly with its lower side, and the quadrant part being turned down, immediately beyond the muzzle, the pendulum-wire, which is fixed to a small pivot in the right angle, exactly at the centre, whence the quadrant was described, will be kept perpendicular by the weight attached thereto; and will thus indicate the exact elevation of the piece. The point of oscillation, *i. e.* the pivot, must, however, be always kept very smooth; that there may not be the least roughness; else the action would be affected, and the index prove erroneous.

QUADRAT, a mathematical instrument, called also a geometrical square, and line of shadows; it is frequently an additional member on the face of the common quadrant, as also on those of Gunter's and Sutton's quadrants; but we shall describe it by itself, as being a distinct instrument.

It is made of any solid matter, as brass, wood, &c. or of any four plain rules joined together at right angles, as represented in Plate XIII. Miscell. fig. 2, where A is the centre, from which hangs a thread with a small weight at the end, serving as a plummet. Each of the sides, B E and D E, is divided into an hundred equal parts; or, if the sides be long enough to admit of it, into a thousand parts; C and F are two sights, fixed on the side A D. There is, moreover, an index, G H, which, when there is occasion, is joined to the centre, A, in such a manner as that it can move freely round, and remain in any given situation; on this instrument are two sights, K L, perpendicular to the right line going from the centre of the instrument. The side D E is called the upright side, or the line of the direct or upright shadows; and the inside B E is termed the reclining side, or the line of the versed or back shadows.

To measure an accessible height, A B, (fig. 3) by the quadrat, let the distance, B D, be measured, which suppose = 96 feet, and let the height of the observer's eye be 6 feet; then holding the instrument with a steady hand, or rather resting it on a support, let it be directed towards the summit A, so that it may be seen clearly through both sights; the perpendicular, or plumb-line, meanwhile hanging free, and touching the surface of the instrument: let now the perpendicular be supposed to cut off on the upper side, K N, 80 equal parts; it is evident, that L K N, A C K, are similar triangles, and (by prop. 4. lib. 6. of Euclid) N K : K L : : K C (*i. e.* B D) : C A; that is, 80 : 100 : : 96 : C A : therefore, by the rule of three, $C\,A = \frac{96 \times 100}{80} = 120$ feet, and C B = 6 feet being added, the whole height B A is 126 feet.

If the observer's distance, as D E, be such, that, when the instrument is directed as formerly towards the summit A, the perpendicular fall on the angle P, and the distance, B E or C G, be 120 feet, C A will also be 120 feet: for P G : G H : : G C :

C A; but P G = G H, therefore G C = C A; that is, C A will be 120 feet, and the whole height B A = 126 feet, as before.

But let the distance B F (*ibid.*) be 300 feet, and the perpendicular or plumb-line cut off 40 equal parts from the reclining side. Now, in this case, the angles Q A C, Q Z I, are equal (29. 1. Eucl.) as are also the angles Q Z I, Z I S: therefore the angle Z I S = Q A C; but Z S I = Q C A, as being both right; hence, in the equiangular triangles A C Q, S Z I, we have (by 4. 6. Eucl.) Z S : S I : : C Q : C A; that is, 100 : 40 : : 300 : C A, or C A = $\frac{40 \times 300}{100} = 120$; and by adding 6 feet, the observer's height, the whole height B A will be 126 feet.

To measure any distance at land or sea, by the quadrat. In this operation the index, A H, is to be applied to the instrument, as was shown in the description; and, by the help of a support, the instrument is to be placed horizontally at the point A (fig. 4,) then let it be turned till the remote point F, whose distance is to be measured, be seen through the fixed sights: and bringing the index to be parallel with the other side of the instrument, observe through its sights any accessible mark, B, at a distance; then carrying the instrument to the point B, let the immoveable sights be directed to the first station A, and the sights of the index to the point F. If the index cut the right side of the square, as in K, the proportion will be (by 4. 6.) B R : RK : : B A (the distance of the stations to be measured with a chain) : A F, the distance sought. But if the index cut the reclined side of the square in the point L; then the proportion is L S : S B : : B A : A G, the distance sought; which, accordingly, may be found by the rule of three.

The quadrat may be used without calculation, where the divisions of the square are produced both ways so as to form the area into little squares. Ex. Suppose the thread to fall on 40 in the side of right shadows, and the distance to be measured 20 poles; seek among the little squares for that perpendicular, to the side of which is 20 parts from the thread, this perpendicular will cut the side of the square next the centre, in the point 50, which is the height of the required poles. If the thread cut the side of the versed shadows in the point 60, and the distance be 35 poles, count 35 parts on the side of the quadrat from the centre, count also the divisions of the perpendicular from the point 35 to the thread, which will be 21, the height of the tower in poles.

QUADRAT, in printing, a piece of metal cast like the letters, to fill up the void spaces between words, &c. There are quadrats of different sizes, as m quadrats, n quadrats &c. which are, respectively, of the dimensions of these letters.

QUADRATIC *equation*, in algebra, that wherein the unknown equality is of two dimensions, or raised to the second power. See ALGEBRA.

QUADRATURE, in geometry, denotes the squaring, or reducing a figure to a square. Thus, the finding of a square, which shall contain just as much surface, or area, as a circle, an ellipsis, a triangle, &c. is the quadrature of a circle, ellipsis, &c. The quadrature of rectilinear figures, or method of finding their areas, has been already delivered. See MENSURATION.

But the quadrature of curvilinear spaces, as the circle ellipsis, parabola, &c. is a matter of much deeper speculation, making a part of the higher geometry; wherein the doctrine of fluxions is of singular use. We shall give an example or two.

Let A R C (Plate XIII. Miscell. fig. 5) be a curve of any kind, whose ordinates R b, C B, are perpendicular to the axis A B. Imagine a right line, b R g, perpendicular to A B, to move parallel to itself from A towards B; and let the velocity thereof, or the fluxion of the absciss, A b, in any proposed position of that line, be denoted by $b\,d$, then will $b\,n$, the rectangle under $b\,d$ and the ordinate, b R, express the corresponding fluxion of the generating area, A b R; which fluxion, if A $b = x$, and b R $= y$, will be $y\dot{x}$. From whence, by substituting for y or $\dot{x}$, according to the equation of the curve, and taking the fluent, the area itself, A b R, will become known.

But in order to render this still more plain, we shall give some examples, wherein x, y, z, and u are all along put to denote the absciss, ordinate, curve-line, and the area, respectively, unless where the contrary is expressly specified. Thus, if the area of a right angled triangle be required; put the base A H (fig 6) $= a$, the perpendicular H M $= b$, and let A B $= x$, be any portion of the base, considered as a flowing quantity; and let B R $= y$ be the ordinate, or perpendicular corresponding. Then because of the similar triangles, A H M and A B R, we shall have $a : b :: x : y = \frac{bx}{a}$. Whence

$y\dot{x}$, the fluxion of the area A B R is, in this case, equal to $\frac{bx\dot{x}}{a}$; and consequently the fluent thereof, or the area itself, $=\frac{bx^2}{2a}$ which, therefore, when $x = a$, and B R coincides with H M, will become $\frac{ab}{2} = \frac{AH \times HM}{2}$ = the area of the whole triangle A H M: as is also demonstrable from the principles of common geometry.

Again, let the curve A R M H, (fig. 7.) whose area you would find, be the common parabola; in which case, if A B = x, and B R = y, and the parameter = a; we shall have $y^2 = ax$, and $y = a^{\frac{1}{2}}x^{\frac{1}{2}}$: and therefore, $\dot{u}$ $(=y\dot{x}) = a^{\frac{1}{2}}x^{\frac{1}{2}}\dot{x}$; whence $u = \frac{2}{3}\times a^{\frac{1}{2}}x^{\frac{3}{2}} = \frac{2}{3}a^{\frac{1}{2}}x^{\frac{1}{2}} \times x = \frac{2}{3}yx = \frac{2}{3} \times AB \times BR$. Hence a parabola is two thirds of a rectangle of the same base and altitude.

The same conclusion might have been found more easily in terms of y; for $x = \frac{y^2}{a}$, and $\dot{x} = \frac{2y\dot{y}}{a}$; and consequently $\dot{u}$ $(=y\dot{x}) = \frac{2y^2\dot{y}}{a}$; whence $u = \frac{2y^3}{3a} = \frac{2y}{3} \times \frac{y^2}{a} = \frac{2y}{3} \times x = \frac{2}{3} \times AB \times BR$, as before.

To determine the area of the hyperbolic curve A M R B, (fig. 8) whose equation is $x^m y^n = a^{m+n}$; whence we have $y = \frac{a^{\frac{m+n}{n}}}{x^{\frac{m}{n}}} = a^{\frac{m+n}{n}} \times x^{\frac{-m}{n}}$; and therefore $\dot{u}$ $(= y\dot{x}) = a^{\frac{m+n}{n}} \times x^{\frac{m-n}{n}}\dot{x}$, whose fluent is $u = \frac{a^{\frac{m+n}{n}} \times x^{1-\frac{m}{n}}}{1-\frac{m}{n}} = \frac{na^{\frac{m+n}{n}} \times x^{\frac{n-m}{n}}}{n-m}$; which, when $x = 0$, will also be $= 0$, if n be greater than m; therefore the fluent requires no correction in this case; the area, A M R B, included between the asymptote, A M, and the ordinate B R, being truly defined by $\frac{na^{\frac{m+n}{n}} \times x^{\frac{n-m}{n}}}{n-m}$, as above. But if n be less than m, then the fluent, when $x = 0$, will be infinite, because the index $\frac{n-m}{n}$ being negative, 0 becomes a divisor to na^{m+n}; whence the area, A M R B, will also be infinite.

But here, the area, B R H, comprehended between the ordinate, the curve, and the part, B H, of the asymptote, is finite, and will be truly expressed by $\frac{na^{\frac{m+n}{n}} + x^{\frac{n-m}{n}}}{m-n}$, the same quantity with its signs changed; for the fluxion of the part A M R B, being $a^{\frac{m+n}{n}} \times x^{\frac{m}{n}}\dot{x}$, that of its supplement B R H must consequently be $-a^{\frac{m+n}{n}} \times x^{\frac{-m}{n}}\dot{x}$, whereof the fluent is $-\frac{a^{\frac{m+n}{n}} \times x^{1-\frac{m}{n}}}{1-\frac{m}{n}} = \frac{a^{\frac{m+n}{n}} \times x^{\frac{n-m}{n}}}{m-n}$ = the area, B R H, which wants no correction; because when x is infinite and the area B R H = 0, the said fluent will also entirely vanish; since the value of $x^{\frac{m-n}{n}}$, which is a divisor to $a^{\frac{m+n}{n}}$, is then infinite.

For further examples see Simpson's Fluxions, vol i. sect. vii.

Quadrature, in astronomy, that aspect of the moon when she is 90 degrees distant from the sun; or when she is in a middle point of her orbit, between the points of conjunction and opposition, namely, in the first and third quarters.

Quadrature *lines*, are two lines placed on Gunter's sector: they are marked with Q. and 5, 6, 7, 8, 9, 10; of which Q. signifies the side of the square, and the other figures the sides of polygons of 5, 6, 7, &c. sides. S, on the same instrument, stands for the semi-diameter of a circle, and 90 for a line equal to ninety degrees in circumference.

QUADRILATERAL, in geometry, a figure whose perimeter consists of four right lines making four angles; whence it is also called a quadrangular figure. The quadrilateral figures are either a parallelogram, trapezium, rectangle, square, rhombus, or rhomboides.

QUADRUPEDS, in zoology, a class of land animals, with hairy bodies, and four limbs or legs proceeding from the trunk of their bodies: add to this, that the females of this class are viviparous, or bring forth their young alive, and nourish them with milk from their teats. This class, though still numerous enough, will be considerably lessened in number, by throwing out of it the frog, lizard, and other four-footed amphibious animals. See Amphibia. On the other hand, it will be increased by the admission of the bat; which, from its having the forefeet webbed with a membrane, and using them as birds do their wings in flying, has erroneously been ranked among the bird kind. Linnæus, whose system we have generally followed, subdivides the quadruped class into six orders, which he characterizes from the number, figure, and disposition of their teeth. See Mammalia, and Natural History.

QUADRUPLE, a sum or number multiplied by four, or taken four times. This word is particularly used for a gold coin worth four times as much as that whereof it is the quadruple.

QUALEA, in botany, a genus of the Monandria Monogynia class and order. Essential character: calyx four-parted; corolla two-petalled; berry. There are two species, *viz.* Q. rosea, and Q. cœrulea. These are both tall trees, growing naturally in the forests of Guiana.

QUAKERS. See Friends.

Quakers, by statute 7 and 8 Wil. III. cap. 27, and 8 George I. cap. 6, making and subscribing the declaration of fidelity, mentioned in 1 William and Mary, shall not be liable to the penalty against others refusing to take such oaths; and not subscribing the declaration of fidelity, &c. they are disabled to vote at the election of members of parliament. By 7 and 8 William III. cap. 34, made perpetual by 1 George I. cap. 6, quakers, where an oath is required, are permitted to make a solemn affirmation or declaration of the truth of any fact; but they are not capable of being witnesses in any criminal cause, serving on juries, or bearing any office or place of profit under government, unless they are sworn like other protestants; but this clause does not extend to the freedom of a corporation. By statute 22 George II. cap. 46, an affirmation shall be allowed in all cases (except criminal) where by any act of parliament an oath is required, though no provision is made for admitting a quaker to make his affirmation.

QUALITY, is defined by Mr. Locke, to be the power in a subject of producing any idea in the mind: thus a snow-ball having the power to produce in us the ideas of white, cold, and round, these powers, as they are in the snow-ball, he calls qualities; and as they are sensations, or perceptions, in our understandings, he calls ideas. It has been demonstrated that every quality that is propagated from a centre, such as light, heat, cold, odour, &c. has its intensity either increased or decreased, in the duplicate ratio of the distances from the centre inversely. So at double the distance from the earth's centre; or from a luminous, or a hot body, the weight, or light, or heat, is but a fourth part, and at three times the distance, it is but a ninth, &c. The great Sir Isaac Newton has laid it down as one of the rules of philosophizing, that those qualities which are incapable of being increased or diminished, and which are found to obtain in all bodies upon which experiments could be tried, are to be esteemed universal qualities of all bodies.

QUAMDIU *se bene gesserit*, as long as he shall behave himself well in his office, is a clause frequently inserted in letters patent of offices, and is inserted in the patent by which the judges are appointed.

QUANTITY, any thing capable of estimation, or mensuration; or which, being compared with another thing of the same kind, may be said to be greater or less than it, equal or unequal to it. Mathematics is the science or doctrine of quantity, which being made up of parts, is capable of being made greater or less. It is increased by addition, and diminished by subtraction; which are therefore the two primary operations that relate to quantity. Hence it is that any quantity may be supposed to enter into algebraic computations two different ways, which have contrary effects, *viz.* either as an increment or as a decrement.

A quantity that is to be added, is called a positive quantity; and a quantity to be subtracted, is said to be negative. Quantities are said to be like or similar, that are of the same denomination, they are represented by the same letter or letters, equally repeated: but quantities of different denominations, or represented by a different letter or letters, are said to be unlike or dissimilar. A quantity consisting of more than one term is called a compound quantity; whereas that consisting of one term only is denominated a simple quantity.

The quantity of matter in any body, is the product of its density into its bulk; or a quantity arising from the joint consideration of its magnitude and density; as if a body be twice as dense, and take up twice as much space as another, it will be four times as great. This quantity of matter is best discoverable by the absolute weight of bodies.

The quantity of motion in any body is the factum of the velocity into the mass, or it is a measure arising from the joint consideration of the quantity of matter, and the velocity of the motion of the body; the motion of any whole being the sum or aggregate of the motion in all its several parts. Hence, in a body twice as great as another, moved with an equal velocity, the quantity of motion is double; if the velocity be double also, the quantity of motion will be quadruple. Hence the quantity of motion is the same with what we call the momentum or impetus of a moving body.

QUANTITY, in grammar, an affection of a syllable, whereby its measure, or the time wherein it is pronounced, is ascertained; or that which determines the syllable to be long or short. Quantity is also the object of prosody, and distinguishes verse from prose; and the economy and arrangement of quantities, that is, the distribution of long and short syllables make what we call the number.

The quantities are distinguished, among grammarians, by the characters ᵕ, short, as pĕr; and ‒, long, as rōs. There is also a common, variable, or dubious quantity; that is, syllables that are one time taken for short ones, and at another time for long ones, as the first syllable in *Atlas*, *patres*, &c. Feet are made up of quantities.

The quantity of syllables is known two ways. 1. By rules for that purpose. And, 2. By authority. The rules for this end are taught by that part of grammar called prosody; the authority made use of in this case is no more than examples from, or the testimony of, approved authors; and is never used but either when the rules are deficient, or when we are unacquainted with them.

QUANTUM *meruit*, is an action on the case, or a count in *assumpsit* grounded upon the promise of another, to pay him for doing any thing, so much as he should deserve or merit.

QUANTUM *valebant*, in like manner, is where goods and wares sold are delivered by a tradesman at no certain price, or to be paid for them as much as they are worth in general; and the plaintiff is to aver them to be worth so much.

QUARANTINE, a trial which ships undergo when suspected of having on board persons infected with a pestilential disease. Physicians are occasionally consulted on this subject by government, who regulate this unpleasant restriction on the commerce of the country by their judgment, as to the period of time within which the effects of any infection received by any individual on board would be shown.

The usual quarantine is forty days. This may be ordered by the king, with the advice of the privy council, at such times, and under such regulations, as he judges proper. Ships ordered on quarantine must repair to the place appointed, and must continue there during the time prescribed, without having any intercourse with the shore, except for necessary provisions, which are conveyed with every possible precaution. When the time is expired, and the goods opened and exposed to the air as directed, if there be no appearance of infection they are admitted to port. Ships infected with the pestilence must proceed to St. Helen's Pool in the Scilly islands, and give notice of their situation to the Custom-house officers, and wait till the king's pleasure be known. Persons giving false information to avoid performing quarantine, or refusing to go to the place appointed, or escaping; also officers appointed to see quarantine performed, deserting their office, neglecting their duty, or giving a false certificate; suffer death as felons.—Goods from Turkey, or the Levant, may not be landed without license from the king, or certificate that they have been landed and aired at some foreign port.

QUARE *impedit*, in law, a writ which lies for him that has purchased a manor, with the advowson thereto belonging, against him that disturbs him in the right of his advowson, by presenting a clerk when the church is void.

QUARRY, a place under ground, out of which are got marble, free-stone, slate, lime stone, or other matters proper for buildings. Quarries of free stone are in many places opened, and the stone brought out in the following manner:—they first dig a hole in the manner of a well, twelve or fourteen feet in diameter, and the rubbish drawn out with a windlass in large osier baskets, they heap up all around; placing their wheel, which is to draw up their stones, upon it. As the hole advances, and their common ladder becomes too short, they apply a particular ladder for the purpose. When they have got through the earth, and are arrived at the first bank or stratum, they begin to apply their wheel and baskets to discharge the stones as fast as they dig through them.

In freeing the stone from the bed, they proceed thus: as common stones, at least the softer kinds, have two grains, a cleaving grain, running parallel with the horizon, and a breaking grain running perpendicular thereto; they observe by the grain where it will cleave, and there drive in a number of wedges, till they have cleft it from the rest of the rock. This done, they proceed to break it; in order to which, applying the ruler to it, they strike a line, and by this cut a little channel with their stone-axe; and in the channel, if the stone be three or four feet long, set five or six wedges, driving them in very carefully with gentle blows, and still keeping them equally forward. Having thus broken the stone in length, which they are able to do of any size within half an inch, they apply a square to the straight side, strike a line, and proceed to break it in breadth. This way of managing stone is found vastly preferable to that where they are broken at random: one load of the former being found to do the business of a load and a half of the latter. But it may be observed, that this cleaving grain being generally wanting in the harder kinds of stones, to break up these in the quarries, they have great heavy stone-axes, with which they work down a deep channel into the stone; and into this channel, at the top lay two iron bars, between which they drive their iron wedges.

QUARRY, among glaziers, a pane of glass cut in a diamond form. Quarries are of two kinds, square and long, each of which are of different sizes, expressed by the number of the pieces that make a foot of glass, *viz.* eighths, tenths, twelfths, eighteenths, and twentieths; but all the sizes are cut to the same angles, the acute angle in the square quarries being 77° $19'$, and 67° $21'$ in the long ones.

QUART, a measure containing the fourth part of some other measure. The English quart is the fourth part of a gallon, or two pints. See PINT.

QUARTER, the fourth part of any thing, the fractional expression for which is $\frac{1}{4}$. Quarter in weights, is generally used for the fourth part of an hundred weight, avoirdupois, or twenty-eight pounds. Used as the name of a dry measure, quarter is the fourth part of a ton in weight, or eight bushels.

QUARTER, in law, the fourth part of a year; and hence the days on which these quarters commence, are called quarter-days, *viz.* March 25, or Lady-day; June 24, or Midsummer-day; September 29, or Michaelmas; and December 21, or St. Thomas the apostle's day. On these days rents on leases, &c. are usually reserved to be paid; though December 25, or Christmas-day, is commonly reckoned the last quarter-day.

QUARTER, in astronomy, the fourth part of the Moon's period: thus, from the new moon to the quadrature is the first quarter; from this to full Moon, the second quarter, &c.

QUARTER, in heraldry, is applied to the parts or members of the first division of a coat that is quartered or divided into four quarters.

QUARTER *sessions*. The sessions of the peace is a court of record holden before two or more justices, whereof one is of the quorum, for the execution of the authority given them by the commission of the peace, and certain statutes and acts of parliament. The justices keep their sessions in every quarter of the year at least, and for three days, if need be; to wit, in the first week after the feast of St. Michael, in the first week after the Epiphany, in the first week after Easter, and in the first week after St. Thomas, and oftener, if need be.

Any two justices, one whereof is of the quorum, by the words of the commission of the peace, may issue their precept to the sheriff, to summon a session for the general execution of their authority; and such session, holden at any time within that quarter of a year, is a general quarter-session. and the sheriff must summons a jury under their authority.

There are many offences, which, by particular statutes, belong properly to this jurisdiction, and ought to be prosecuted in this court as the smaller misdemeanors, not amounting to felony, and especially offences relating to the game, highways, alehouses, bastard children, the settlements and provision of the poor, vagrants, servants' wages, apprentices, and popish recusants. Some of these are proceeded upon by indictment, and others in a summary way, by motion and order, which may, for the most part, unless guarded against by any particular statute, be removed into the Court of King's Bench by certiorari, and be there either quashed or confirmed.

The business done at quarter sessions is become of the highest importance to the country, and the public are greatly indebted to those magistrates who have sufficient knowledge of law to perform the duties of their office and give their attendance. In Ireland a practising barrister is appointed at each session to assist as chairman. In England this is not generally the case by law, but barristers are chiefly preferred, and the duty to be performed is so multifarious, that it requires no small skill in law, accompanied with much activity and industry, to execute it justly.

Quarter *of a ship*, is that part of a ship's hold which lies between the steerage room and the transom.

Quarters, *close*, in a ship, those places where the seamen quarter themselves in case of boarding, for their own defence, and for clearing the decks, &c.

Quarter *masters*, or Quarteers, in a man of war, are officers whose business it is to rummage, stow, and trim the ship in the hold; to overlook the steward in his delivery of victuals to the cook, and in pumping or drawing out beer, or the like. They are also to keep their watch duly, in conning the ship, or any other duty.

Quarter is also used for a division of a city, consisting of several ranges of buildings, &c. separated from some other quarter by a river, great street, &c. Such were formerly the twenty quarters of the city of Paris.

Quarter, in war, is used in various senses, as for the place allotted to a body of troops to encamp upon: thus they say, the general has extended his quarters a great way, &c. Quarter also signifies the sparing men's lives: thus, it is said, the enemy asked quarter; we gave no quarter.

Quarter *of an assembly*, is the place of rendezvous, where the troops are to meet, and draw up in a body.

Quarters, *head*, is the place where the general of an army has his quarters, which is generally near the centre of the army.

Quarter *master*, an officer in the army, whose business is to look after the quarters of the soldiers; of which there are several kinds, *viz.* the quarter-master general, whose business is to provide good quarters for the whole army. Quarter-master of horse, he who is to provide quarters for a troop of horse. Quarter-master of foot, he who is to provide quarters for a regiment of foot.

Quarters, in a clock, are the little bells that sound the quarters in an hour.

Quarters, in building, are those slight upright pieces of timber placed between the puncheons and posts, used to lath upon. These are of two sorts, single and double; the single quarters are sawed to two inches thick, and four inches broad; the double quarters are sawed to four inches square. It is a rule in carpentry, that no quarters be placed at a greater distance than fourteen inches.

QUARTERING, in the sea-language, is disposing the ship's company at an engagement, in such a manner as that each may readily know where his station is, and what he is to do. As some to the master for the management of the sails; some to assist the gunners in traversing the ordnance; some for plying of the small shot; some to fill powder in the powder-room; others to carry it from thence to the gunners, in cartridges, &c.

The number of men appointed to manage the artillery is in proportion to the nature of the guns, number and condition of the ship's crew. When a ship is well manned, so as to fight both sides occasionally, then

Pounder.	Men.
To a 42 there are	15
32	13
24	11
18	9, &c.

This number may be reduced, if necessary, and yet the guns be well managed.

The number of men appointed to the small arms, on board his Majesty's ships, will be as follows, *viz.*

To a First rate	150
Second ditto	120
Third of 80 guns	100
——— of 70	80
Fourth of 60	70
——— of 50	60
Fifth	50
Sixth	40
Sloops of war	30

Lieutenants command the different batteries; the master superintends the movements of the ship; and the boatswain and a number of men have charge of the rigging, &c.

When a ship under sail goes at large, neither by wind, nor before a wind, but as it were between both, she is said to go quartering.

Quartering, in gunnery, is when a piece of ordnance is so traversed that it will shoot on the same line, or on the same point of the compass as the ship's quarter bears.

Quartering, in heraldry, is dividing a coat into four or more quarters, or quarterings, by parting, couping, &c. that is, by perpendicular and horizontal lines, &c.

Quartering is also applied to the partitions or compartments themselves; that is, to the several coats borne on an escutcheon, or the several divisions made in it, when the arms of several families are placed on the same shield, on account of intermarriages, or the like. Quartering is also used for distinguishing younger brothers from the elder. In blazoning, when the quartering is performed per cross, the two quarters a-top are numbered the first and second; and those at bottom the third and fourth; beginning to tell on the right side. When the quartering is by a saltier, &c. the chief and point are the first and second quarters, the right side the third, and the left the fourth.

QUARTERLY, in heraldry. A person is said to bear quarterly when he bears arms quartered.

QUARTERN, a diminitive of quart, signifying a quarter of a pint.

QUARTZ, in mineralogy, a species of the Flint genus, which is divided into five sub-species, *viz.* the Amethyst, which see; the rock-crytal; milk-quartz; common-quartz; and prase. The rock-crystal is white, passing to brown through all the intermediate shades. It occurs rarely massive, often in rolled pieces, and often in crystals of different forms. Externally, the crystals are generally splendent, the rolled pieces are only glistening; internally, they are splendent and vitreous. It is harder than glass, and gives vivid sparks when struck against steel. It is brittle, and easily frangible. Specific gravity 2.65 when pure, but when deeply coloured by metallic oxides, it is considerably more. If two of the crystals are rubbed together they afford a phosphorescent light, and exhale a peculiar odour. By exposure to the blow-pipe, this crystal undergoes no change, except the loss of colour. It remains unaltered even when exposed to a stream of oxygen gas. It is composed of

Silica	93.0
Alumina	6.0
Lime	1
	100

It is found in abundance in the Alps, also in Hungary, Saxony, and in many parts of the British islands. It is used as an article of jewelry, and is very much prized, particularly the wine and orange yellow.

Milk-quartz is sometimes of white colour, but more frequently of a rose red, passing through all the degrees of intensity to a flesh red. It occurs massive: internally shining: sometimes passes to splendent, and is vitreous, inclining a little to resinous. Hard, but yielding to the file; easily frangible, and not very heavy: it is imagined to be composed of silica and oxide of manganese. It is found in beds, but never in veins, in primitive mountains, in Germany, Sweden, Greenland, Siberia, and also in Coll, one of the Hebrides. It is employed in ornamental works, takes a good polish, and when the colour is good the ornaments made of it are very beautiful. It loses its colour by keeping in a warm place.

Common-quartz is commonly of a white or grey colour, though many specimens are brown, yellow, red, &c. It is found massive, disseminated, in blunt edged pieces, in roundish grains, and rolled pieces. It occurs also in crystals of different kinds. Externally, the lustre of the true crystals varies from splendent to glistening: internally, it is shining and vitreous. Fragments angular, and sharp-edged, massive. Occurs commonly unseparated, but often in prismatic distinct concretions, which are straight, transversely streaked. It is hard, brittle, easily frangible. Specific gravity about 2.6. It is infusible, without addition, before the blow-pipe; but when exposed to a stream of oxygen gas, it melts into a white porcellanous ball. It occurs abundantly in the mineral kingdom, and found forming whole rocks, also in beds and veins, and is a constituent part of granite, gneiss, mica, slate, &c. It is employed in place of sand in the manufactory of glass, also in the preparation of smalt, and as an ingredient in poreclain and different kinds of earthenware.

Prase is of a leek-green colour, of various degrees of intensity. It occurs generally massive, seldom crystallized; it is hard, difficultly frangible, not very heavy. It is found in Saxony, in Finland, and Siberia; and is sometimes cut and polished for ornamental purposes.

QUASSIA, in botany, so named in memory of Quassi, a negro slave, who discovered the wood of this tree, a genus of the Decandria Monogynia class and order. Natural order of Gruinales. Magnoliæ, Jussieu. Essential character: calyx five-leaved; petals five; nectary five-leaved; perianth five, distant, each having one seed. There are three species, each of which we shall notice in their order. Q. simaruba, is a tree that grows to a considerable height and thickness, with alternate spreading branches; the bark on the trunk of old trees is black and a little furrowed, that of younger trees is smooth, grey, and marked with broad yellow spots; the wood is hard, white, and without any remarkable taste; leaves numerous, alternate, composed of several leaflets, oblong, or nearly elliptic, sharp at the end, of a deep green colour, placed alternately on very short foot-stalks; flowers on branched spikes, of a yellow colour. Simaruba is a native of South America and the West Indies; in Jamaica it is known by the names of mountain-damson, bitter-damson, and stave-wood. The drug known by the name of quassia is the bark of the roots of this tree, which is rough, scaly, and warted; the inside, when fresh, is a full yellow; when dry, it is paler; it has a little smell; the taste is bitter, but not disagreeable; macerated in water, or in rectified spirit, it quickly impregnates them with its bitterness, and with a yellow tincture; the cold infusion in water is rather stronger in taste than the decoction; the latter gets turbid and of a reddish brown as it cools.

Q. amara, grows to the height of several feet, and sends off many strong branches. The wood is of a white colour, and light; the bark is thin and grey. It is a native of South America, particularly of Surinam, and also of some of the West Indian islands. The root, bark, and wood of this tree, have all places in the materia medica. The wood is most generally used, and is said to be a tonic, stomachic, antiseptic, and febrifuge.

Q. excelsa, or polygama, is likewise very common in the woodlands of Jamaica. It is a beautiful, tall, and stately tree; some of them being one hundred feet high, and ten feet in circumference. The trunk is straight, smooth, and tapering, sending off its branches towards the top. The outside bark is pretty smooth, and of a light grey, or ash colour. The bark of the roots is of a yellow cast, somewhat like the cortex simaruba. The inner bark is tough, and composed of fine flaxy fibres. The bark of this quassia, but especially the wood, is intensely bitter. The wood is of a yellow colour, tough, but not very hard; it takes a good polish, and is used as flooring. In taste and virtues it is nearly equal to the Q. amara, and frequently sold for the same. Besides its use in medicine, quassia is supposed to be consumed in large quantities by the brewers, to give a bitterish taste to the beer.

QUAVER, in music, a measure of time equal to half a crotchet, or an eighth of a semibreve. The quaver is divided into two semiquavers, and four demisemiquavers.

QUERCITRON, in dying, the internal bark of the quercus nigra; it yields its colour, which is yellow, by infusion to water, and by the common mordants gives a permanent dye. See DYING.

QUERCUS, in botany, the *oak tree*, a genus of the Monoecia Polyandria class and order. Natural order of Amentaceæ. Essential character: male, calyx commonly five-cleft; corolla none; stamina five to ten: female, calyx one-leaved, quite entire, rugged; corolla none; styles two to five; seed one, ovate. There are twenty-six species, and many varieties; Q. robur, the common oak, attains to a great size, particularly in woods; singly, it is rather a spreading tree, sending off, horizontally, immense branches, which divide and subdivide considerably; the trunk is covered with a rugged brown bark; leaves alternate, oblong, broader towards the end, the edges deeply sinuate, forming obtuse or rounded lobes, of a dark green colour, five inches in length, two and a half in breadth, they are deciduous, but often remain on the tree till the new buds are ready to burst. The male flowers come out on aments, in bundles, from the buds, alternately and singly from the axils of the leaves; they are pendulous, cylindrical, consisting of yellow, short, roundish, scattered bundles of anthers; above the males the aments of female flowers come out, each composed of three or four small reddish florets, placed alternately, having at the base little reddish scales, which afterwards become the cup, forming the rugged external surface of it; acorn ovate, cylindrical, coriaceous, very smooth, except at the base, where it appears as if rasped, one-celled, valveless, received at bottom in a hemispherical cup, tubercled on the outside; the germ is three-celled, with two embryos in each cell, fastened to the base. The wood of the oak, when of a good sort, is well known to be hard, tough, tolerably flexible, not easily splintering, strong without being too heavy, and not easily admitting water; for these qualities it is preferred to all other timber for building ships; it would be difficult to enumerate all the uses to which it may be applied. Oak saw-dust is the principal indigenous vegetable used in dyeing fustian; all the varieties of drabs and different shades of brown, are made with oak saw-dust, variously managed and compounded. Oak apples are also used in dyeing, as a substitute for galls. See GALLS.

Q. suber, cork-barked oak, or cork tree: there are two or three varieties of this species, one with a broad leaf, a second with a narrow leaf, both ever green; and one or two which cast their leaves in autumn; the broad-leaved evergreen is the most common; the leaves of this are entire, about two inches long, and an inch and quarter broad, with a little down on their under sides, on short footstalks; these leaves continue green through the winter till May, when they generally fall off just before the new leaves come out; the acorns are very like those of the common oak. The exterior bark is the cork, which is taken from the tree every eight or ten years; there is an interior bark which nourishes them, so that stripping off the outer bark is so far from injuring the trees, that it is necessary to continue them; for when the bark is not taken off, they seldom last longer than fifty or sixty years in health; whereas trees which are barked every eight or ten years, will live one hundred and fifty years, or more.

The uses of the cork are well known, both by sea and land; the poor people in Spain lay broad planks of it by their bedside to tread on, as great persons use Turkey and Persian carpets, to defend them from the floor; they frequently line the walls and the inside of their houses, built of stone, with this bark, which renders them warm, and corrects the moisture of the air. This tree is a native of the south of Europe.

QUERIA, in botany, so named from Joseph Quer, professor of botany at Madrid, a genus of the Triandria Trigynia class and order. Natural order of Caryophyllei. Caryophylleæ, Jussieu. Essential character: calyx five-leaved; corolla none; capsule one-celled; seed one.—There are three species.

QUICKSILVER. See MERCURY.

QUILLS, are the large feathers taken out of the end of the wings of geese, ostriches, crows, &c. They are denominated from the order in which they are fixed in the wing; the second and third quills being the best for writing, as they have the largest and roundest barrels. Crow quills are chiefly used for drawing. In order to harden a quill that is soft, thrust the barrel into hot ashes, stirring it till it is soft, and then taking it out, press it almost flat upon your knee, with the back of a penknife, and afterwards reduce it to a roundness with your fingers. Another method to harden quills is, by setting water and alum over the fire, and while it is boiling, put in a handful of quills, the barrels only, for a minute, and then lay them by. Large quantities of quills are yearly imported into Britain, from Germany and Holland. The goodness of quills are judged by the size of the barrels, but particularly the weight; hence the denomination of quills of fourteen, fifteen, &c. loths, *viz.* the thousand consisting of twelve hundred quills, weighing fourteen, fifteen, &c. loths. The loth is a German weight, weighing somewhat more than an ounce. Particular attention should be paid, on purchasing quills, that they may not be left-handed, that is, not out of the left wing.

QUILTING, a method of sewing two pieces of silk, linen, or stuff, on each other, with wool or cotton between them; by working them all over in the form of chequer or diamond-work, or in flowers. The same name is also given to the stuff so worked.

QUINCHAMALA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Elæagni, Jussieu. Essential character: calyx inferior, five-toothed; corolla tubular, superior; anthers sessile; seed one. There is only one species, *viz.* Q. chilensis, a native of Chili.

QUINCUNX *order*, in gardening, a plantation of trees, disposed originally in a square; and consisting of five trees, one at each corner, and a fifth in the middle: or a quincunx is the figure of a plantation of trees, disposed in several rows, both length and breadthwise, in such a manner, that the first tree in the second row commences in the centre of the square formed by the two first trees in the first row, and the two first in the third, resembling the figure of the five on cards.

QUINDECAGON, in geometry, a plain figure with fifteen sides and fifteen angles; which, if the sides be all equal, is termed a regular quindecagon, and irregular when otherwise. The side of a regular quindecagon inscribed in a circle, is equal in power to the half difference between the side of the equilateral triangle and the side of the pentagon inscribed in the same circle; also the difference of the perpendiculars let fall on both sides, taken together.

QUINTESSENCE, properly the fifth essence, or the result of five successive distillations. The term is now obsolete; but was formerly used to express the highest degree of rectification to which any substance can be brought.

QUINTILE, in astronomy, an aspect of the planets, when they are seventy-two degrees distant from one another, or a fifth part of the zodiac.

QUINTO *Exactus*, in law, the fifth and last call of a defendant who is sued to outlawry; whereupon, if he appears not, he is by the judgment of the coroners returned outlawed.

QUIRE *of Paper*, the quantity of twenty-four or twenty-five sheets.

QUISQUALIS, in botany, a genus of the Decandria Monogynia class and order. Natural order of Veprecula. Thymeleæ, Jussieu. Essential character: calyx five-cleft, filiform; petals five; drupe five-cornered. There is but one species; *viz.* Q. indica, a native of the East Indies, China, and Cochinchina.

QUI *tam*, in law, is part of the phrase *qui tam pro domine rege quam pro se ipso in hac parte sequitur;* who sues as well for our Lord the King as himself, and denotes an action for a penalty which is given in part to the first person who will sue.

QUIT *Rent*, a small acknowledgment paid in money, so called, because such payment acquitted the tenant from all other services and duties to the lord. It is considered chiefly as an acknowledgment of tenancy and proof of copyhold.

QUOIL, or COIL, in the sea-language, a rope or cable laid up round, one fack or turn over another, so that it may the more easily be stowed out of the way, and also run out free and smooth, without twistings or doublings.

QUOIN, or COIN, on board a ship, a wedge fastened on the deck close to the breech of a carriage of a gun, to keep it firm up to the ship side. Cantic quoins are short three legged quoins put between casks to keep them steady.

QUOINS, in architecture, denote the corners of brick or stone walls. The word is particularly used for the stones in the corners of brick buildings. When these stand out beyond the brick-work, their edges being chamfered off, they are called rustic quoins.

QUOITS, a kind of exercise or game known among the ancients under the name discus.

QUORUM, a word which often occurs in our statutes, and is much used in commissions, both of justices of the peace, and others, and so called from the words of the commission, *quorum unum esse volumus*, of whom we wish that A, B, &c. should be one. All magistrates are now of the quorum.

QUOTIENT, in arithmetic, the number which arises by dividing the dividend by the divisor.

QUO *minus*, in law, is the name of a writ of different sorts, but principally used in the Court of Exchequer, where it gives the title to the common process.

QUO *Warranto*, is in nature of a writ of right for the King, against him who claims or usurps any office, franchise, or liberty, to inquire by what authority he supports his claim, in order to determine the right.

R.

R, Or r, a liquid consonant, being the seventeenth letter of our alphabet. Its sound is formed by a guttural extrusion of the breath, vibrated through the mouth, with a sort of quivering motion of the tongue drawn from the teeth, and cannulated with the tip a little elevated towards the palate. In Greek words it is frequently aspirated with an *h* after it, as in *rhapsody*, *rhetoric*, &c. otherwise it is always followed by a vowel at the beginning of words and syllables.

Used as a numeral, R anciently stood for 80, and with a dash over it, thus $\bar{R}$ for 80,000; but the Greek r, or ρ, signified an hundred. In the prescriptions of physicians, R or ℞ stands for *recipe*, *i. e.* take.

RABBETING, in carpentry, the planeing, or cutting of channels or grooves in boards, &c. In ship-carpentry it signifies the letting in of the planks of the ship into the keel; which, in the rake and run of a ship, is hollowed away, that the planks may join the closer.

RABBIT. See Lepus.

RACCOON. See Ursus.

RACE, in genealogy, a lineage or extraction continued from father to son.

RACEMUS, in botany, a term that properly signifies a cluster of grapes: but scientifically it is used to signify a mode of flowering, in which the flowers placed along a common foot-stalk are furnished with proper foot-stalks, proceeding as lateral branches from the common flower-stalk. This is exemplified in the vine and current tree.

RACK, an infernal engine of torture, furnished with pullies and chords, &c. for extorting confession from criminals. This instrument is happily banished from almost every civilized state of the world. The trial by the rack was never known to the law of England. It was proposed in the privy council to put Felton, the assassin of the Duke of Buckingham, to the rack, in order to discover his accomplices; but the judges, being consulted, unanimously declared, that no such proceeding could be admitted by the laws of England.

Rack, Arac, or Arrac, in commerce, a spirituous liquor made by the Tartars of mare's milk, which is left to be sour, and afterwards distilled twice or thrice. Rack is also a spirituous liquor which the English get from Batavia or Malacca, of which there are three sorts, the one being extracted from the cocoa-tree, the second from rice, and the third from sugar; but the first is the best, and most in use. It is made of the blossom bunch of the cocoa-tree; for which purpose they tie the bunch while it is still wrapped up within its cod, or membrane, with a piece of packthread, and then with a a knife make a cross cut in that bunch, a little above the place where it is tied, and adapt a pitcher to it to receive the liquor, which is called toddy, and is vinous, palatable, and sweet: others use a bamboo-cane instead of a pitcher. Having thus drawn the liquor, they let it ferment, and afterwards distil it.

Rack *rent*, the full extended yearly value of the land, &c. let by lease, payable by tenants for life or years.

RACKET, a kind of bat to strike the ball with at tennis; usually consisting of a lattice or net-work of catgut strained very tight in a circle of wood, with a shaft or handle.

RADIANT, or Radiating *point*, in optics, is any point of a visible object from whence rays proceed.

RADIATION, the act of a body emitting or diffusing rays of light all round, as from a centre.

RADICAL, in general, something that serves as a basis or foundation. In grammar, we give the appellation radical to primitive words, in contradistinction to compounds and derivatives. Algebraists also speak of the radical sign or quantities, which is the character expressing their roots.

RADICAL *vinegar*, in chemistry. When acetate of copper, reduced to powder, is put into a retort and distilled, there comes over a liquid at first nearly colourless and almost insipid, and afterwards a highly concentrated acid. The distillation is to be continued till the bottom of the retort is red hot. What remains in it then is only a powder of the colour of copper. The acid product, which should be received in a vessel by itself, is tinged green by a little copper which passes along with it; but when distilled over again in a gentle heat, it is obtained perfectly colourless and transparent. The acid thus obtained is exceeding pungent and concentrated. It was formerly distinguished by the names of radical vinegar, and vinegar of Venus; it has since been found to be acetous acid combined with a new dose of oxygen, and is called acetic acid.

RADICLE. See Plants.

RADIUS, in geometry, the semi-diameter of a circle, or a right line drawn from the centre to the circumference. In trigonometry, the radius is termed the whole sine, or sine of 90 degrees.

RADIX, or *root*, in mathematics, is a certain finite expression or function, which being evolved or expanded, according to certain rules, produces a series. See Series. That finite expression or radix is the value of the infinite series: thus $\frac{1}{3} = .3333$, &c. $\frac{1}{9} = .1111$, &c. In the same way

$$\frac{1}{1+r} = 1 - r + r^2 - r^3 + r^4, \text{ \&c.}$$

$$\frac{1}{1+1} = 1 - 1 + 1 - 1 + 1, \text{ \&c.}$$

RAFT, a sort of float, formed by an assemblage of various planks or pieces of timber, fastened together side by side, so as to be conveyed more commodiously to any short distance in a harbour or road than if they were separate. The timber and plank, with which merchant ships are laden, in the different parts of the

Baltic, are attached together in this manner, in order to float them off to the shipping. The same mode is adopted on the Thames in this country, on the Rhine, and on many of the large lakes and rivers in North America.

RAGG, *rowley*, in mineralogy, a class of silicious stones, of a dark grey colour, with many shining crystals, having a granular texture, and acquiring an ochry crust, by exposure to the air. The specific gravity is about 2.8. It becomes somewhat magnetic by being heated in an open fire. In a strong fire it melts without addition, but with more difficulty than basaltes. It consists of

Silica	47.5
Alumina	32.5
Iron	20
	100.0

RAGG *stone*, in some respects similar to the rowley-ragg. The texture is obscurely laminar, or rather fibrous, but the laminæ or fibres consist of a congeries of grains of a quartzy appearance, coarse and rough: it effervesces with acids, and strikes fire with the steel: it contains a portion of mild calcareous earth, and a small portion of iron. It is used as a whetstone for coarse cutting tools. It is found about Newcastle, and in several other parts of England, where there are large rocks of it in the hills.

RAIA, the *ray*, in natural history, a genus of fishes of the order Cartilaginei. Generic character: five spiracles on each side, placed beneath, near the neck; mouth beneath the head, transverse, beset with teeth; head small, pointed, and not distinct from the body; body somewhat rhomboidal. These fishes are found only in the salt water, where they feed on whatever animal substances they meet with. They are sometimes of the weight of two hundred pounds. They conceal themselves for the greater part of the winter in the mud or sand of the bottoms, and, in consequence of being unprovided with an air bladder, they are seldom seen near the surface of the water. The female is larger than the male, and produces her offspring living, and only one at a time; the young extricating itself gradually from its confinement, and remaining some time attached by the umbilical vessels, after its complete appearance. There are nineteen species.

R. batis, or the skate, is one of the largest of the genus, weighing sometimes two hundred pounds, and one of this size is reported to have been served up at St. John's College, Cambridge, England. It is the most esteemed species of the genus.

R. clavata, or the thorn-back, is much inferior to the skate in size and goodness. It inhabits the Mediterranean and other seas, and is distinguished by its long and curved spines, on its upper surface. The above are rhomboidal.

R. pastinaca, or the sting ray, inhabits the Indian and Mediterranean seas, and its tail is armed with a very long serrated spine, with which it can inflict very formidable wounds, and which it casts off every year. This was formerly supposed to contain the most subtle poison, and ancient naturalists have been extremely elegant and glowing in their descriptions on this subject. It injures, however, only by piercing and laceration, and, to prevent this, the tail is almost always cut off as soon as the fish is caught. These fishes often lie in ambuscade, and seize their prey by surprise, and frequently take it by active and persevering pursuit.

R. torpedo, the torpedo, inhabits the Mediterranean and the North Seas, and grows to the weight of twenty pounds. This fish possesses a strong electrical power, and is capable of giving a very considerable shock through a number of persons forming a communication with it. This power was known to the ancients, but exaggerated by them with all the fables natural to ignorance, and it is only recently that the power has been ascertained to be truly electric. It is conducted by the same substances as electricity, and intercepted by the same. In a minute and a half no fewer than fifty shocks have been received from this animal, when insulated. The shocks delivered by it in air, are nearly four times as strong as those received from it in water. This power appears to be always voluntarily exercised by the torpedo, which occasionally may be touched and handled without its causing the slightest agitation. When the fish is irritated, however, this quality is exercised with proportional effect to the degree of irritation, and its exercise is stated, in every instance, to be accompanied by a depression of the eyes. When the animal exerts that benumbing power from which it derives its name, and when it operates by separate and repeated efforts, this is always the case, both in the continued, and in the instantaneous process, the eyes, which are at other times prominent, are withdrawn into their sockets, a circumstance very naturally attaching both to the condensation and discharge of the subtle fluid. Specimens have been seen of this fish weighing fifty and even eighty pounds. It commonly lies in forty fathom water, and is supposed to stupify its prey by this extraordinary faculty. It is sometimes nearly imbedded in the sands of shallows, and is stated, in these cases, to give to any one who happens to tread upon it, an astonishing and overwhelming shock. On dissection, it was found to exhibit no material difference from the general structure of the ray, excepting with respect to the electric or galvanic organs, which have been minutely examined and detailed by the celebrated anatomist, John Hunter. He states them "to be placed on each side of the cranium and gills, reaching thence to each great fin, and extending longitudinally from the anterior extremity of the animal to the transverse cartilage which divides the thorax from the abdomen." From the whole description, it appears, that these organs, as Mr. Shaw observes, constitute a pair of galvanic batteries, disposed in the form of perpendicular hexagonal columns; while, in the gymnotus electricus, the galvanic battery is disposed lengthwise on the lower part of the animal. It is stated, that the torpedo, in its dying state, communicates shocks in more than usually rapid succession, but in proportional weakness, and in seven minutes, in these circumstances, three hundred and sixty small shocks were distinctly felt. On the same authority (that of Spallanzani) it is reported, that the young torpedo can exercise this power at the moment after its birth, and even possesses it while a fœtus, several of these having been taken from the parent fish, and been found to commmunicate perceivable shocks, which, however, were more distinctly felt when these animals were insulated on a plate of glass.

RAJANIA, in botany, so named in memory of John Ray, our celebrated naturalist; a genus of the Dioecia Hexandria class and order. Natural order of Sarmentaceæ. Asparagi, Jussieu. Essential character: calyx six-parted; corolla none: female, styles three; germ inferior, three celled, with two of the cells obliterated; seed one, with one wing. There are seven species; these are climbing plants, by means of the stem twisting towards the left; the root is tuberous; the flowers in axillary spikes or racemes. They are all natives of the West Indies.

RAIL, in architecture, is used in different senses, as for those pieces of timber which lie horizontally between the pannels of wainscot; for those which lie over and under the balusters in balconies, staircases, and the like; and also for those pieces of timber which lie horizontally from post to post in fences, either with poles or without.

RAIL, (see RALLUS) *ortygometra*, in ornithology, a genus of birds of the order of Grallæ, the beak of which is shorter than the toes: it is of a compressed form, and terminated in a point; but the two chaps are equal in length. It is of the size of the common magpie, and is an elegant bird, of a bright-brown colour, variegated with black spots; it is common in rich pastures, where its constant note is *crex, crex*.

RAIN. See METEOROLOGY.

RAIN *gauge*, a machine for measuring the quantity of rain that falls. There are various kinds of rain-gauges: that used at the apartments belonging to the Royal Society at Somerset-house, is thus described. The vessel which receives the rain is a conical funnel, strengthened at the top by a brass ring twelve inches in diameter. The sides of the funnel, and inner lip of the brass ring, are inclined to the horizon in an angle of more than 65°, and the outer lip is an angle of more than 50°, which are such degrees of steepness, that there seems no probability either that any rain which falls within the funnel, or on the inner lip of the ring, shall dash out, or that which falls on the outer lip shall dash into the funnel.

Plate XIII. Misc. fig. 9, represents one of the best construction of rain-gauges. It consists of a hollow cylinder, having within it a cork-ball attached to a wooden stem, which passes through a small opening at the top, on which is placed a large funnel. When this instrument is placed in the open air in a free place, the rain that falls within the circumference of the funnel will run down into the tube, and cause the cork to float; and the quantity of water in the tube may be seen by the height to which the stem of the float is raised. The stem of the float is so graduated, as to show by its divisions the number of perpendicular inches of water which fell on the surface of the earth since the last observation. It is hardly necessary to observe, that after every observation the cylinder must be emptied.

A very simple rain-gauge, and one which will answer all practical purposes, consists of a copper funnel, the area of whose opening is exactly ten square inches: this funnel is fixed in a bottle, and the quantity of rain caught is ascertained by multiplying the weight in ounces by .173, which gives the depth in inches and parts of an inch. In fixing these gauges, care must be taken that the rain may have free access to them: hence the tops of buildings are usually the best places. When the quantities of rain collected in them at different places are compared, the instruments ought to be fixed at the same heights above the ground at both places, because, at different heights, the quantities are always different, even at the same place.

RAINBOW. The rainbow is a circular image of the sun, variously coloured. It is thus produced: the solar rays, entering the drops of falling rain, are refracted to their further surfaces, and thence, by one or more reflections, transmitted to the eye: at their emergence from the drop, as well as at their entrance, they suffer a refraction, by which the rays are separated into their different colours, and these, therefore, are exhibited to an eye properly placed to receive them. That this is the true account of the formation of the rainbow, appears from the following considerations: 1. That a bow is never seen but when rain is falling, and the sun shining at the same time, and that the sun and bow are always in opposite quarters of the heavens: this every one's experience can testify. 2. That the same appearance can be artificially represented by means of water thrown into the air, when the spectator is placed in a proper position with his back turned to the sun: experiment will shew this. 3. That its formation, as above described, can be clearly explained from the properties of light, already demonstrated in the former parts of this dictionary.

Let A B, (Plate XIII. Miscel. fig. 10) be a drop of water, and C D, a pencil of solar rays incident thereon; if all the rays of any one colour, as red, belonging to the pencil C D, be refracted to the same point, G, and thence reflected, they will fall on the space, R Q, with the same obliquity, and at the same distances from each other as the refracted rays, if proceeding backward from G, would fall on the space, T S, but these, at their refraction, would emerge into T D, C S, &c. parallel to each other; ∵ the rays, G R, G Q, will emerge from the drop parallel to each other, and therefore will enter an eye properly placed copiously enough to cause a sensation; a red colour will therefore appear in the direction of these rays, and so of others. But if the refracted rays do not meet in the same point, the reflected rays, (fig. 11) I V, P Q, will not fall on the surface at the same distance from each other that P T and I S do, though their obliquity to the surface be equal to that of the latter; therefore, the refracted rays will emerge, diverging from each other, and consequently will not enter the eye copiously enough to cause a perception of their colour. It is plain, that where the rays of any colour emerge parallel, all these emerging rays will be inclined to the incident rays in the same angle. And by calculation it is found, that the red rays, when they emerge parallel to each other, make with the incident rays an angle, A B O, (fig. 12) of 42° 2′, and the violet an angle, A C O, of 40° 17′, and the rays of the other colours, angles greater than the latter, and less than the former.

If through the eye which receives the emerging rays, there be drawn a line, A X, parallel to the incident rays, it will make, with the emerging rays of each colour, angles, R A X, and V A X, &c. equal to the above. This line, A X, is called the axis of vision. The several drops placed in the lines, A R, A V, &c. will exhibit to the eye at A, the several prismatic colours respectively, as appears from what has been said; and if those lines be supposed to revolve with a conical motion round the axis of vision, it is evident, for the same reason, that all the drops placed in each of the conic surfaces, so generated, will transmit the rays of each colour respectively to the eye, and therefore, that a number of circular, concentric arches of the prismatic colours, adjoining to each other, will be exhibited to the eye. This explanation relates to the interior bow, whose colours, beginning from the outside, are red, orange, &c. as in the prismatic spectrum. This bow can never be seen if the sun be elevated more than 42° 2′ above the horizon; for the horizon, H O, (fig. 13) always makes with the axis of vision, A X, an angle equal to the elevation of the sun, ∵ in the case here stated, the line, A Q, marking the vertex of a rainbow, would fall entirely below the horizon. As the anterior bow is formed by one reflection and two refractions, the exterior bow is formed by two reflections and two refractions at the surfaces of the drops of falling rain. If the red rays of any pencil, C D, (fig. 14) of solar rays, after refraction intersect each other at R, so that when reflected at T V, they may proceed parallel within the drop, after a second reflection at X Q, they will proceed to L M, intersecting each other at S, equally distant from X Q, as R is from T V: and as the rays, Q T, X V, if they proceeded backward, would, after reflection, so fall on the surface, N O, as to be refracted into air parallel to each other; so X M, Q L, falling on the surface precisely in the same circumstances, shall be refracted to the eye parallel to each other, and therefore will enter it copiously enough to cause a perception of their colour, (and so of the rest). The red rays, when emerging parallel after two reflections, are by calculation found to make with the incident rays, and therefore with the axis of vision, an angle of 50° 57′. The violet rays, when emerging parallel, are found to make with their incident rays, and therefore with the axis of vision, an angle of 54° 7′: the other emerging rays meet the axis of vision in the intermediate angles. From hence it is easy to explain the generation of the exterior bow, (fig. 12) in the same manner as that of the interior. It is to be remarked, that the order of colours in the exterior bow is the reverse of that in the interior, and the reason of this appears in the above explanation; for A E, which marks the direction of the violet rays in the outer bow, contains with A X, the axis of vision, a greater angle than A D, which marks the direction of the red rays, contains with the same axis. The reverse is the case with the interior bow. It is evident, (for a reason similar to that given in the case of the interior bow) that an exterior bow cannot be seen when the elevation of the sun is above 54° 7′.

Rainbow, *lunar*. The Moon sometimes also exhibits the phenomenon of an iris, by the refraction of her rays in drops of rain in the night time.

Rainbow, *marine*, the sea bow, is a phenomenon sometimes observed in a much agitated sea, when the wind, sweeping part of the tops of the waves, carries them aloft, so that the rays of the sun are refracted, &c. as in a common shower.

RAISING *pieces*, or Reason *pieces*, in architecture, are pieces that lie under the beams, and over the posts or puncheons.

RAISINS, grapes prepared by suffering them to remain on the vine till they are perfectly ripe, and then drying them in the sun, or by the heat of an oven.

RAKE *of a ship*, is all that part of her hull which hangs over both ends of her keel. That which is before, is called the fore-rake, or rake-forward; and that part which is at the setting on of the stern-post, is called the rake-aft, or afterward.

RAKING, the act of cannonading a ship on the stern or head, so as that the balls shall range the whole length of the decks, which is one of the most dangerous circumstances that can happen in a naval action; this is frequently called raking fore and aft, and is similar to what is termed by engineers enfilading.

RALLUS, the *rail*, in natural history, a genus of birds of the order Grallæ. Generic character: bill slender, slightly compressed, and incurvated; nostrils small; tongue rough at the end; body much compressed; tail very short. There are twenty-two species, of which we shall notice the following:

R. aquaticus, or the water-rail, is frequently to be seen in England, and is about four ounces and a half in weight. It resides in moist situations, abounding in sedges and reeds, where it finds cover and security. It is timid and solitary, flies with considerable awkwardness, with its legs hanging down, and shows great reluctance, even when much pressed by the sportsman and his dogs, to take wing. It runs with wonderful rapidity, and seldom rises in the air till it has fatigued both itself and its pursuers, by an exhausting progress on its feet. It swims with tolerable ease, and where there are any weeds upon the water, will run over them with great lightness. It is migratory, and winters in Africa. Its flesh is good. See Aves, Plate XIII. fig. 1.

R. porzana, or the water crake or skitty. This also is fond of low and marshy grounds, in which are covers of reeds and rushes, and in which it shelters itself in security. It is extremely timid and sequestered, eluding observation by its perpetual vigilance and lurking habits. Its nest is formed with singular care, of matted rushes, and materials which will float on the water, on which it remains tied, by some filaments, to the stalks of reeds, by which it is prevented from being carried away by the tide or current.

This bird is in great esteem for the table. Inhabits Europe.

RAM, in zoology, the male of the sheep kind. See Ovis.

Ram, *battering*, in antiquity, a military engine used to batter and beat down the walls of places besieged. The battering ram was of two sorts, the one rude and plain, the other compound. The former seems to have been no more than a great beam which the soldiers bore on their arms and shoulders, and with one end of it by main force assailed the wall. The compound ram is thus described by Josephus: it is a vast beam, like the mast of a ship, strengthened at one end with a head of iron, something resembling that of a ram, whence it took its name.

Ram's *head*, in a ship, is a great block belonging to the fore and main halliards. It has three shivers in it, into which the halliards are put, and in a hole at the end of it are reeved the ties.

RAMMER *of a gun*, the gun-stick, a rod used in charging of a gun, to drive home the powder, as also the shot and the wad, which keeps the shot from rolling out. The rammer of a great gun is used for the same purpose. It has a round piece of wood at one end, and the other is usually rolled in a piece of sheep skin, fitted to the bore of the piece, and is used to clear her after she has been discharged, which is called sponging the piece.

RAMPANT, in heraldry, a term applied to a lion, leopard, or other beast that stands on his hind legs, and rears up his fore feet in the posture of climbing, shewing only one half his face, as one eye, &c. It is different from salient, in which the beast seems springing forward as if making a sally.

RAMPART, in fortification, is an elevation of earth round a place, capable of resisting the cannon of an enemy, and formed into bastions, curtins, &c. A rampart ought to be sloped on both sides, and to be broad enough to allow room for the marching of waggons and cannon, beside that allowed for the parapet which is raised on it: its thickness is generally about ten or twelve fathom, and its height not above three, which is sufficient to cover the houses from the battery of the cannon. The rampart is encompassed with a ditch, and is sometimes lined or fortified on the inside. Upon the rampart the soldiers continually keep guard, and pieces of artillery are planted there for the defence of the place.

Rampart, in civil architecture, is used for the space left between the wall of a city, and the next houses.

RAMPHASTOS, the *toucan*, in natural history, a genus of birds of the order Picæ. Generic character: bill extremely large, hollow, carinated on the top, and serrated at the edges; nostrils long, narrow, and behind the base of the bill; tongue ciliated. These birds have been met with only in South America, and there merely between the tropics, being totally incapable of sustaining the cold.—They subsist on fruits, particularly of the palm tree. They build in the hollows of trees, and generally in recesses previously formed for the same purpose by the woodpecker, their own bill being exquisitely tender. They are easily tamed and familiarized, and several species have been brought to England, where fruits, fish, and flesh, have been promiscuously devoured by them with considerable voracity. Whatever was received by the bill was thrown into the air, and on its return caught, and without the slightest mastication, or almost compression, instantaneously swallowed. The climate alone appeared to disagree with them. There are seventeen species enumerated by Gmelin, and fifteen by Latham. For the yellow-throated toucan, see Aves, Plate XIII. fig. 2.

RAN, an old English word, denoting open and barefaced robbery: hence has obtained the phrase, "he has taken all he can rap and ran." The word has been defined by law writers: "Ran dicitur aperta rapina quæ negari non potest."

RANA, the *frog*, in natural history, a genus of Amphibia of the order Reptiles. Generic character: body four-footed, tailless, and without any integument but the skin; hind legs longer than the fore. There are thirty-six species, of which the following deserve the chief attention:

R. bufo, the toad, is found in shady and damp situations throughout Europe, and often is met with in cellars, concealed in recesses and holes, which it sometimes prepares for itself, but generally finds already accommodated to its purpose. In spring it moves towards the water, and lays its ova in a brilliant band of glutinous substance, several feet in length. The ova appear like beads of jet, and in fourteen days these convolved larvæ are developed and swim about, nourishing themselves by insects and vegetable substances, till their tail disappears, and their legs are formed, and they pass from water to land. The toad is always covered with tubercles, is generally of a dark brown colour above, and a light yellow on the lower parts both of the body and limbs. It lives to a considerable age, surviving, in some instances, even twenty years, and the case of a toad, which arrived at the age of forty, is mentioned by Mr. Pennant. This was remarkable, not only for its longevity, but for being in a great degree domesticated. It was introduced to the table of the family, caught its food, consisting of insects, with great alertness and dexterity, grew to an uncommon size, would approach on being called by a particular name given to it, and regularly resided in a hole under the garden steps. The ideas formerly entertained of venomous qualities possessed by this animal, and on which the writers of almost every age have expatiated with firm belief, are now ascertained to be groundless, and the toad is regarded as an inoffensive animal, at least with respect to mankind, on whom its touch or bite never produces any serious injury. The small lizard appears, after biting the toad, to experience a temporary paralysis; even the mouths of dogs are stated to be somewhat irritated and inflamed by the exudation in the skin of this animal, in a state of alarm and irritation. But the limpid fluid, which it otherwise discharges during this state, is said to be free from even the slightest corrosive quality. The exudation of some other species, however, is considered to be highly acrimonious. The statements which have repeatedly been published of toads found living in large blocks of wood and of stone, with no perceivable inlet for the air, and touched on all sides by the substance in which they were inclosed, appear to savour of the marvellous, and such representations are certainly not to be credited upon light authority. It is ascertained that a toad will live for many weeks, and even months, in a very small case, or under a pan buried deeply in the earth. A gentleman inclosed three toads in three boxes before the members of the French Academy, and covered these boxes with thick mortar, leaving them in the apartments of that Society, and after eighteen months the boxes were opened, and two of the animals were found still living. The eyes of the toad are remarkable for their clearness and beauty, and excite sensations of a very different nature from that disgust and even horror, which its general appearance almost universally excites. See Amphibia, Plate II. fig. 2.

The common toad of the United States bears considerable resemblance to this, but is specifically distinct, as well in the external characters of the body as in its habits: the bufo walks, but that invariably leaps. To the toad of the United States deleterious qualities have been attributed; when provoked or captured, it is apt to eject its urine; if this falls on the hand or any part of the body, it is supposed that warts will be the consequence; this is a vulgar error, and may have arisen from the repulsive appearance of the animal, and the wart-like tubercles of its body; a species of toad in Carolina has been described by Shaw under the name of *Lentiginosa.*

R. cornuta, or the horned toad, is distinguished by two sharp horns on its head, or rather by so peculiar a structure of the upper lids of its eyes, as to produce the resemblance of horns. Its mouth is of a most extravagant width, and in the whole list of amphibious animals it is difficult perhaps to point out one equally calculated by deformity and ugliness to excite disgust. It is found only in South America.

R. pipa, or the Surinam toad, is much larger than the common toad, being sometimes seven inches in length. This animal is almost equally loathsome with the last, and is distinguished particularly by that curious deviation from the general course of nature, the exclusion of its young from its back, which contains a variety of cells for their residence, and a certain degree of maturation. It appears, however, that the ova are first deposited on the margin of some stagnant water, and afterwards, with great care, collected on the back of the female, and pressed into the cells, which are at particular seasons opened for their reception, and immediately on receiving them close over them. Here the young, from the egg state to that of the tadpole, and from the latter to the form of the perfect animal, and after the expiration of three months from their inclosure, are dislodged in this matured state. In the space of five days one female has been seen to exclude in this manner seventy-five young ones.

R. temporania, or frog, is met with almost every were throughout Europe, in low and wet situations, where it can procure that food on which it principally subsists, worms and insects. During the heat of summer it generally resides in water, and is able to swim with great dexterity, its hind feet being furnished with strong webs, admirably adapted for this exercise, and in winter it remains imbedded in the muddy bottoms of pools, or lodges in deep recesses in their banks, in a state of torpor, from which it is revived by the influence of spring. In March it deposits an accumulation of transparent ova, from which, within about a month are hatched tadpoles, every egg in the mean time advancing daily in size, so that before the expiration of this period, these tadpoles may be clearly seen struggling in the viscous fluid which surrounds them. When first hatched they subsist on the remainder of this glutinous fluid. These animals appear to possess little more than head and tail, and exhibit a singular contrast to the form of the animal which they are destined perfectly to resemble. The internal structure of the old and young is little less different than their external appearance. These animals live to the age of twelve or fifteen years, and do not attain their maturity before their fifth year. They will survive the amputation of several of their organs, and of consequence must possess a strong principle of vitality. They are fond of basking in the sun, cannot well dispense with water for any considerable time, and are incapable of sustaining rigorous cold. See Amphibia, Plate II. fig. 1.

R. esculenta, or green frog, is much larger than the last species, and abounds in many countries of Europe, though but rarely to be found in England. These animals croak so loudly as to be heard at a very great distance, and to produce great annoyance. They are extremely voracious, and will occasionally seize small birds, and chickens and ducks when very young, swallowing them entire. They are in some places much used for food, particularly in France, and thought fittest for the table in the month of June.

R. catesbeiana, or the bull-frog, is found in North America, and grows to the length of eighteen inches from the nose to the hind feet. Its sounds resemble the lowing of a bull. In Virginia these frogs are supposed to be great purifiers of the water. On being surprised by the traveller, they make two or three leaps, and plunge into the water, where they are secure from molestation. They are highly rapacious, often committing great depredations on the poultry.

R. paradoxa, or the paradoxical frog, is of the size of the frog of Europe, and is found chiefly in America, and particularly in Surinam. It is remarkable for the circumstance, of the tadpole bearing a greater proportion to the size of the parent animal than in any other species. This proportion, indeed, is truly extraordinary and curious.

R. zebra, or the zebra frog, is a native of Carolina and Virginia, and is by far the largest of the slender bodied frogs. It is of a pale reddish brown, and beautifully marked, transversely, on the back and limbs, with bars of a chesnut colour.

R. arborea, or tree frog, is not found in Great Britain, but is met with in various other parts of Europe, and in elegance and activity is superior to every other European species. In summer it resides in the woods, and haunts the trees in quest of insects, which it approaches on its belly, in the same manner as a cat to a mouse, and at length seizes with an elastic and instantaneous spring. It is particularly noisy on the approach of rain. In winter it takes up its abode in the bottoms of the waters, remaining till the spring in a state of torpor.

RANCIDITY, in chemistry; fixed oils are liable, by keeping, to undergo a change well known by the name of rancidity. They become thick; acquire a brown colour, an acrid taste, and a disagreeable smell. The oil thus altered converts vegetable blues into red, and of course contains an acid. It is believed that this change is owing to the alteration of the foreign substances present in oils, or to the action of those foreign bodies upon the oily matter itself. Several of the fixed oils, when newly extracted, let fall, on standing, a quantity of mucilaginous matter; and from the experiments of Scheele, it appears probable that they always retain less or more of a similar principle.

RANDOM *shot*, in gunnery, is a shot made when the muzzle of a gun is raised above the horizontal line, and is not designed to shoot directly, or point blank. The utmost random of any piece is about ten times as far as the bullet will go point blank. The bullet will go furthest when the piece is mounted to about forty-five degrees above the level range.

RANGE, in gunnery, the path of a bullet, or the line it describes from the mouth of the piece to the point where it lodges. If the piece lie in a line parallel to the horizon, it is called the right or level range: if it be mounted to forty-five degrees, it is said to have the utmost range, all others between 00 and 45° are called the intermediate ranges.

RANK, the order or place allotted a person, suitable to his quality or merit. See PRECEDENCE.

RANK, in war, is a row of soldiers, placed side by side. To double the ranks, is to put two ranks into one. To close the ranks, is to bring the men nearer; and to open them, is to set them further apart.

RANSOM, was the sum formerly given by captains or passengers for the redemption of a vessel captured by pirates. This is now prohibited by statute.

RANUNCULUS, in botany, *crowfoot*, a genus of the Polyandria Polygynia class and order. Natural order of Multisiliquæ, Linnæus. Ranunculaceæ, Jussieu. Essential character: calyx five-leaved; petals five to eight, with a honied pore at the claw; seeds naked. There are fifty-nine species. R. aconitifolius, aconite leaved crowfoot, is a very handsome species, about three or four feet in height, branched; stems hollow within; leaves large, digitate, three-lobed, divided to the base; segments lanceolate, hirsute, especially at the base; flowers white, terminating each branch; petals roundly serrate. Native of the Alps of Europe. The double flowering variety has been obtained by seeds, and is preserved in many gardens for the beauty of its flowers. By some gardeners it is called fair-maid of France. The Persian crow-foot, or garden ranunculus, has been greatly improved by culture, and many new flowers obtained from seeds, amongst which are several with semidouble flowers, which produce seeds; and from these there are such prodigious varieties of new flowers annually obtained, which are large, and of such variety of beautiful colours, as to exceed all other flowers of that season; many of them are finely scented; the roots, when strong, generally produce twenty or thirty flowers upon each; it is a native of the Levant.

RAPE *of women*, is where a man has carnal knowledge of a woman by force, and against her will, which is by our law a capital felony, and subjects the offender to the punishment of death, which is never remitted. By 18 Elizabeth, c. 7, if any person shall, unlawfully and carnally, know and abuse any woman child under the age of ten years, whether with her consent or against it, he shall be punished as for a rape. And it is not a sufficient excuse in the ravisher to prove that she is a common strumpet; for she is still under the protection of the law, and may not be forced. Nor is the offence of a rape mitigated, by showing that the woman at last yielded to the violence, if such her consent were forced by fear of death or duress; nor is it any excuse that she consented after the fact.

RAPE is also a name given to a division of a county, and sometimes means the same as a hundred, and at other times signifies a division consisting of several hundreds; thus Sussex is divided into six rapes, every one of which, besides its hundreds, has a castle, a river, and a forest belonging to it. The like parts in other counties are called tithings, lathes, or wapentakes.

RAPHANUS, in botany, *radish*, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ, Cruciformes, or Cruciferæ. Essential character: calyx closed; silique torose, subarticulate, cylindrical; glands four, two between each shorter stamen and the pistil, and two between the longer stamens and the calyx. There are six species, R. sativus, common garden radish, has a large fleshy, fusiform, annual root; stem upright, thick, much branched and diffused, rough with pellucid bristles; leaves rough; calyx green, rough haired; petals pale violet, with large veins running over them. It is a native of China. There are four varieties of the common radish, *viz.* the long-rooted radish; the small white turnip-rooted or Naples radish; the black Spanish radish; and the large turnip-rooted, or white Spanish radish. The first variety is that which is commonly cultivated in our kitchen gardens for its roots; of this there are several subordinate variations.

RAPHIDIA, in natural history, a genus of insects of the order Neuroptera. Generic character: mouth with a curved toothed horny mandible; thorax long, cylindrical; three stemmata; wings deflected; antennæ filiform, as long as the thorax, the anterior part elongated and cylindrical; four feelers very short, filiform; tail of the female terminated by a large recurved bristle. There are two species, *viz.* the R. ophiosis, a smallish fly, with rather large transparent wings, and a narrow thorax, stretching forwards in a remarkable manner; it is found on trees in summer, though but seldom; the pupa resembles the complete insect, except being destitute of wings. R. rotata, mentioned by Gmelin, has, by other naturalists, been supposed to be a mere variety of the ophiosis. Dr. Shaw mentions two other species, *viz.* R. cornuta, which in size is equal to one of the larger dragon flies, and is distinguished by its very long horn-like jaws, which extend far beyond the thorax, and are terminated by a bifid tip; the wings are large, reticulated, and semi-transparent. It is a native of North America. R. mantispa, a small species that has the habits of the genus Mantis, and is supposed by some to belong to that genus.

RAREFACTION, in physics, is the making a body to expand or occupy more room or space, without the accession of new matter. It is by rarefaction that gunpowder takes effect; and to the same principle also we owe eolipiles, thermometers, &c. The degree to which air is rarefiable exceeds all imagination; perhaps indeed its degree of expansion is absolutely beyond all limits. Upon the rarefaction of the air is founded the method of measuring altitudes by the barometer; in all cases of which the rarity of the air is found to be inversely as the force that compresses it, or inversely as the weight of all the air above it at any place.

The open air, in which we breathe, says Sir Isaac Newton, is 8 or 900 times lighter than water, and by consequence 8 or 900 times rarer. And since the air is compressed by the weight of the incumbent atmosphere, and the density of the air is proportionable to the compressing force, it follows by computation, that at the height of about seven Engligh miles from the earth, the air is four times rarer than at the surface of the earth; and at the height of 14 miles, it is 16 times rarer than at the surface of the earth; and at the height of 21, 28, or 35 miles, it is respectively 64, 256, or 1024 times rarer, or thereabouts; and at the height of 70, 140, and 210 miles, it is about 1,000,000, 1,000,000,000,000, or 1,000,000,000,000,000,&c.

Mr. Cotes has found, from experiments made with a thermometer, that linseed-oil is rarefied in the proportion of 40 to 39 in the heat of the human body; in that of 15 to 14, in that degree of heat wherein water is made to boil; in the proportion of 15 to 13, in that degree of heat wherein melted tin begins to harden; and finally, in the proportion of 23 to 20, in that degree wherein melted tin arrives at a perfect solidity. The same author discovered, that the rarefaction of the air, in the same degree of heat, is ten times greater than that of the linseed-oil; and the rarefaction of the oil, about fifteen times greater than that of the spirit of wine.

RASANT, or Razant, in fortification. Rasant-flank, or line, is that part of the curtain or flank, whence the shot exploded rase, or glance, along the surface of the opposite bastion.

RAT. See Mus.

RATCH, or Rash, in clock-work, a sort of wheel having twelve fangs, which serve to lift up the detents every hour, and make the clock strike.

RATCHETS, in a watch, are the small teeth at the bottom of the fusy, or barrel, which stops it in winding up.

RATE, a standard or proportion, by which either the quantity or value of a thing is adjusted.

Rate *of a ship of war* is its order, degree, or distinction, as to magnitude, burden, &c. The rate is usually accounted by the length and breadth of the gun-deck, the number of tons, and the number of men and guns the vessel carries. Of these there are six rates. A first-rate man of war has its gun-deck from 159 to 174 feet in length, and from 44 to 50 feet broad; it contains from 1313 to 1882 tons, has from 706 to 800 men, and carries from 96 to 100 guns. Second rate ships have their gun-decks from 153 to 165 feet long, and from 41 to 46 feet broad; they contain from 1086 to 1482 tons, and carry from 524 to 640 men, and from 84 to 90 guns. Third rates have their gun-decks from 140 to 158 feet in length, from 37 to 42 feet broad; they contain from 871 to 1262 tons; carry from 389 to 476 men, and from 64 to 80 guns. Fourth rates are in length on the gun-decks from 118 to 146 feet, and from 29 to 38 broad; they contain from 448 to 915 tons; carry from 226 to 346 men, and from 48 to 60 guns. Fifth rates have their gun-decks from 100 to 120 feet long, and from 24 to 31 broad; they contain from 259 to 542 tons, and carry from 145 to 190 men, and from 26 to 44 guns. Sixth rates have their gun-decks from 87 to 95 feet long, and from 22 to 25 feet broad; they contain from 152 to 256 tons, carry from 50 to 110 men, and from 16 to 24 guns.

It is to be observed, that the new-built ships are much larger, as well as better, than the old ones of the same rate; whence they double numbers all along; the larger of which express the proportions of the new-built ships, as the less those of the old ones.

RATIO, in mathematics, is the relation which one quantity bears to another in respect of magnitude, the comparison being made by considering how often one contains, or is contained by the other. Thus, in comparing 6 with 3, we observe that it has a certain magnitude with respect to 3, which it contains twice; again, in comparing it with 2, we see that it has a different relative magnitude, for it contains 2 three times, or it is greater when compared with 2 than it is when compared with 3. The ratio of a to b is usually expressed by two points placed between them, thus, $a : b$; and the former is called the *antecedent* of the ratio, the latter the *consequent*. When one antecedent is the same multiple part, or parts, of its consequent, that another antecedent is of its consequent, the ratios are equal. Thus, the ratio of 4 : 6 is equal to the ratio of 2 : 3, *i. e.* 4 has the same magnitude when compared with 6, that 2 has when compared with 3, since $\frac{4}{6} = \frac{2}{3}$ the ratio of $a : b$ is equal to the ratio of $c : d$, if $\frac{a}{b} = \frac{c}{d}$, because $\frac{a}{b}$ and $\frac{c}{d}$, represent the multiple, part, or parts, that a is of b, and c of d.

If the terms of a ratio be multiplied or divided by the same quantity, the ratio is not altered. For $\frac{a}{b} = \frac{ma}{mb}$.

That ratio is greater than another, whose antecedent is the greater multiple, part, or parts of its consequent. Thus, the ratio of 7 : 4 is greater than the ratio of 8 : 5; because $\frac{7}{4}$ or $\frac{35}{20}$ is greater than $\frac{8}{5}$ or $\frac{32}{20}$. These conclusiens follow immediately from our idea of ratio.

"A ratio is called a ratio of greater inequality, of less inequality, or of equality, according as the antecedent is greater, less than, or equal to the consequent."

"A ratio of greater inequality is diminished, and of less inequality increased, by adding any quantity to both its terms. If to the terms of the ratio 7 : 4, 1 be added, it becomes the ratio of 8 : 5, which is less than the former. And in general, let x be added to the terms of the ratio $a : b$, and it becomes $a + x : b + x$, which is greater or less than the former, according as $\frac{a+x}{b+x}$ is greater or less than $\frac{a}{b}$; or by reducing them to a common denominator, as $\frac{ab + bx}{b.\overline{b+x}}$ is greater or less than $\frac{ab + ax}{b.\overline{b+x}}$; that is, as b is greater or less than a. Hence, a ratio of greater inequality is increased, and of less inequality diminished, by taking from the terms a quantity less than either of them.

If the antecedents of any ratios be multiplied together, and also the consequents, a new ratio results, which is said to be compounded of the former. Thus, $ac : bd$ is said to be compounded of the two $a : b$ and $c : d$. It is also sometimes called the sum of the ratios; and when the ratio $a : b$ is compounded with itself, the resulting ratio, $a^2 : b^2$, is called the double of the ratio of $a : b$; and if three of these ratios be compounded together, the result $a^3 : b^3$, is called the triple of the first, &c. Also, the ratio of $a : b$ is said to be one third of the ratio of $a^3 : b^3$; and $a^{\frac{1}{m}} : b^{\frac{1}{m}}$ is said to be an m^{th} part of the ratio of $a : b$.

Let the first ratio be $a : 1$; then $a^2 : 1$, $a^3 : 1$, ...$a^n : 1$, are twice three times, ...n times the first ratio; where n the index of a, shows what multiple, or part, of the ratio $a^n : 1$, the first ratio, $a : 1$, is. On this account, the indices, 1, 2, 3, ...n, are called measures of the ratios $a^1 : 1$, $a^2 : 1$, $a^3 : 1$, ... $a^n : 1$.

"If the consequent of the preceding ratio be the antecedent of the succeeding one, and any number of such ratios be taken, the ratio which arises from their composition is that of their first antecedent to the last consequent." Let $a : b$, $b : c$, $c : d$, &c. be the ratios, the compound ratio is $a \times b \times c : b \times c \times d$; or dividing by $b \times c$, $a : d$.

"A ratio of greater inequality, compounded with another, increases it; and a ratio of less inequality diminishes it." Let the ratio of $x : y$ be compounded with the ratio of $a : b$, and the resulting ratio $ax : by$ is greater or less than the ratio $a : b$, according as $\frac{ax}{by}$ is greater or less than $\frac{a}{b}$ *i. e.* according as x is greater or less than y.

"If the difference between the antecedent and consequent of a ratio be small when compared with either of them, the double of the ratio, or the ratio of their squares, is nearly obtained by doubling this difference."

Let $a + x : a$ be the proposed ratio, where x is small when compared with a; then $a^2 + 2ax + x^2 : a^2$ is the ratio of the squares of the antecedent and consequent; but since x is small when compared with a, x^2 or $x \times x$ is small when compared with $2a \times x$, and much smaller than $a \times a$; therefore, $a^2 + 2ax : a^2$, or $a + 2x : a$ will nearly express the ratio of $a^2 + 2ax + x^2 : a^2$.

Thus the ratio of the square of 1001 to the square of 1000 is nearly 1002 : 1000; the real ratio is 1002.001 : 1000, in which the antecedent differs from its approximate value, only by one thousandth part of an unit.

Hence the ratio of the square root of $a + 2x$ to the square root of a is the ratio $a \times x : a$, nearly, that is, if the difference of two quantities be small with respect to either of them, the ratio of their square roots is nearly obtained by halving their difference.

In the same manner, $a + 3x : a$; $a + 4x : a$; $a + mx : a$; are nearly equal to the ratios $\overline{a + x}|^3 : a^3$; $a + x^4 : a^4$; $\overline{a + x}|^m : a^m$; if mx be small when compared with a.

Or we may treat the subject differently, thus; ratio is that relation of homogeneous things which determines the quantity of one from the quantity of another, without the intervention of a third. Two numbers, lines, or quantities, A and B, being proposed, their relations one to another may be considered under one of these two heads: 1. How much A exceeds B, or B exceeds A; and this is found by taking A from B, or B from A, and is called arithmetic reason, or ratio. 2. Or how many times and parts of a time, A contains B, or B contains A; and this is called geometric reason, or ratio; (or, as Euclid defines it, it is the mutual habitude, or respect, of two magnitudes of the same kind, according to quantity; that is, as to how often the one contains, or is contained, in the other;) and is found by dividing A by B, or B by A; and here note, that the quantity which is referred to another quantity, is called the antecedent of the ratio; and that to which the other is referred is called the consequent of the ratio; as, in the ratio of A to B, A is the antecedent, and B the consequent. Therefore any quantity, as antecedent, divided by any quantity as a consequent, gives the ratio of that antecedent to the consequent.

Thus the ratio of A to B is $\frac{A}{B}$, but the ratio of B to A is $\frac{B}{A}$; and, in numbers, the ratio of 12 to 4 is $\frac{12}{4} = 3$, or triple; but the ratio of 4 to 12 is $\frac{4}{12} = \frac{1}{3}$, or subtriple.

The quantities, thus compared, must be of the same kind; that is, such which, by multiplication, may be made to exceed one the other, or as these quantities are said to have a ratio between them, which, being multiplied, may be made to exceed one another. Thus a line, how short soever, may be multiplied, that is, produced so long as to exceed in length any given right line, and consequently these may be compared together, and the ratio expressed; but as a line can never, by any multiplication whatever, be made to have breadth, that is, to be made equal to a superficies, how small soever; these can therefore never be compared together, and consequently have no ratio or respect one to another, according to quantity; that is, as to how often the one contains, or is contained in the other.

RATION, in the army, a portion of ammunition, bread, drink, and forage, distributed to each soldier in the army, for his daily subsistence, &c. The horse have rations of hay and oats when they cannot go out to forage. The rations of bread are regulated by weight. The ordinary ration of a foot soldier is a pound and a half of bread per day. The officers have several rations, according to their quality and the number of attendants that they are obliged to keep. When the ration is augmented on occasions of rejoicing, it is called a double ration. The ships' crews have also their rations or allowances of biscuit, pulse, and water, proportioned according to their stock.

RATIONAL, is a word applied to integral, fractional, and mixed numbers: thus we say rational fraction, rational integer, and rational mixed number; for the explanation and doctrine of which, see Number and Fraction.

Rational is applied to the true horizon, in opposition to the sensible or apparent one. See Horizon.

RATIONALE, a solution, or account of the principles of some opinion, action, hypothesis, phenomenon, or the like.

RATLINES, or, as the seamen call them, Ratlins, those lines which make the ladder steps to get up the shrouds and puttocks, hence called the ratlins of the shrouds.

RATTLE *snake*. See Crotalus.

RAVELIN, in fortification, was anciently a flat bastion, placed in the middle of a curtain; but now a detached work, composed only of two faces, which make a saliant angle, without any flanks, and raised before the curtain on the counterscarp of the place. A ravelin is a triangular work resembling the point of a bastion, with the flanks cut off. Its use before a curtain is to cover the opposite flanks of the two next bastions. It is used also to cover a bridge, or a gate, and is always placed without the moat. There are also double ravelins, that serve to cover each other: they are said to be double when they are joined by a curtain.

RAVEN. See Corvus.

RAUWOLFIA, in botany, so named in honour of Leonhard Rauwolff, physician at Augsburg, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; berry succulent, two-seeded. There are four species.

RAY, in optics, a beam of light, emitted from a radiant, or luminous body. Rays are defined, by Sir Isaac Newton, to be the least parts of light, whether successive in the same line, or contemporary in several lines. For that light consists of parts of both kinds is evident, since one may stop what comes this moment in any point, and let pass that which comes presently after: now the least light, or part of light, which may be thus stopped, he calls a ray of light.

Rays *of the Sun*. It has been found by experiment, that there is a very great difference in the heating power of the different rays of light.

It appears, from the experiments of Dr. Herschel, that this heating power increases from the middle of the spectrum to the red ray, and is greatest beyond it, where the rays are invisible. Hence it is inferred that the rays of light and caloric nearly accompany each other, and that the latter are in different proportions in the different coloured rays. They are easily separated from each other, as when the sun's rays are transmitted through a transparent body, the rays of light pass on seemingly undiminished, but the rays of caloric are intercepted. When the sun's rays are directed to an opaque body, the rays of light are reflected, and the rays of caloric are absorbed and retained. This is the case with the light of the moon, which, however much it may be concentrated, gives no indication of being accompanied with heat. It has also been shown, that the different rays of light produce different chemical effects on the metallic salts and oxides. These effects increase on the opposite direction of the spectrum, from the heating power of the rays. From the middle of the spectrum, towards the violet end, they become more powerful, and produce the greatest effect beyond the visible rays. From these discoveries it appears that the solar rays are of three kinds: 1. Rays which produce heat; 2. Rays which produce colour; and, 3. Rays which deprive metallic substances of their oxygen. The first set of rays is in greatest abundance, or are most powerful towards the red end of the spectrum, and are least refracted. The second set, or those which illuminate objects, are most powerful in the middle of the spectrum. And the third set produce the greatest effect towards the violet end, where the rays are most refracted. The solar rays pass through transparent bodies without increasing their temperature. The atmosphere, for instance, receives no increase of temperature by transmitting the sun's rays, till these rays are reflected from other bodies, or are communicated to it by bodies which have absorbed them. This is also proved by the sun's rays being transmitted through convex lenses, producing a high degree of temperature when they are concentrated, but giving no increase of temperature to the glass itself. By this method the heat which proceeds from the sun can be greatly increased. Indeed, the intensity of temperature produced in this way is equal to that of the hottest furnace. This is done, either by reflecting the sun's rays from a concave polished mirror, or by concentrating or collecting them by the refractive power of convex lenses, and directing the rays thus concentrated on the combustible body.

REACTION, in physiology, the resistance made by all bodies to the action or impulse of others, that endeavour to change its state, whether of motion or rest.

REALGAR, in chemistry. Arsenic, mineralised by sulphur, forms two ores, named orpiment and realgar, the chemical distinction of which is not very accurately determined. That which has been named realgar is of a red colour, sometimes inclining to scarlet, sometimes to orange. It occurs massive, disseminated, and crystallised, in oblique, tetraedral, or hexaedral prisms, generally small and translucent, or semi-transparent, with a shining lustre. Its fracture is uneven; it is soft and brittle, and has a specific gravity of 3.2, or 3.3. It exhales before the blow-pipe a white arsenical smoke, with an arsenical and sulphurous odour, and gives a blue flame. It consists of arsenic and sulphur in the proportions of 80 of the former, and 20 of the latter.

REASONING, the exercise of the faculty of the mind called reasoning; or it is an act or operation of the mind, deducing some unknown proposition from other previous ones that are evident and known.

REAUMURIA, in botany, so named in honour of René Antoine Ferchault de Reaumur, a genus of the Polyandria Pentagynia class and order. Natural order of Succulentæ. Ficoideæ, Jussieu. Essential character: calyx six-leaved; petals five; capsule one celled, five-valved, many-seeded. There is but one species, *viz.* R vermiculata, an annual plant, and a native of the coasts of Egypt, Syria, and Sicily.

RECEIPTS, are acknowledgments in writing of having received a sum of money, or other value. A receipt is either a voucher for an obligation discharged, or one incurred. Receipts for money above 40*s.* must be on stamps; but on the back of a bill of exchange or promissory note, which is already stamped, they are good without a further duty. Writing a receipt on a stamp of greater value than the law requires, incurs no penalty, and the receipt is good; but if on a stamp of a lower value, or on unstamped paper, then a receipt is no discharge, and incurs a penalty. The stamp acts are very strict in making every written acknowledgment of the receipt of money, however framed, subject to a stamp, and the party liable to a penalty for want of compliance with the act. The word "settled" to a bill is a receipt; and also a name at the back of a check; or at least these can neither of them be produced, nor any other writing, to show a payment made, unless accompanied with a stamp.

RECEIVER, in pneumatics, a glass vessel for containing the thing on which an experiment in the air-pump is to be made. See PNEUMATICS.

RECEIVER. Receiving stolen goods, knowing them to be stolen, is an high misdemeanor at the common law; and by several statutes is made a transportable felony, and, in some particular instances, felony without benefit of clergy. In some cases the receiver may be prosecuted without prosecuting the thief, and he may be a witness against the receiver.

RECEPTACLE, in botany, one of the seven parts of fructification, which, according to Linnæus, is the base which connects or supports the other parts. A proper receptacle obtains different names from the parts of the fructification which supports and connects. When both flower and fruit are supported by it, it is generally stiled the receptacle of the fructification. When the receptacle supports the parts of the flower only, it is called the receptacle of the flower. In such cases, the seed-bud or fruit, which is placed below the receptacle of the flower, has a proper base of its own, which is distinguished by the name of receptacle of the fruit. There are simple flowers, which have the seed-bud placed above the receptacle of the flower, the fruit has a separate receptacle; this is exemplified in the magnolia, tulip-tree, &c. The term receptacle is often used to signify the base to which the seeds are fastened within their inclosure, as in the deadly night-shade.

RECIPE, in medicine, a prescription or remedy, to be taken by a patient; so called because always beginning with the word *recipe, i. e. take;* which is generally denoted by the abbreviature ℞. For the rules proper to be observed in forming recipes, see MATERIA MEDICA, &c.

RECIPROCAL *terms*, among logicians, are those which have the same signification; and consequently are convertible, or may be used for each other.

RECIPROCAL, in arithmetic, is the quotient arising by dividing 1 by any number or quantity, thus the reciprocal of 2 is $\frac{1}{2}$ of 5, it is $\frac{1}{5}$ and generally of a it is $\frac{1}{a}$: hence, the reciprocal of a vulgar fraction is found, by barely making the numerator and denominator mutually change places; thus, the reciprocal of $\frac{1}{2}$ is $\frac{2}{1} = 2$; of $\frac{2}{3}$ it is $\frac{3}{2}$; of $\frac{a}{b}$ it is $\frac{b}{a}$. Hence any quantity being multiplied by its reciprocal, the product is always equal to unity; thus, $\frac{1}{2} \times \frac{2}{1} = 1$; and $\frac{a}{b} \times \frac{b}{a} = \frac{a\,b}{a\,b} = b$.

RECIPROCAL *figures*, in geometry, those which have the antecedents and consequents of the same ratio, in both figures. Thus, in two rectangles, the side A : B : : C : D; or 12 : 4 : : 9 : 3; that is, as much as the side A, in the first rectangle, is longer than B, so much deeper is the side C, in the second rectangle, than the side D in the first; and, consequently, the greater length of the one is compensated by the greater breadth or depth of the other; for, as the side A is one-fourth longer than C, so B is one-fourth longer than D, and the rectangles of course equal; that is, $A \times D = B \times C$, or $12 \times 3 = 4 \times 9 = 36$. This is the foundation of that capital theorem, *viz.* that the rectangle of the extremes is always equal to that of the means; and, consequently, the reason of the rule of three. Hence it follows, that if any two triangles, parallelograms, prisms, parallelopipeds, pyramids, cones, or cylinders, have their bases and altitudes reciprocally proportional, those two figures or solids are equal to each other; and *vice versa*, if they are equal, then their bases and altitudes are reciprocally proportional.

Reciprocal *proportion*, in arithmetic, is when, in four numbers, the fourth is less than the second, by so much as the third is greater than the first; and *vice versa*. This is the foundation of the inverse, or indirect rule of three; thus, 4 : 10 : : 8 : 5. See Rule. Reciprocal proportion is of great use in determining the laws of motion.

RECIPROCALLY, one quantity is reciprocally as another, when the one is greater in proportion as the other is less; or when the one is proportional to the reciprocal of the other. Thus a is reciprocally as b when a is always proportional to $\frac{1}{b}$. So also in mechanics, to perform any given effect, the less the power is, the greater must be the time in performing it, or as we have formerly observed, what is gained in power is lost in time. If p denote any power or agent, and t the time of performing a given work, then p is as $\frac{1}{t}$, and t is as $\frac{1}{p}$, that is, p and t are reciprocally proportional to each other.

RECITAL, in law, is the rehearsal or making mention, in a deed or writing, of something which has been done before.

RECKONING, or *a Ship's Reckoning*, in navigation, is that account, whereby at any time it may be known where the ship is, and on what course or courses she is to steer, in order to gain her port; and that account, taken from the log-board, is called the dead-reckoning.

RECOGNIZANCE, in law, is an obligation of record, which a man enters into before some court of record, or magistrate duly authorized, with condition to the same particular act; as to appear at the assizes or quarter sessions, to keep the peace, &c. If the party does not comply with it, the recognizance is estreated into the Exchequer. In some cases, the court will upon motion respite, and in some discharge the recognizance; but all parties should be careful to apply in good time to the court, where the recognizance is to be returned.

RECOIL, or Rebound, the starting backward of a fire-arm, after an explosion.

This term is particularly applicable to pieces of ordnance, which are always subject to a recoil, according to the sizes and the charges which they contain. To lessen the recoil of a gun, the platforms are generally made sloping towards the embrasures of the battery.

RECONNOITRE, in military affairs, implies to view and examine the state of things, in order to make a report thereof. Reconnoitring parties are those sent to observe the country, and the enemy, to remark the routes, conveniences, and inconveniences of the first; the position, march, or forces of the second.

RECORD, an act committed to writing in any of the King's courts; during the term wherein it is written, it is alterable, being no record; but that term once ended, and the act duly inrolled, it is a record, and of that credit, which admits of no alteration on proof to the contrary.

RECORDARE, or *Recordari Facias*, in law, a writ directed to the sheriff, to remove a cause depending in an inferior court, or court of ancient demesne, hundred, or county, to the King's Bench or Common Pleas.

RECOVERY, in law, the name of a species of conveyance of great effect and much utility. Common recoveries were invented by the ecclesiastics, to elude the statutes of mortmain; and afterwards encouraged by the courts at law, in order to put an end to all fettered inheritances, and bar not only all estates tail, but also all remainders and reversions expectant thereon. A common recovery is so far like a fine, that it is a suit or action, either actual or fictitious; and in it, the lands are recovered against the tenant of the freehold; which recovery, by a supposed adjudication of the right, binds all persons, and vests a free and absolute fee simple in the recoverer. And a common recovery is now looked upon as the best assurance, except an act of parliament, that purchasers can have.

There must be three persons at least to make a common recovery, a recoverer, a recoveree, and a vouchee. The recoverer is the plaintiff or demandant, that brings the writ of entry. The recoveree is the defendant or tenant of the land, against whom the writ is brought. The vouchee, is he whom the defendant or tenant voucheth or calls to warranty of the land in demand, either to descend the right, or to yield him other lands in value, according to a supposed agreement. And this being by consent and permission of the parties, it is therefore said that a recovery is suffered.

A common recovery may be had of such things, for the most part, as pass by a fine. An use may be raised upon a recovery, as well as upon a fine; and the same rules are generally to be observed and followed for the guiding and directing the uses of a recovery, as are observed for the guidance and direction of a fine. That is to say, that when a fine is levied, or a recovery is suffered, a deed is made between the parties really interested, which declares the purposes of the fine or recovery, and this deed is called a deed to lead or to declare the uses, according as it is made before or after the fine or recovery. To enter at full into the learning of fines and recoveries, would be impossible in a general dictionary. It is sufficient to say, that both of them are in the nature of a sham suit, while one of which is compromised, and the other carried on to judgment by default between the parties really interested, and the use of them is to enable a married woman to make a good conveyance, and a tenant in tail to turn his estate into an estate in fee, or as it is called, to dock or bar the entail. See Fine and Estate.

RECTANGLE, in geometry, the same with a right-angled parallelogram. In arithmetic and algebra, a rectangle signifies the same with factum or product.

RECTANGLED, Rectangular, or Right-angled, appellations given to figures and solids which have one or more right angles: thus a triangle with one right angle, is termed a rectangled triangle; also parallelograms with right angles, squares, cubes, &c. are rectangular. Solids, as cones, cylinders, &c. are also said to be rectangular, with respect to their situation, when their axes are perpendicular to the plane of the horizon. The ancient geometricians always called the parabola, the rectangular section of a cone.

RECTIFICATION, the art of setting any thing to rights: and hence, to rectify the globes, is to fit them for performing any problem.

Rectification, in geometry, is the finding a right line, equal in length to a curve. The rectification of curves is a branch of the higher geometry, where the use of the inverse method of fluctions is very conspicuous, of which we shall give an example.

Case I. Let A C G, (Plate Miscel. XIII. fig. 15.) be any kind of curve, whose ordinates are parallel to themselves, and perpendicular to the axis A Q. Then if the fluxion of the absciss A M be denoted by M m, or by C n, (equal and parallel to M m) and n S, equal and parallel to C r, be the representation of the corresponding fluxion of the ordinate M C; then will the diagonal C S, touching the curve in C, be the line which the generating point p would describe, were its motion to become uniform at C; which line, therefore, truly expresses the fluxion of the space A C, gone over. Hence, puting A M $= x$, C M $= y$, and A C $= z$; we have $\dot{z}$ $(= \text{C S} = \sqrt{\text{C}n^2 + \text{S}n^2} = \sqrt{\dot{x}^2 + \dot{y}^2}$; from which, and the equation of the curve, the value of z may be determined. Thus, let the curve proposed be a parabola of any kind, the general equation for which is $x = \frac{y^n}{a^{n-1}}$; and hence $\dot{x} = \frac{ny^{n-1}\dot{y}}{a^{n-1}}$, and therefore

$$(= \dot{z}\sqrt{\dot{y}^2 + \dot{x}^2}) = \sqrt{\dot{y}^2 + \frac{n^2y^{2n-2}\dot{y}^2}{a^{2n-2}}}$$

$$= \dot{y} \times \overline{1 + \frac{n^2y^{2n-2}}{a^{2n-2}}}\Big|^{\frac{1}{2}}$$; the fluent of which, universally expressed in an infinite series, is

$$y + \frac{n^2y^{2n-1}}{\overline{2n-1} \times 2a^{2n-2}} - \frac{n^4y^{4n-3}}{\overline{4n-3} \times 8a^{4n-4}} + \frac{n^6y^{6n-5}}{\overline{6n-5} \times 16a^{6n-6}}, \text{ \&c.} = z.$$

Case II. Let all the ordinates of the proposed curve A R M (fig. 16), be referred to a centre C: then putting the tangent R P (intercepted by the perpendicular C P) $= t$, the arch, B N, of a circle, described about the centre C, $= x$; and the radius C N (or C B) $= a$; we have $\dot{z} : \dot{y} :: y$ (C R) : t (R P); and, consequently, $\dot{z} = \frac{\dot{y}y}{t}$: from whence the value of z may be found, if the relation of y and t is given. But, in other cases, it will be better to work from the following equation, *viz.* $\dot{z} = \sqrt{\dot{y}^2 + \frac{y^2 x^2}{a^2}}$, which is thus derived; let the right line C R be conceived to revolve about the centre C; then since the celerity of the generating point R, in a direction perpendicular to C R, is to $(\dot{x})$ the celerity of the point N, as C B (y) to C N (a), it will therefore be truly represented by $\frac{y\dot{x}}{a}$; which being to $(\dot{y})$ the celerity in the direction of C R, produced as C B (s) : R P (t), it follows that $\frac{y^2\dot{x}^2}{a^2} : \dot{y}^2 :: s^2 : t^2$; whence, by composition, $\frac{y^2x^2}{a^2} + \dot{y}^2 : \dot{y}^2 :: s^2 + t^2 (y^2) : t^2$; therefore $\frac{y^2\dot{x}^2}{a^2} + \dot{y}^2 = \frac{y^2\dot{y}^2}{t^2}$, and consequently $\sqrt{\frac{y^2x^2}{a^2} + y^2}$ $(= \frac{y\dot{y}}{t}) = \dot{z}$. Q.E.D.

But the same conclusion may be more easily deduced from the increments of the flowing quantities: for, if R m, r m, and N n be assumed to represent $(\dot{z}, \dot{y}, \dot{x})$ any very small corresponding increments of A R, C R, and B N; then will C N (a) : C R (y) :: $\dot{x}$ (the arch N n) : the similar arch R $r = \frac{y\dot{x}}{a}$. And if the triangle R r m (which, while the point m is returning back to R, approaches continually nearer and nearer to a similitude with C R B) be considered as rectilinear, we shall also obtain $\dot{z}^2$ $(= \text{R}\,m^2 = \text{R}\,r^2 + r\,m^2) = \frac{y^2\dot{x}^2}{a^2} + \dot{y}^2$; and $\sqrt{\frac{\dot{y}^2\dot{x}^2}{a^2} + \dot{y}^2}$ $(= \frac{y\dot{y}}{a})$ $= \dot{z}$, as before.
See Simpson's "Fluxions."

RECTIFICATION, in chemistry, is nothing but the repetition of a distillation, or sublimation, several times, in order to render the substance purer, finer, and freer from aqueous or earthy parts.

RECTIFIER, in navigation, an instrument consisting of two parts, which are two circles, either laid one upon, or let into, the other, and so fastened together in their centres, that they represent two compasses, one fixed, the other moveable; each of them divided into the thirty-two points of the compass, and three hundred and sixty degrees, and numbered both ways, from the north and the south, ending at the east and west, in ninety degrees.

RECTIFYING *the globe.* See GLOBE.

RECTORY, in law, is taken for an entire parish-church, with all its rights, glebes, tithes, and other profits whatsoever.

RECTUM, in anatomy, the third and last of the large intestines.

RECURRING *series*, is a series constituted in such a manner, that having taken at pleasure any number of its terms, each following term shall be related to the same number of preceding terms, according to a constant law of relation.

RECURVIROSTRA, the *avoset*, in natural history, a genus of birds of the order Grallæ. Generic character: the bill long, very thin, and bending considerably upwards; nostrils narrow and pervious; tongue short; feet palmated; hind toe very short and high. There are three species. We shall notice only that which is found in this island. The R. avosetta, or scooping avoset, is as large as a lapwing, and has extremely long legs; its bill is three inches and a half in length. In winter it is often seen in England, particularly at the mouth of the Severn, and on the coasts of Suffolk. In the fens of Cambridgeshire these birds are known to breed, and appear often in vast flocks. Their subsistence is on insects and worms, which they procure from the soft, muddy bottoms with their bills. They often wade into the water to the top of their legs, and are able to swim; but are seldom seen swimming, and never, unless at a very small distance from the shore. In France, on the coasts of Bas Poictou, their nests are plundered annually of several thousands of eggs, which form a nourishing and valued food for the peasantry of that district. See Aves, Plate XIII. fig. 4.

RECUSANT, a person who refuses to go to church, and worship God after the manner of the church of England, as by law established: to which is annexed the penalty of 20*l.* a month for nonconformity. 23 Elizabeth, c. 1.

RED. See COLOUR, DYING, OPTICS, &c.

RED *book*, of the Exchequer, an ancient record, or MS. volume, in the keeping of the King's remembrancer, containing divers miscellaneous tracts relating to the periods before the conquest.

REDDENDUM, a clause in a lease, whereby the rent is reserved to the lessor. See DEED.

REDDLE, *red-chalk*, in mineralogy, a species of the iron genus: its name bespeaks its colour: it soils strongly, and writes; is easily frangible; adheres strongly to the tongue; feels meagre; specific gravity 3.9. Exposed to a red heat, it decrepitates, and becomes black; it may even be melted into a greenish grey spumous enamel. In Silesia it is found in compact limestone: it is principally used for drawing: the coarser kinds are used by the carpenter, the finer by the painter. It is sometimes used in its natural state, and sometimes pulverized, washed, and mixed with gum, and cast into moulds.

REDEMPTION, and EQUITY *of Redemption*, in law. See MORTGAGE.

REDOUBT, in fortification, a square work raised without the glacis of the place, about musket-shot from the town; having loop-holes for the small arms to fire through, and surrounded by a ditch. Sometimes they are of earth, having only a defence in front, surrounded by a parapet and ditch. Both the one and the other serve for detached guards to interrupt the enemy's works; and are sometimes made on the angles of the trenches, for covering the workmen againt the sallies of the garrison. The length of their sides may be about twenty fathoms: their parapets must have two or three banquettes, and be about nine or ten feet thick. They are sometimes (in a siege) called places of arms.

REDUCTION *of metals*, in chemistry. All metals, even the few that resist the action of heat and air, undergo a similar change when exposed to acids, especially the sulphuric, the nitric, and the muriatic, or a mixture of the two last. All metals, by these means, may be converted into powders, which have no resemblance to the metals from which they were obtained. These powders were formerly called calces; but at present they are better known by the name of oxides. They are of various colours, according to the metal and the treatment, and are frequently manufactured in large quantities, to serve as paints. When these oxides are mixed with charcoal powder, and heated in a crucible, they lose their earthy appearance, and are changed again into the metals from which they were produced. Oil, tallow, hydrogen gas, and other combustible bodies, may be often substituted for charcoal. By this operation, which is called the reduction of the oxides, the combustible is diminished, and indeed undergoes the very same change as when it is burnt. In the language of Stahl, it loses its phlogiston; and this induced him to conclude that metals are composed of earth and phlogiston. Mr. Davy, as we have seen in other parts of this work, inclines to the opinion that there are only two principles in nature, an inflammable and metallic principle.

REDUCTION. See ARITHMETIC.

REDUCTION *of a figure, design, or draught*, is the making a copy thereof, either larger or smaller than the original; still preserving the form and proportion. The great use of the proportional compasses is the reduction of figures, &c. whence they are called compasses of reduction. There are various methods of reducing figures, the most easy is by means of the pentagraph, or parallelogram; but this has its defects. See PENTAGRAPH.

REE, REIS, or RES, a little Portuguese copper coin.

REED, an ancient Jewish measure. See MEASURE.

REED, or the *Common* REED, in botany, *arundo*. See ARUNDO.

REEF, a term in navigation. When there is a great gale of wind, they commonly roll up part of the sail below, that by this means it may become the narrower, and not draw so much wind; which contracting or taking up the sail they call a reef, or reefing the sail: so also when a top-mast is sprung, as they call it, that is, when it is cracked, or almost broken in the cap, they cut off the lower piece that was nearly broken off, and setting the other part, now much shorter, in the step again, they call it a reefed topmast. The term "reef" implies also a chain of rocks lying near the surface of the water.

REEL, in the manufactories, a machine serving for the office of reeling. There are various kinds of reels, some very simple, others very complex. Of the former kinds those most in use are, 1. A little reel held in the hand, consisting of three pieces of wood, the biggest and longest whereof (which does not exceed a foot and a half in length, and one-fourth of an inch in diameter) is traversed by two other pieces disposed different ways. 2. The common reel, or windlass, which turns upon a pivot, and has four flights traversed by long pins or sticks, whereon the skein to be reeled is put, and which are drawn closer or opened wider, according to the skein.

REELING, in the manufactories, the winding of thread, silk, cotton, or the like, into a skein, or upon a bottom, to prevent its entangling. It is also used for the charging or discharging of bobbins or quills, to use them in the manufacture of different stuffs, as thread, silk, cotton, &c. Reeling is performed different ways, and on different engines.

RE-ENTRY, in law, signifies the resuming or retaking a possession in land lately lost.

REFERENCE, in law, is where a matter is referred by the Court of Chancery to a master, and by the courts at law to a prothonotary, or secondary, to examine and report to the court. Reference also signifies where a matter in dispute is referred to the decision of an arbitrator. This is done either by parol agreement, or by bond, or upon a suit, in which latter case the party has a rule of court, that the party against whom the award is made shall perform it, and then he may move to have an attachment against him if he does not perform it. By statute also this may be done, where the parties agree that the award should be made a rule of court, although there is no suit.

REFINING. See Assaying.

REFLECTING *circle*, an astronomical instrument for measuring angles. It is called reflecting from its property, in common with the Hadley's quadrant (of which it is a modification) of observing one of the objects of the angle to be measured by distinct vision, and the other by reflection of plane mirrors. The first instrument of this kind was invented by Tobias Mayers, in 1770, a celebrated astronomer of Gottingen, who calculated the lunar and solar tables for determining the longitude at sea, for which a reward of 3,000*l.* was given by the board of longitude. In making use of these tables he found that the Hadley's quadrants, though made by the first artists of that time, were not divided with sufficient accuracy for his purpose; he therefore contrived the reflecting and repeating circle; to comprehend which, the reader must turn to our article Quadrant, by Hadley, from which this instrument differs, principally, in being a whole circle of divisions instead of an octant; and is so contrived, that when an observation has been made, it is repeated upon a fresh portion of the divisions, then a third time, a fourth, and so on as many times as is necessary; the observation is then read off, and the product is divided by the number of observations, made so as to take a mean of the errors there may be in any part of the divisions on the circle. This contrivance, though useful, was found so tedious, in taking so many observations, that it was laid aside in favour of the Hadley's quadrant, to which in point of accuracy it was really superior.

For the particular description of this instrument we must refer our readers to a work, entitled, "Tabula Motum Solis et Lunæ," by Tobias Mayer, London, 1770. This instrument received an improvement from the Chevalier de Borda, at Paris, which rendered its operation much more simple; but it was not until the year 1796 that the instrument became much used in the British navy, when it was new modelled by Mr. Edward Troughton, and the objections to the former instruments done away. We have obtained permission from this gentleman to make a drawing of this instrument (see Plate Reflecting Circle) where (fig. 1.) is a plan of the divided side of the instrument, (and fig. 2) a perspective view of its upper side. A A, in both figures, is a circle of brass, with a narrow ring of silver let into a circular groove in it, as is seen in fig. 1, on which silver the divisions are made. B B B are three arms carrying verniers at their ends, they are all cast in one piece, and screwed to a truly turned steel axis, fitting into a tube, which is screwed to the centre of the circle (this tube cannot be seen in the plan, but is denoted by *a* in fig. 2) the index glass, *b*, which is a plane silvered mirror, is fastened to the other end of this axis by three screws, in such a position that the centre line of the steel axis it is fixed to, if produced, would exactly coincide with the plane of the silvered surface of the mirror, and consequently that the plane of the mirror produced passes through the centre of the circle A A, perpendicular to its plane.

To the upper end of the tube, *a* (fig. 2) a crooked plate of brass, *d d*, is fastened, and connects it with two other tubes, *e* and *f*, whose lower ends are fixed to the cross bar frame of the circle; one of these, *f*, has the mirror, *h*, called the object glass placed on it; the other has a telescope, *k*, fixed to it, directed to the object glass, *h*. The instrument is held, when in use, by handles adapted to different occasions, of which there are four; two perpendicular and two parallel to the plane of the circle; of the latter, *e*, is one on the upper side, supported by a small pillar coming from the interception of two of the bars of the frame, and steadied by entering the tube; *a*, the other handle is at the divided side of the circle, and is fastened to the circle at the upper side, in the same manner as *e*, by a crooked hollow tube, G, going round the circle; of the other two handles, one, *m*, is above the circle, screwed into a cock fixed to it, so that it is perpendicular to the centre of the circle; it comes over the index glass, but does not touch it. The other handle is screwed into the handle of the crooked tube, G, so as to be in the same line with the upper handle *m*; *o*, are three dark glasses, between the index and horizon glasses, turning on a joint, so as to be put out of the way when necessary, or any one or two of them can be turned in the line of the telescope to darken the light, more or less, in observations of the sun; *p*, are three other glasses supported by a small pillar behind the horizon glass, which can also be turned back as is necessary. The telescope is screwed into a brass ring, *r*, this is supported by a square piece of brass, tapped at the corners, so as to form a screw; and by turning, *s*, a nut upon a screw, the telescope can be raised or lowered parallel to itself; there is also an adjustment, to bring the line of collimation of the telescope to be parallel to the plan of the circle.

The circle is divided on the silver ring shown in the plan, into 720 parts, each of which answers to a degree; as this instrument measures double the angle shown upon the arc, the same as the Hadley's quadrant, these are subdivided into three, each of which will be twenty minutes. The verniers include fifty-nine of these divisions, and are divided into sixty, the coincidences of these will subdivide each original division of the circle into sixty parts, each equal to twenty seconds. The arm on which the vernier, D, is fixed, has a clamp at its end to fasten it to the circle; and a fine screw, *x*, to move it slowly a small quantity after it is clamped.

We shall now describe the manner of making an observation by this instrument, of the angle between two objects, nearly in the same horizontal plane; we suppose all the adjustments of the instrument to be perfect; the observer first holds the instrument in his right hand by the handle screwed to the lower handle of the tube G, he looks through the telescope, *k*, and unsilvered part of the horizon glass, *h*, and directs it to one of the objects which will be in the dotted line, *k g*, he then turns the index and index glass, *b*, by its arm D (which must be unclamped) until the other object in the line, *y b*, is reflected from *b* to *h*, and from *h*, by the silvered part of the glass, into the line *k g*, in which is placed the observer's eye; he then clamps the arm, D, and gently turns the screws, *x*, backwards or forwards, until the reflected image of the object in the line *y*, and the other object seen through the telescope, both exactly cover one another. The observation is now half made, and the observer reads off and writes down the degrees, minutes and seconds, of each vernier, he then inverts the instrument, holding it by the handle, *m*, and directs the telescope to the object, in the line *y b*, and brings the reflected image of the object, in the line *k g*, into view, by turning round the index and index glass the same as before; the observation is then read off and registered.—To determine the angle measured, a mean of the products of both observations must be taken; this is the angle between the lines, *y b* and *k g*. A small microscope, M, in the plan, is used to examine the verniers, and it can be applied to either verniers as required.

The dark glasses, *o p*, are only wanted in observing the sun or moon.

It is evident that by inverting the instrument, as we have described, the index error is of no consequence, as it will be always more in one observation and less in the other,

REFLECTION. As the rays of light are reflected by polished surfaces, so it is found that the rays of caloric have the same property. The Swedish chemist Scheele discovered, that the angle of reflection of the rays of caloric is equal to the angle of incidence. This has been more fully established by Dr. Herschel. Some very interesting experiments were made by Professor Pictet of Geneva, which proved the same thing.

These experiments were conducted in the following manner. Two concave mirrors of tin, of nine inches focus, were placed at the distance of twelve feet two inches from each other. In the focus of the one was placed the bulb of a thermometer, and in that of the other a ball of iron two inches in diameter, which was just heated so as not to be visible in the dark. In the space of six minutes the thermometer rose 22°. A similar effect was produced by substituting a lighted candle in place of the ball of iron. Supposing that both the light and heat acted in the last experiment, he interposed between the two mirrors a plate of glass, with the view of separating the rays of light from those of caloric. The rays of caloric were thus interrupted by the plate of glass, but the rays of light were not perceptibly diminished. In nine minutes the thermometer sunk 14°; and in seven minutes after the glass was removed, it rose about 12°. He therefore justly concluded, that the caloric reflected by the mirror, was the cause of the rise of the thermometer. He made another experiment, substituting boiling water in a glass vessel in place of the iron ball; and when the apparatus was adjusted, and a screen of silk which had been placed between the two mirrors removed, the thermometer rose 3°; namely, from 47° to 50°. The experiments were varied by removing the tin mirrors to the distance of 90 inches from each other. The glass vessel with boiling water was placed in one focus, and a sensible thermometer in the other. In the middle space between the mirrors, there was suspended a common glass mirror, so that either side could be turned towards the glass vessel. When the polished side of this mirror was turned towards the glass vessel, the thermometer rose only five-tenths of a degree; but when the other side, which was darkened, was turned towards the glass vessel, the thermometer rose 3° 5′. And in another experiment performed, in the same way, the thermometer rose 3° when the polished side of the mirror was turned to the glass vessel, and 9° when the other side was turned. These experiments show clearly, that the rays of caloric are reflected from polished surfaces, as well as the rays of light. Transparent bodies have the power of refracting the rays of caloric as well as those of light. They differ also in their refrangibility. So far as experiment goes, the most of the rays of caloric are less refrangible than the red rays of light. The experiments of Dr. Herschel show, that the rays of caloric, from hot or burning bodies, as hot iron, hot water, fires and candles, are refrangible, as well as the rays of caloric which are emitted by the sun. Whether all transparent bodies have the power of transmitting these rays, or what is the difference in the refractive power of these bodies, is not yet known.

The light which proceeds from the sun seems to be composed of three distinct substances. Scheele discovered, that a glass mirror held before the fire reflected the rays of light, but not the rays of caloric; but when a metallic mirror was placed in the same situation, both heat and light were reflected. The mirror of glass became hot in a short time, but no change of temperature took place on the metallic mirror. This experiment shows that the glass mirror absorbed the rays of caloric, and reflected those of light; while the metallic mirror, suffering no change of temperature, reflected both. And if a plate of glass be held before a burning body, the rays of light are not sensibly interrupted, but the rays of caloric are intercepted; for no sensible heat is observed on the opposite side of the glass: but when the glass has reached a proper degree of temperature, the rays of caloric are transmitted with the same facility as those of light. And thus the rays of light and caloric may be separated. But the curious experiments of Dr. Herschel have clearly proved, that the invisible rays which are emitted by the sun, have the greatest heating power. In these experiments, the different coloured rays were thrown on the bulb of a very delicate thermometer, and their heating power was observed. The heating power of the violet, green, and red rays, were found to be to each other as the following numbers:

Violet	16.0
Green	22.4
Red	55.0

The heating power of the most refrangible rays was least, and this power increases as the refrangibility diminishes. The red ray, therefore, has the greatest heating power, and the violet, which is the most refrangible, the least. The illuminating power, it has been already observed, is greatest in the middle of the spectrum, and it diminishes towards both extremities; but the heating power, which is least at the violet end, increases from that to the red extremity; and when the thermometer was placed beyond the limit of the red ray, it rose still higher than in the red ray, which has the greatest heating power in the spectrum. The heating power of these invisible rays was greatest at the distance of half an inch beyond the red ray, but it was sensible at the distance of one inch and a half. See OPTICS.

REFORMATION, in church history, is that amazing change in the religion and politics of a great part of Europe, which began to take place in the early part of the sixteenth century. An event of such magnitude, with which the progress of the arts and universal learning is so intimately connected, demands a more enlarged and detailed account than the prescribed limits of our work will admit. It would, nevertheless, be highly improper wholly to omit the notice of so very important an era in the history of Europe.

At a time when the peace and harmony of the Romish Church seemed fully established, and when the authority of the Holy See had just received a most signal triumph by the labours of the Council of the Lateran; when the address and perseverence of Leo the Tenth had surmounted a thousand difficulties, and given peace to his dominions; when Rome had begun once more to assume its ancient grandeur, and was again become the centre of genius, letters, and the arts; when the dark clouds of the middle ages were scattered before the rays of science, and the light of genius had begun to illumine the moral horizon, the attention of the whole Christian world was directed to an event that threatened nothing less than the speedy ruin of the Papal authority, and the complete demolition of that fabric of religious magnificence which the labours of myriads had united to raise, and which the lapse of centuries had left rather established than impaired. It is curious to reflect, that what bid fair to have been the glory and security of the church, conspired to her destruction, and threatened her total overthrow. Leo the Tenth, in aiming to enhance the glory of his pontificate by the encouragement of literature and the patronage of the arts, was fostering in his bosom an enemy to destroy his peace and degrade his power. The seeds of learning which his father, Lorenzo de' Medici, had sown, and he so plentifully watered, sprung up to choak his pleasures, and reward him with trouble. No sooner had the human mind begun to be emancipated from its slavery, than it employed its newly restored liberty in bold and presumptuous investigatigations into the conduct of the Roman Pontiffs, the extravagances of the Papal court, the foundations of church governments, and the truth of established doctrines. The errors and misconduct of the clergy were exposed to the shafts of ridicule and the remonstrances of reason. The hardy and intrepid genius of Dante, which placed the vicars of Christ in the infernal regions, lighted up the fire of Petrarca, and encouraged him to identify the court of Rome with that of ancient Babylon. He made the vices and errors of the Church the subject of his sonnets, and the constant theme of his abuse. Protected by their genius, and respected for their character, these two great men not only escaped the censures of the Holy See, but emboldened the populace to question the infallibility of a church which had nothing but luxury in its train, and learning for its boast. The entertaining work of Boccaccio exposed the debaucheries of the religious, and opened the eyes of the people; and the emancipation of the human race, from the ignominious shackles of ignorance and priestcraft, was hastened by the celebrated *Facetiæ* of Poggio, and the writings of Burchiello, Pulci, and Franco. To the light which these men threw upon the corruptions of the church, and the licentiousness of the Holy See, the patronage of painters, sculptors, and poets, and the protection and maintenance of buffoons and jesters, afforded but a poor defence. Leo X. loved and admired men of learning, notwithstanding their learning was often employed to expose his extravagances, and endanger the church.

These exposures had begun to be made during the pontificate of Sixtus IV. and that Pope, and his immediate successors, less remiss to the concerns of the church than Leo X. had taken some measures to ward off the danger; but instead of applying the only preventative, by reforming their morals and their lives, the heads of the church sought to stifle investigation by threatenings and punishment. Several very severe restrictions had been laid upon the publication of those works which had a tendency to open the eyes of the people, and expose the errors and vices of the church. These restrictions were, however, in a great measure neglected, by the ardent love of literature which so eminently characterised the conduct of Leo X. That pontiff forgot even his own safety, amidst poets, painters, sculptors, wits, and entertainments.

What tended also to pave the way for the reformation, was the rage which at that time prevailed among the learned for Grecian literature and the Pagan mythology. The barbarous latinity of the middle ages gave way to the refined beauties of poetry and classical learning. The paganism of Cicero, and the beauties of Virgil, were made to illustrate and adorn the sublime mysteries of the Christian faith; and Jupiter, Apollo, and Diana, were deemed fit representatives of the persons of the Blessed Trinity, and luminous illustrations of Christian platonism. The doctrine of atonement, by the sufferings of Christ, was explained and enforced by the examples of the Decii and of Curtius; of Cecrops, Menæcius, and Iphigenia; of Socrates and Phocion; of Epaminondas, Scipio, and Aristides. The doctrines and practices of Paganism being thus honoured by the ministers of the church, no wonder that the poets, particularly Pontano, Sanazzaro, and Marullus, should constantly endeavour to adorn even their sacred poems with a reference to the mythology of Greece and Rome.

With this mixture of Paganism and Christianity, the mysteries of the Platonic philosophy were incorporated. Those refinements of the Platonists, which were so ingeniously infused into the devotion of Lorenzo de Medici, were propagated among the learned by the labours of Marsilio Ficino, of Pico of Mirandula, of his nephew Gian-Francesco, of Girolamo Benivieni, and others.

The liberties thus taken with the Christian faith, and with the peculiar dogmas of the Romish church, naturally begat a degree of scepticism in the minds of those by whom they were indulged; and from them it spread, more or less, over the minds of the multitude, and prepared the way for a general reformation in the creed and discipline of the church.

At length the danger arising from these unbounded speculations became too evident to pass any longer unnoticed; accordingly, in the eighth session of the Council of the Lateran, several decrees were passed, tending to restrain ecclesiastical students in their pursuits relative to poetry and philosophy; but these restraints and prohibitions were made too late: a spirit of speculation and research had gone abroad, and it was not to be checked by decrees and councils, fulminations and threats.

In addition to the causes of the reformation which we have just enumerated, there were others more obvious, which are said to have been "the long schism of the Church of Rome in the fourteenth century; the misconduct of Alexander VI. and of Julius II.; the encroachments of the clergy on the rights of the laity; the venality of the Roman court; and above all, perhaps, the general progress of liberal studies, and the happy invention of the art of printing."

The spirit of inquiry, aided by the light of science and the invention of printing, had more or less diffused itself over the minds of Christians in every part of Europe; but no where had this spirit more successfully made its approaches than in Saxony. Intoxicated with the luxury, and dazzled with the magnificence of the Roman court, the Italians satisfied themselves with ridiculing the vices of the church in poems and visions; but took no effectual steps towards bringing about a reformation. They consoled themselves with the reflection, that though their chief city was the seat of vice and debauchery, it was also the residence of the supreme head of the church, the great depository of riches, the scene of pomp and grandeur, and the nursery of the fine arts. The magnificence of ancient ruins, the number of religious edifices, and the splendour of crowded processions, gave a sort of dignity and importance to the city of the Cæsars, and superseded pure devotion and simple prayers; while a religion which captivated the senses of the Italians, lulled their vices, and caused them to think reformation less needful than it was. In Saxony, however, the case was different. This hardy race of men had never been corrupted by luxury. Almost the last to embrace the doctrines of the Christian faith, when they were compelled by Charlemagne to become Christians, they soon embraced the gospel with sincerity and simplicity. They had, with the profession of popery, preserved their principles in a great degree free from the evils with which that system of religion had been attended in other countries. They were papists; but popery was not the whole of their religion: when, therefore, the corruptions of the church were brought before their view, they first despised, then abhorred, and at last forsook them. They had always been impatient under the Roman yoke, and were fully ripe for a reformation which promised them freedom of thought and the full exercise of natural liberty. The revival of literature, which manifested itself in Italy by the fine arts, the enjoyments of taste, and the classical beauties of ancient Greece and Rome, operated on the minds of the sober and active Saxons in the cultivation of metaphysics, philosophy, and history. When, therefore, the reformation broke forth, the Saxon theologians were more than a match for the Italian poets, painters, and platonists. Ariosto and Luther were very different characters: To the one the world is indebted for a diffusion of the true spirit of poetry; to the other, that of piety, and the right of private judgment in matters of faith and worship. It was reserved for the bold and enterprising genius of Luther to unloose the trammels by which the minds of men had been so long fettered; to open the prison doors to those that were bound; to silence by scripture and argument the thunders of the Vatican; and to assure the world, that the human mind is naturally free.

To support the expenses of a luxurious court, Leo X. had availed himself of an ancient custom in the church to raise money by the sale of indulgences, by which the purchasers were allowed the practice of several sins, and a deliverance from the pains of purgatory. To defend these indulgences, it was urged, that as one drop of Christ's blood is sufficient to atone for the sins of the whole world, the remainder of blood shed by the death of the Saviour belonged to the church, and that its efficacy might be sold out to the people. It was supposed also, that to the church belonged all the good works of the saints, beyond what were employed in their own justification. These superabundant merits were accordingly sold to the unthinking multitude at various prices, according to the nature of the offence for which they were to atone. The form of these indulgences not being very generally known, we will give an exact copy of one of these most extraordinary instruments.

"May our Lord Jesus Christ have mercy upon thee, and absolve thee by the merits of his most holy passion. And I, by his authority, that of his blessed apostles, Peter and Paul, and of the most holy Pope, granted and committed to me in these parts, do absolve thee, first from all ecclesiastical censures, in whatever manner they have been incurred; and then, from all thy sins, transgressions, and excesses, how enormous soever they may be, even from such as are reserved for the cognizance of the holy see; and as far as the keys of the holy church extend, I remit you all punishment you deserve in purgatory on their account; and I restore you to the holy sacraments of the church, to the unity of the faithful, and to that innocence and purity you possessed at baptism; so that when you die, the gates of punishment shall be shut, and the gates of the paradise of life shall be opened; and if you shall not die at present, this grace shall remain in full force when you are at the point of death. In the name of the Father, of the Son, and of the Holy Ghost. Amen."

This is the form of absolution sold by the agents of Leo X. in various parts of the Christian world; an instrument so absurd, that were it not well authenticated, and had we not even in our day a similar instance of imposture on the one hand, and credulity on the other, in the seals disposed of by Johanna Southcott, one might be tempted to doubt the truth of its existence.

The promulgation of these indulgences in Germany, together with a share arising from the profits in the sale of them, was assigned to Albert, Elector of Mentz, and Archbishop of Magdeburg, who, as his chief agent for retailing them, employed one Tetzel, a Dominican Friar, of licentious morals, but of a bold and active spirit. Tetzel, assisted by the monks of his order, executed this ignoble commission with great zeal and success; but with the most shameless indecency and indiscretion; at the same time magnifying the benefits of these indulgences in the most extravagant manner. To such enormities did Tetzel proceed in describing the efficacy of these pretended dispensations, that he even said, "if any one had ravished the mother of God, he (Tetzel) had wherewithal to efface his guilt." He also boasted, that "he had saved more souls from hell by these indulgences, than St. Peter had converted to Christianity by his preaching." These enormous blasphemies and abuses roused the indignation of Martin Luther, a monk of the Augustinian Eremites, and professor of divinity in the academy at Wittemberg, to such a pitch of fervour, that he began to declaim with boldness against these scandals of the Christian name. In ninety-five propositions, maintained publicly at Wittemberg, on the 30th of September, 1517, he censured the extravagant extortions of the questors, and plainly pointed out the Roman Pontiff as a partaker of their guilt, since he suffered the people to be seduced by such delusions, from placing their principal confidence in Christ, the only proper object of their trust. So daring an opposition from an obscure monk, in a corner of Germany, excited the surprise and admition of all the world, except Rome itself, which seemed most likely to have been first alarmed. Luther had no sooner published his propositions than multitudes flocked to his standard, and joined him in the outcry against the shameful abominations of the Church of Rome. It was, however, some time before an irruption took place; or that the friends of reform declared open war against the decrees and authority of the Church. Tetzel and others vainly attempted to defend the indulgences, but were continually repulsed, and put to shame by the arguments and intrepidity of Luther. The history of the various disputes which called forth the energies of this Reformer, and exposed the nakedness of the Church, is both interesting and curious: we must nevertheless pass over this portion of the history of the reformation in Germany; observing, that Luther and his adherents soon found most powerful auxiliaries in the University of Wittemberg, and the protection of Frederick, Elector of Saxony.

While the Saxon reformer was daily making inroads on the authority of the Roman See, first by an opposition to the promulgation of indulgences, and from that, by a fearless exposure of the errors and doctrines of the Catholic Church itself, the Pope and Cardinals at Rome were asleep in the arms of luxury, and insensible of their danger amidst the enjoyments of polite literature, the mysticisms of Plato, the glare of outward grandeur, and the stupefactions of sensuality. It is true, the supineness of Leo was often reproved by those who had the interests of the Church at heart; but the natural benevolence of that pontiff's disposition, and his utter aversion to business, or solicitude, rendered it difficult to convince him that the disputes in Saxony were any thing besides the squabbles of restless and ignorant monks, unworthy his regard, and beneath his interference. And when at length he was reminded by the Emperor Maximilian, that his forbearance or negligence began to be dangerous, the matter had gone too far to be easily arrested.

Emboldened by success, encouraged by the increasing number of his adherents, and above all, protected by the secular power, Luther had already proceeded much farther in the work of reformation, than it is probable he himself at first intended; when, therefore, he was summoned by the Pope to appear before him at Rome, by the interference of Frederick the Wise, he procured the liberty of being heard in a conference to be held in Germany. This indulgence might possibly have somewhat abated the zeal and opposition of Luther, had proper persons been chosen to give him a hearing. But, instead of this, the persons appointed to this service were his avowed enemies, the Bishop of Ascula, and Sylvestero Prierio. Poor and bare-footed, Luther, having commended himself and his cause to God, boldly repaired to Augsburg, after having written to his friend and fellow reformer, Philip Melancthon, to the following effect: "I know nothing new or extraordinary here, except that I am become the subject of conversation throughout the whole city, and that every one wishes to see the man who is to be the victim of such a conflagration. You will act your part properly, as you have always done; and teach the youth intrusted to your care. I go, for you, and for them, to be sacrificed, if it should so please God. I rather choose to perish, and what is more afflicting, to be for ever deprived even of your society, than to retract what I have already asserted, or to be the means of affording the stupid adversaries of all liberal studies an opportunity of accomplishing their purpose."

With such sentiments and resolutions, this fearless reformer proceeded to defend himself and his doctrines against the sense and authority of the Pope's legate, and any whom that Cardinal might be pleased to appoint for the purpose of opposing the reformation.

At this memorable conference, every thing that remonstrance, persuasion, and condescension, on the part of the Cardinal of Gaeta, could effect, were used, to bring back this unruly reformer to an implicit obedience to the authority and practices of the holy see; but all in vain. Luther gained additional strength and boldness by every encounter; and the conference closed with an appeal to Leo the Tenth, in which, after recapitulating the proceedings which had already taken place, Luther declares that he is not conscious of having advanced any thing against the holy scriptures, the ecclesiastical fathers, the decrees of the popes, or right reason; but that all which he has said is catholic, proper, and true. Being, however, a man, and therefore liable to error, he submits himself to the church, and offers himself personally, either there or elsewhere, to adduce the reasons of his belief, and reply to all objections that may be made against it. This protest not satisfying the mind of the Cardinal, through the interference of some of Luther's friends, he procured from the reformer a conciliatory letter, in which he acknowledges that he has been indiscreet in speaking in disrespectful terms of the supreme pontiffs; and promises even to be silent in future respecting indulgences, provided his adversaries were also compelled to be silent, or were restrained in their abuse of him. With these concessions, and an appeal from Leo the Tenth, prejudiced and misled, to Leo the Tenth, better informed on the subject, Luther abruptly quitted the city of Augsburg. Notwithstanding this disrespectful conduct, the Cardinal did not avail himself of the powers with which he had been entrusted, to excommunicate

Luther and his adherents; but appealed to the Elector of Saxony, and requested, that if Luther still persisted in his opposition to the church, he might be either sent to Rome, or, at least, banished from his dominions. The Elector refused to comply with either of these requests; and the work of reformation was suffered to go on.

As it was impossible that the vicar of Christ should enter into a formal dispute with the monk of Wittemberg, nothing now remained, but either to adopt the decisive measure of excommunicating the unbending reformer, or to put his professions of obedience to the test, by a formal decree against his doctrines, and by a papal bull, expressly declaring, that as the Pope is the successor of St. Peter, and vicar of Christ upon earth, he hath an undoubted power of granting indulgences, which avail as well the living as the dead in purgatory; and that this doctrine is essential to the salvation of every true and obedient son of the church. Accordingly, a bull, to this purport, was signed on the 7th day of November, 1518, and published throughout the christian world. This put the sincerity and boldness of Luther to the test, who soon decided concerning the measures he should adopt, either of instant and unqualified submission, or open contumacy. Luther determined upon the latter, and commenced hostilities against the infallibility of the Pope, by an appeal from the authority of the supreme head to a general council. Here then commenced that schism which caused even the vicar of Christ to tremble, and which laid a train under the foundations of spiritual domination and superstition, that must one day not only agitate and deform the superstructure, as it already has done, but finally destroy the whole fabric, and leave not one stone upon another that shall not be thrown down.

Nothing now could have prevented the immediate destruction of Luther and his adherents, had not the attention of Europe been drawn aside from theological disputes to subjects of political discussion and debate. Luther was therefore suffered, without any great interference, to proceed in the work in which he had engaged. By voluntarily offering to submit his opinions to the decisions of reason and revelation, and by making common cause with the friends of freedom and literature, his success exceeded even the most sanguine expectations of his warmest friends. In what manner Luther conducted himself after he had succeeded in establishing a new system of religious faith and discipline, and what were the peculiarities of his creed, the reader will have observed in the articles LUTHERANS, and PROTESTANTS. See also ROMAN CATHOLICS.

From Germany, by the writings of Luther, and from Switzerland, by the zeal and perseverance of Zuinglius, the work of reform proceeded to spread itself over Denmark, Sweden, Geneva, Holland, England, and Scotland. In France, Spain, and Italy, the reformation made comparatively but little progress. The same also is to be observed of Poland and Russia. The names of the principal reformers are the following, and we are induced to enumerate them, that by consulting the various biographical accounts that have, from time to time, been published of them, our readers may enter more minutely into this very important branch of modern history:

Luther, Erasmus, and Melancthon; Calvin, Zuinglius, and Oecolampadius: Bullinger, Beza, and Martyr. In England, Henry VIII. Edward VI. Ridley, Latimer, Hooper, Cranmer, and Queen Elizabeth. In Scotland, the reformation was forwarded by the zeal and industry of Knox. These are the names of some of those men to whom the religious world is at this time indebted for that freedom of thought, and many of those Christian privileges, with which it is so eminently favoured.

That in every instance the motives of the reformers were pure, we do not contend; nor are we disposed to conceal the fact, that many of them possessed a spirit of intolerance inconsistent with the principles of entire liberty. The priestly audacity of Luther, the time-serving policy of the learned Erasmus, the censurable timidity of Melancthon, and, above all, the fiery spirit and persecuting zeal of Calvin, which condemned to the flames one of the best men of his age, M. Servetus, who had presumed to express his doubts concerning the Trinity, are so many blots in the history of the reformation, which Christians of our own time would do well carefully to avoid. For a brief, but elegant, account of the causes and progress of the reformation by Luther, the reader may consult the invaluable work of Mr. Roscoe, entitled The Life and Pontificate of Leo the Tenth; vols. iii. and iv. He should also peruse Burnet's History of the Reformation, and Dr. Robertson's History of Charles the Fifth.

REFRACTION.

REFRACTION, in astronomy, or REFRACTION *of the stars*, is an inflexion of the rays of those luminaries, in passing through our atmosphere, by which the apparent altitudes of the heavenly bodies are increased. This refraction arises from hence, that the atmosphere is unequally dense in different stages or regions; rarest of all at the top, and densest of all at the bottom; which inequality, in the same medium, makes it equivalent to several unequal mediums, by which the course of the ray of light is continually bent into a continued curve line. And Sir Isaac Newton has shown, that a ray of light, in passing from the highest and rarest part of the atmosphere, down to the lowest and densest, undergoes the same quantity of refraction that it would do in passing immediately, at the same obliquity, out of a vacuum into air of equal density with that in the lowest part of the atmosphere.

Hence arise the phenomena of the crepusculum or twilight; and hence also it is, that the moon is sometimes seen eclipsed, when she is really below the horizon, and the sun above it.

That there is a real refraction of the stars, &c. is deduced not only from physical considerations, and from arguments *a priori*, but also from precise astronomical observations; for there are numberless observations, by which it appears that the sun, moon, and stars rise much sooner, and appear higher, than they should do according to astronomical calculations. Hence it is argued, that as light is propagated in right lines, no rays could reach the eye from a luminary below the horizon, unless they were deflected out of their course, at their entrance into the atmosphere: and therefore it appears that the rays are refracted in passing through the atmosphere. Since the stars appear higher by refraction than they really are, to bring the observed or apparent altitudes to the true ones, the quantity of refraction must be subtracted. Accordingly the ancients, as they were not acquainted with this refraction, reckoned their altitudes too great. Refraction lengthens the day, and shortens the night, by making the sun appear above the horizon a little before his rising, and a little after his setting. Refraction also makes the moon and stars appear to rise sooner, and set later than they really do. The apparent diameter of the sun or moon is about 32′; the horizontal refraction is about 33′; whence the sun and moon appear wholly above the horizon when they are entirely below it. Also from observations it appears, that the refractions are greater nearer the pole than at lesser latitudes, causing the sun to appear some days above the horizon, when he is really below it; doubtless from the greater density of the atmosphere, and the greater obliquity of the incidence.

Stars in the zenith are not subject to any refraction: those in the horizon have the greatest of all: from the horizon the refraction continually decreases to the zenith. All which follows from hence, that in the first case, the rays are perpendicular to the medium; in the second, their obliquity is the greatest, and they pass through the largest space of the lower and denser part of the air, and through the thickest vapours; and in the third, the obliquity is continually decreasing. The air is condensed, and consequently refraction is increased, by cold; for which reason it is greater in cold countries than in hot ones. It is also greater in cold weather than in hot, in the same country; and the morning refraction is greater than that of the evening, because the air is rarified by the heat of the sun in the day, and condensed by the coldness of the night. Refraction is also subject to some small variation at the same time of the day in the finest weather.

The horizontal refraction, being the greatest, is the cause that the sun and moon appear of an oval form at their rising and setting; for the lower edge of each being more refracted than the upper edge, the perpendicular diameter is shortened, and the under edge appears more flattened also. Again, if we take with an instrument the distance of two stars when they are in the same vertical and near the horizon, we shall find it considerably less than if we measure it when they are both at such a height as to suffer little or no refraction; because the lower star is more elevated than the higher. There is also another alteration made by refraction in the apparent distance of stars: when two stars are in the same parallel of declination, their apparent distance is less than the true; for since refraction makes each of them lighter in the azimuth or vertical in which they appear, it must bring them into parts of the vertical where they come nearer to each other; because all vertical circles converge and meet in the zenith. This contraction of distance, according to Dr. Halley, (Philos. Trans. numb. 368) is at the rate of at least one second in a degree; so that, if the distance between two stars in a position parallel to the horizon measure 30°, it is at most to be reckoned only 29°, 59′, 32″.

The quantity of the refraction at every altitude, from the horizon, where it is greatest, to the zenith where it is nothing, has been determined by observations by many astronomers; those of Dr. Bradley and Mr. Mayer are esteemed the most correct of any, being nearly alike, and are now chiefly used by astronomers. Dr. Bradley, from his observations, deduced this general rule for the refraction, r, at any altitude, a, whatever; *viz.* as rad. 1 : cotang. $\overline{a+3r}$: : 57″ : r'' the refraction in seconds. This rule is adapted to these states of the barometer and thermometer, *viz.* either 29.6 inch barometer and 50° thermometer, or 30 inch barometer and 55° thermometer, for both which states it answers equally the same. But for any other states of the barometer and thermometer, the refraction above found is to be corrected in this manner; *viz.* if b denote any other height of the barometer in inches, and t the degrees of the thermometer, r being the refraction incorrected, as found in the manner above. Then as 29.6 : b : : r : R the refraction corrected on account of the barometer, and 400 : 450 t : : R the refraction corrected both on account of the barometer and thermometer; which final corrected refraction is therefore $= \frac{450-t}{11840} br$. Or, to correct the same refraction, r, by means of the latter state, *viz.* barometer 30 and thermometer 55, it will be as 30 : b : : r : R $= \frac{br}{30}$, and 400 : 455 $-t$: : R : $\frac{455-t}{400}$ R $=$ $\frac{455-t}{12000} br$ the correct refraction.

Mr. Simpson has determined, by theory, the astronomical refractions, from which he brings out this rule, *viz.* as 1 to .9986, or as radius to sine of 86° 58′ 30″, so is the sine of any given zenith distance, to the sine of an arc; $\frac{2}{11}$ of the difference between this arc and the zenith distance, is the refraction sought for that zenith distance. And by this rule Mr. Simpson computed a table of the mean refractions, which are not much different from those of Dr. Bradley and Mr. Mayer, and are as in the following table. See Simpson's Dissertations.

MR. SIMPSON'S TABLE OF MEAN REFRACTIONS.

Apparent Altitude.	Refraction.	Apparent Altitude.	Refraction	Apparent Altitude.	Refraction.
0°	33′ 0″	17°	2′ 50″	38°	1′ 7″
1	23 50	18	2 40	40	1 2
2	17 43	19	2 31	42	0 58
3	13 44	20	2 23	44	0 54
4	11 5	21	2 16	46	0 50
5	9 10	22	2 9	48	0 47
6	7 49	23	2 3	50	0 44
7	6 48	24	1 57	52	0 41
8	5 59	25	1 52	54	0 38
9	5 21	26	1 47	56	0 35
10	4 50	27	1 42	58	0 32
11	4 24	28	1 38	60	0 30
12	4 2	29	1 34	65	0 24
13	3 43	30	1 30	70	0 19
14	3 27	32	1 23	75	0 14
15	3 13	34	1 17	80	0 9
16	3 1	36	1 12	85	0 4½

It is evident that all observed altitudes of the heavenly bodies ought to be diminished by the numbers taken out of the foregoing table. It is also evident that the refraction diminishes the right and oblique ascensions of a star, and increases the descensions; it increases the northern declination and latitude, but decreases the southern; in the eastern part of the heavens it diminishes the longitude of a star, but in the western parts of the heavens it increases the same. See QUADRANT.

REFRACTION, *terrestrial*, is that by which terrestrial objects appear to be raised higher than they really are, in observing their altitudes. The quantity of this refraction is estimated by Dr. Maskelyne at one tenth of the distance of the object observed, expressed in degrees of a great circle. So, if the distance be 10,000 fathoms, its tenth part, 1000 fathoms, is the sixtieth part of a degree of a great circle on the earth, or 1″, which therefore is the refraction in the altitude of the object at that distance. But M. Le Gendre is induced, he says, by several experiments, to allow only one fourteenth part of the distance for the refraction in altitude. So that, upon the distance of 14,000 fathoms, the fourteenth part of which is 714 fathoms, he allows only 44″ of terrestrial refraction, so many being contained in the 714 fathoms. See his Memoir concerning the trigonometrical operations, &c. Again, M. de Lambre, an ingenious French astronomer, makes the quantity of the terrestrial refraction to be the eleventh part of the arch of distance. But the English measurers, Col. Edward Williams, Capt. Mudge, and Mr. Dalby, from a multitude of exact observations made by them, determine the quantity of the medium refraction to be the twelfth part of the said distance. The quantity of this refraction, however, is found to vary considerably, with the different states of the weather and atmosphere, from the fifteenth part of the distance to the ninth part of the same, the medium of which is the twelfth part, as above mentioned. Some whimsical effects of this refraction are also related, arising from peculiar situations and circumstances. Thus, it is said, any person standing by the side of the river Thames, at Greenwich, when it is high water there, he can see the cattle grazing on the Isle of Dogs, which is the marshy meadow on the other side of the river at that place; but when it is low water there, he cannot see any thing of them, as they are hid from his view by the land wall or bank on the other side, which is raised higher than the marsh, to keep out the waters of the river. This curious effect is probably owing to the moist and dense vapours, just above and rising from the surface of the water, being raised higher or lifted up with the surface of the water at the time of high tide, through which the rays pass, and are the more refracted.

Refraction, in general, is the deviation of a moving body from its direct course, occasioned by the different density of the medium it moves in; or it is a change of direction, occasioned by a body's falling obliquely out of one medium into another of a different density. The great law of refraction, which holds in all bodies, and all mediums, is, that a body, passing obliquely out of one medium into another wherein it meets with less resistance, is refracted or turned towards the perpendicular; and, on the contrary, in passing out of one medium into another wherein the resistance is greater, it is refracted or turned from the perpendicular. Hence the rays of light, falling out of air into water, are refracted towards the perpendicular; whereas a ball thrown into the water, is refracted from it. Now the reason of this difference is, that water, which resists the motion of light less than air, resists that of the ball more; or, to speak more justly, because water, by its greater attraction, accelerates the motion of the rays of light more than air does. See Optics.

Refraction *in island crystal.* There is a double refraction in this substance, contrary ways, whereby not only oblique rays are divided into two, and refracted into opposite parts, but even perpendicular rays, and one half of them refracted.

REGALIA, in law, the royal rights of a King, which, according to civilians, are six; power of judicature; power of life and death; power of war and peace; goods without owner, as waifs, strays, &c.; assessments; and minting of money.

REGIMEN, in grammar, that part of syntax, or construction, which regulates the dependency of words, and the alterations which one occasions in another.

REGIMENT, in war, is a body of men, either horse or foot, commanded by a colonel. Each regiment of foot is divided into companies, but the number of companies is not always alike, though our regiments generally consist of ten companies, one on the right of grenadiers, and another on the left of light troops. Regiments of horse most commonly consist of six troops, but some have nine. Regiments of dragoons, in time of war, are generally composed of eight troops, and in time of peace, of six. Each regiment has a chaplain and a surgeon. See Troop and Company. Some German regiments consist of 2000 foot, and the regiments of Picardy, in the old French service, consisted of 120 companies, or 6000 men.

REGISTER, a public book, in which is entered and recorded memoirs, acts, and minutes, to be had recourse to occasionally, for knowing and proving matters of fact. Of these there are several kinds; as, 1. Registers of deeds in Yorkshire and Middlesex, in which are registered all deeds, conveyances, wills, &c. that affect any lands or tenements in those counties, which are otherwise void against any subsequent purchasers, or mortgagees, &c.; but this does not extend to any copyhold estate, nor to leases at a rack-rent, or where they do not exceed twenty-one years. The registered memorials must be engrossed on parchment, under the hand and seal of some of the grantors or grantees, attested by witnesses who are to prove the signing or sealing of them, and the execution of the deed. But these registers, which are confined to two counties, are in Scotland general, by which the laws of North Britain are rendered very easy and regular. Of these there are two kinds: the one general, fixed at Edinburgh, under the direction of the Lord Register; and the other is kept in the several shires, stewartries, and regalities, the clerks of which are obliged to transmit the registers of their respective courts to the general register. No man in Scotland can have a right to any estate, but it must become registered within forty days of his becoming seized thereof; by which means all secret conveyances are cut off. 2. Parish registers are books in which are registered the baptisms, marriages, and burials of each parish.

Among dissenters who admit of infant baptism, each minister is supposed to keep a register of the several children baptized by him. But as these are frequently lost, by the succession of new ministers to the same congregation; or at best do not give an account of the date of the births, which may have happened many weeks or months before baptism; it is now almost generally the custom among dissenters of all denominations to register the births of their children at the Library in Red-cross Street, Cripplegate, for which the charge is sixpence. This register is admitted in the courts of law.

Register, is also used for the clerk or keeper of a register. Of these we have several, denominated from the registers they keep; as Register of the High Court of Delegates; Register of the Arches Court of Canterbury; Register of the Court of Admiralty; Register of the Prerogative Court; Register of the Garter, &c.

Register *ships*, in commerce, are vessels which obtain a commission either from the King of Spain, or the Council of the Indies, to traffic in the ports of the Spanish West Indies; which are thus called from their being registered before they set sail from Cadiz, for Buenos Ayres. Each of these permissions costs 30.000 pieces of eight, and by the tenor of the cedula, or permit, they are not to exceed 300 tons; but there is such a good understanding between the merchants, and the Council of the Indies, that ships of 5 or 600 tons frequently pass unnoted; and though the quantity and quality of the merchandizes on board are always expressed, yet, by means of presents, the officers, both in Spain and the Indies, allow them to load and unload vastly more than the permission expresses.

Register, in printing, is disposing the forms on the press, so as that the lines and pages printed on one side of the sheet fall exactly on those of the other.

Register, among letter founders, is one of the inner parts the mould in which the printing types are cast. Its use is to direct the joining the mould justly together again, after opening it to take out the new cast letter.

Registers, in chemistry, are holes, or chinks with stopples, contrived in the sides of furnaces, to regulate the fire; that is, to make the heat more intense, or remiss, by opening them to let in the air, or keeping them close to exclude it.

REGULAR, denotes any thing that is agreeable to the rules of art: thus, we say a regular building, verb, &c. A regular figure, in geometry, is one whose sides, and consequently angles, are equal; and a regular figure with three or four sides is commonly termed an equilateral triangle, or square, as all others with more sides are called regular polygons. All regular figures may be inscribed in a circle. A regular solid, called also a platonic body, is that terminated on all sides by regular and equal planes, and whose solid angles are all equal. See Body.

REGULUS, in chemistry, an imperfect metallic substance, that falls to the bottom of the crucible, in the melting of ores, or impure metallic substances.

Regulus, in astronomy, a star of the first magnitude, in the constellation Leo, called also, from its situation, *Cor Leonis*, or the lion's heart. Its longitude, according to Mr. Flamstead, is 25° 31′ 20″, and its latitude 0° 26′ 38″ north.

REHEARING, in chancery, is when either of the parties thinks himself aggrieved by a decree, and petitions the Chancellor for the cause to be heard again.

REIN *deer*. See Cervus.

REJOINDER, in law, is the name of a part of the pleadings where the defendant answers to the plaintiff's replication.

RELEASE, in law. Releases are distinguished into express releases in deed, and those arising by operation of law; and are made of lands and tenements, goods and chattels, or of actions real, personal, and mixed. By a release of all demands, all actions real, personal, and mixed, and all actions of appeal, are extinct. The release of a right to lands is now become the most usual form of conveyance. A lease is made for a year, which puts the party in possession, and then a release of all the right to the lessee and his heirs is made the next day;

which, by the operation of the statute of uses, conveys the whole fee. This is called a conveyance by lease and release

RELHANIA, in botany, so named in honour of the Rev. Richard Relhan, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Essential character: calyx imbricate, scariose; corollets of the ray very many; pappus membranaceous, cylindrical, short; receptacle chaffy. There are sixteen species, all natives of the Cape of Good Hope.

RELIEF, a certain sum of money which the tenant holding by knight's service, grand serjeantry, or other tenure, for which homage or legal service is due, and being at full age at the death of his ancestor, formerly paid to his lord at his entrance.

RELIEVO, or Relief, in sculpture, &c. is the projecture or standing out of a figure, which arises prominent from the ground or plan on which it is formed; whether that figure be cut with the chissel, moulded, or cast.

There are three kinds or degrees of relievo, *viz.* alto, basso, and demi-relievo. The alto-relievo, called also haut-relief, or high relievo, is when the figure is formed after nature, and projects as much as the life. Basso-relievo, bass-relief, or low-relievo, is when the work is raised but a little from the ground, as in medals, and the frontispieces of buildings, and particularly in the histories, festoons, foliages, and other ornaments of friezes. Demi-relievo is when one half of the figure rises from the plan. When, in a basso-relievo, there are parts that stand clear out, detached from the rest, the work is called a demi-basso. In architecture, the relievo or projecture of the ornaments, ought always to be proportioned to the magnitude of the building it adorns, and to the distance at which it is to be viewed.

Relievo, or Relief, in painting, is the degree of boldness with which the figures seem, at a due distance, to stand out from the ground of the painting.—The relievo depends much upon the depth of the shadow, and the strength of the light; or on the height of the different colours, bordering on one another; and particularly on the difference of the colour of the figure from that of the ground. Thus, when the light is so disposed as to make the nearest parts of the figure advance, and is well diffused on the masses, yet insensibly diminishing, and terminating in a large spacious shadow, brought off insensibly, the relievo is said to be bold, and the clair-obscure well understood.

RELIGION, seditious words, in derogation of the established religion, are indictable, as tending to a breach of the peace.

REMAINDER, in law, is an estate limited in lands, tenements, or rents, to be enjoyed after the expiration of another particular estate. As if a man seized in fee-simple grant lands to one for twenty years, and, after the determination of the said term, then to another, and his heirs for ever; here the former is tenant for years, remainder to the latter in fee. Both interests are, in fact, only one estate: the present term of years, and the remainder afterwards, when added together, being equal only to one estate in fee. When a remainder is limited in a will, it is sometimes called an executory devise. This is not strictly a remainder, but something in nature of a remainder, which, though informal and bad, as such, is held good as an executory devise. The doctrine of remainders is very abstruse, chiefly from the difficulty of ascertaining from the form of the deed or will by which it is created, whether or not the remainder is contingent, and liable to be defeated. Where a remainder is limited after an estate tail, the tenant in tail can at all times, by suffering a recovery, defeat the remainder, and get possession of the fee. This is called docking the entail, and it is allowed for the purpose of preventing limitations in perpetuity. For, otherwise, men of large landed estates would be enabled to tie up the inheritance so strictly by will, that in a few years all the landed property in the kingdom would be vested for ever in certain families, and that circulation of wealth, which is the great spur to industry, would be wholly at an end. Hence would be introduced all the inconvenience of a system of casts similar to those in the East Indies, and in a short time there would be no change in the course of inheritances, except upon forfeitures for felony, or high treason, which would rarely occur. Or, perhaps, the consequence would be, that the inheritance of females not being forbidden, the land would be so subdivided by different descents to coheiresses, that there would be no large estates in the country. This sufficiently evinces the wisdom of the law, which prevents bequests in perpetuity, and we have thought it better to notice this in a popular work, than to explain at length a term of art which unavoidably leads to the most abstruse reasoning. For further information, see Jacob's Law Dict. by Tomlins, title Remainder; Fearne's Essay on Remainders, and other works there cited.

REMEMBRANCERS, anciently called clerks of the remembrance, certain officers in the Exchequer, whereof three are distinguished by the names of the King's Remembrancer, the Lord Treasurer's Remembrancer, and the Remembrancer of the First Fruits. The King's Remembrancer enters in his office all recognizances taken before the Barons, for any of the King's debts, for appearances or observances of orders; he also takes all bonds for the King's debts, &c. and makes out processes thereon. He likewise issues processes against the collectors of the customs, excise, and others, for their accounts; and informations upon penal statutes are entered and sued in his office, where all proceedings in matters upon English bills in the Exchequer Chamber remain. His duty further is to make out the bills of compositions upon penal laws, to take the statement of debts; and into his office are delivered all kinds of indentures and other evidences, which concern the assuring any lands to the crown. He, every year, in *crastino animarum*, reads in open court the statute for election of sheriffs; and likewise openly reads, in court, the oaths of all the officers, when they are admitted.

The Lord Treasurer's remembrancer is charged to make out process against all sheriffs, escheators, receivers, and bailiffs, for their accounts. He also makes out writs of fieri facias, and extent for debts due to the King, either in the pipe or with the auditors; and process for all such revenue as is due to the King, on account of his tenures. He takes the account of sheriffs; and also keeps a record, by which it appears whether the sheriffs or other accountants pay their profers due at Easter and Michaelmas; and at the same time he makes a record, whereby the sheriffs or other accountants keep their prefixed days. There are likewise brought into his office all the accounts of customers, comptrollers and accountants, in order to make entry thereof on record: also all estreats and amercements are certified here, &c.

The Remembrancer of the First Fruits takes all compositions and bonds for the payment of first fruits and tenths, and makes out process against such as do not pay the same.

REMITTER, a term in law, which implies that a person having a right is dispossessed, and then by a bad title, different from his former one, gets possession. He is then said to be remitted to his former title, or to be in by remitter, and cannot be turned out, although he gained his last possession by a bad title.

RENDEZVOUS, in a military sense, the place appointed by the general, where all the troops that compose the army are to meet at the time appointed, in case of an alarm. This place should be fixed upon according to the situation of the ground, and the sort of troops quartered in the village. In an open country it is easy to fix upon a place of rendezvous, because the general has whatever ground he thinks necessary. In towns and villages, the largest streets, or marketplaces, are very fit; but let the place be where it will, the troops must assemble with ease, and be ready for the prompt execution of orders.

RENEALMIA, in botany, so named from Paul Reneaume, physician at Blois, a genus of the Monandria Monogynia class and order. Natural order of Scitamineæ. Cannæ, Jussieu. Essential character: calyx trifid; nectary oblong; calyx one-leafed, bursting into two or three irregular teeth; anther sessile, opposite to the nectary; berry fleshy. There is but one species, *viz.* R. exaltata, a tree about twenty feet in height, having a straight trunk; leaves five or six feet long, lanceolate, waved about the edge: the raceme or bunch of flowers springs from the trunk above the root. It is a native of Surinam.

RENT, is a certain profit issuing yearly out of lands and tenements corporeal. There are at common law three kinds of rents; rent service, rent charge, and rent seck. Rent service is where the tenant holds his land of his lord by fealty and certain rent; or by homage, fealty, and certain rent; or by other service and certain rent; and it is called a rent service, because it has some corporeal service incident to it, which at least is fealty. Rent charge is so called, because the land for payment thereof is charged with a distress. Rent seck is where the land is granted without any clause of distress for the same.

The time for payment of rent, and, consequently, for a demand, is such a convenient time before the sun-setting of the last day, as will be sufficient to have the money counted; but if the tenant meet the lessor on the land at any time of the last day of payment, and tender the rent, that is sufficient tender, because the money is to be paid indefinitely on that day, and therefore a tender on that day is sufficient. The remedy for non-payment of rent is by distress, or taking the goods and chattels, or by action of debt. See Woodfall's Landlord and Tenant, or Tomlins's Law Dictionary.

REPELLING *power*. See REPULSION.

REPETEND, in arithmetic, denotes that part of an infinite decimal fraction which is continually repeated ad infinitum. Repetends chiefly arise in the reduction of vulgar fractions to decimals: thus $\frac{1}{3} = 0.333$, &c. A single repetend is that in which only one figure is repeated, as in the instance just given. A compound repetend is that in which two or more figures are repeated. "To find the value of any repetend, or to reduce it to a vulgar fraction." Rule. Take the given repeating figure, or figures, for the numerator, and for the denominator, take as many 9's as there are recurring figures or places in the given repetend: thus, 3 $= \frac{3}{9} = \frac{1}{3}$ and 123 $= \frac{123}{999} = \frac{41}{333}$.

REPETITION, in rhetoric, a figure which gracefully and emphatically repeats either the same word, or the same sense in different words. In the use of this figure care is to be used that we run not into insipid tautologies, nor affect a trifling sound and chime of insignificant words. All turns and repetitions are so that do not contribute to the strength and lustre of the discourse, or at least one of them. The nature and design of this figure is to make deep impressions on those we address. It expresses anger and indignation, full assurance of what we affirm, and a vehement concern for what we have espoused.

REPLEVIN, in law, is a writ by him, who has cattle or other goods distrained by another, for any cause. If he wishes to dispute the propiety of the distress, he sues this writ, and upon putting in surety to the sheriff, that upon delivery of the thing distrained, he will prosecute the action against the distrainer, the cattle or goods are delivered back, and said to be replevied. In this writ, or action, both the plaintiff and defendant are called actors; the one, that is, the plaintiff, suing for damages, and the defendant, who is also called avowant, to have a return of the goods or cattle.

Replevins by writ issue properly out of Chancery, returnable into the courts of King's Bench and Common Pleas at Westminster.

After the goods are delivered back to the party replevying, he is bound to bring his action of replevin against the distrainer; which may be prosecuted in the county court, be the distress of what value it may: but either party may remove it to the superior courts of King's Bench or Common Pleas, the plaintiff at pleasure, and the defendant upon reasonable cause.

If the sheriff is shown a stranger's goods, and he takes them, an action of trespass lies against him, for otherwise he could have no remedy; for being a stranger he cannot have the writ *de proprietate probanda*, and were he not entitled to this remedy, it would be in the power of the sheriff to strip a man's house of all his goods.

If the replevin be determined for the plaintiff, namely, that the distress was wrongfully taken, he has already got his goods back into his own possession, and shall keep them, and recover damages. But if the defendant prevail, by the default or non-suit of the plaintiff, then he shall have a writ *de returno habendo*, or to have a return, whereby the goods or chattels, which were distrained and then replevied, are returned again into his custody, to be sold, or otherwise disposed of, as if no replevin had been made. If the distress were for damage feasant, that is, for cattle breaking through fences, and coming upon the land of the party, the distrainer may keep the goods so returned, until tender shall be made of sufficient amends.

REPLICATION, a law term, signifying a part of the pleadings upon the record, being the plaintiff's answer to the defendant's pleas.

REPRIEVE, an order to suspend a prisoner from the execution and proceeding of the law for a time. Every judge, who has power to order any execution, has power to reprieve.

REPRISE, or REPRIZE, at sea, is a merchant ship which, after its being taken by a corsair, privateer, or other enemy, is retaken by the opposite party. If a vessel thus retaken has been twenty-four hours in the possession of the enemy, it is deemed a lawful prize; but if it be retaken within that time it is to be restored to the proprietor, with every thing therein, upon his allowing one-third to the vessel who made the reprise. Also if the reprise has been abandoned by the enemy, either in a tempest, or from any other cause, before it has been led into any port, it is to be restored to the proprietor.

REPRODUCTION is usually understood to mean the restoration of a thing before existing and since destroyed. It is very well known that trees and plants may be raised from slips and cuttings; and some late observations have shown, that there are some animals which have the same property. The polype (See HYDRA) was the first instance we had of this kind; but we had scarcely time to wonder at the discovery M. Trembley had made, when M. Bonett discovered the same property in a species of waterworm. Amongst the plants which may be raised from cuttings, there are some which seem to possess this quality in so eminent a degree, that the smallest portion of them will become a complete tree again. A twig of willow, poplar, or many other trees, being planted in the earth, takes root, and becomes a tree, every piece of which will in the same manner produce other trees. The case is the same with these worms; they are cut to pieces, and these several pieces become perfect animals; and each of these may be again cut into a number of pieces, each of which will in the same manner produce an animal. It has been supposed by some that these worms were oviparous; but M. Bonett, on cutting one of them to pieces, having observed a slender substance, resembling a small filament, to move at the end of one of the pieces, separated it; and on examining it with glases, found it to be a perfect worm, of the same form with its parent, which lived and grew larger in a vessel of water, into which he put it. These small bodies are easily divided, and very readily complete themselves again, a day usually serving for the production of a head to the part that wants one; and, in general, the smaller and more slender the worms are, the sooner they complete themselves after this operation. When the bodies of the large worms are examined by the microscope, it is very easy to see the appearance of the young worms alive, and moving about within them; but it requires great precision and exactness to be certain of this; since the ramifications of the great artery have very much the appearance of young worms, and they are kept in a sort of continual motion by the systoles and diastoles of the several portions of the artery, which serve as so many hearts. It is very certain, that what we force in regard to these animals, by our operations, is done also naturally every day in the brooks and ditches where they live. A curious observer will find in these places many of them without heads or tails, and some without either; as also other fragments of various kinds, all which are then in the act of completing themselves; but whether accidents have reduced them to this state, or they thus purposely throw off parts of their own body for the reproduction of more animals, it is not easy to determine. They are plainly liable to many accidents, by which they lose the several parts of their body, and must perish very early if they had not a power of reproducing what was lost; they often are broken into two pieces, by the resistance of some hard piece of mud which they enter; and they are subject to a disease, a kind of gangrene, rotting off the several parts of their bodies, and must inevitably perish by it, had they not this surprising property.

The reproduction of several parts of lobsters, crabs, &c. is one of the greatest curiosities in natural history. It seems, indeed, inconsistent with the modern system of generation, which supposes the animal to be wholly formed in the egg, that, in lieu of an organical part of an animal cut off, another should arise perfectly like it: the fact, however, is too well attested to be denied. The legs of lobsters, &c. consist each of five articulations; now when any of the legs happen to break by any accident, as by walking, &c. which frequently happens, the fracture is always found to be at the suture near the fourth articulation; and what they thus lose is exactly reproduced in some time afterwards; that is, a part of the leg shoots out, consisting of four articulations, the first whereof has two claws, as before; so that the loss is entirely repaired.

If the leg of a lobster be broken off by design at the fourth or fifth articulation, what is thus broke off is always reproduced. But if the fracture be made in the first, second, or third articulation, the reproduction is not so certain. And it is very surprising, that, if the fracture be made at these articulations, at the end of two or three days all the other articulations are generally found broke off to the fourth, which, it is supposed, is done by the creature itself, to make the reproduction certain. The part reproduced is not only perfectly similar to that retrenched, but also, in a certain space of time, grows equal to it. Hence it is that we frequently see lobsters which have their two large legs unequal in all proportions. And if the part reproduced be broken off, a second will succeed.

REPTILIA, in natural history, an order of Amphibia, the character of which is, that they breathe through the mouth; have feet, and flat naked ears without auricles. There are five genera, *viz.*

Draco	Siren
Lacerta	Tertudo.
Rana	

REPULSION, in physics, that property in bodies, whereby, if they are placed just beyond the sphere of each other's attraction of cohesion, they mutually fly from each other. Thus, if an oily substance, lighter than water, be placed on the surface thereof, or if a piece of iron be laid upon mercury, the surface of the fluid will be depressed about the body laid on it: this depression is manifestly occasioned by a repelling power in the bodies, which hinders the approach of the fluid towards them. But it is possible, in some cases, to press or force the repelling bodies into the sphere of one another's attraction; and then they will mutually tend towards each other, as when we mix oil and water till they incorporate. Dr. Knight defines repulsion to be that cause which makes bodies mutually endeavour to recede from each other, with different forces, at different times; and that such a cause exists in nature, he thinks evident, for the following reasons. 1. Because all bodies are electrical, or capable of being made so; and it is well known, that electrical bodies both attract and repel. 2. Both attraction and repulsion are very conspicuous in all magnetical bodies. 3. Sir Isaac Newton has shown from experiments, that the surfaces of two convex glasses repel each other. 4. The same great philosopher has explained the elasticity of the air, by supposing its particles mutually to repel each other. 5. The particles of light are, in part at least, repelled from the surfaces of all bodies. 6. Lastly, it seems highly probable, that the particles of light mutually repel each other, as well as the particles of air. The same gentleman ascribes the cause of repulsion, as well as that of attraction, to the immediate effect of God's will; and as attraction and repulsion are contraries, and consequently cannot, at the same time, belong to the same substance, the doctor supposes there are in nature two kinds of matter, one attracting, the other repelling; and that those particles of matter which repel each other, are subject to the general law of attraction in respect of other matter. A repellent matter being thus supposed, equally dispersed through the whole universe, the doctor attempts to account for many natural phenomena by means thereof He thinks light is nothing but this repellent matter put into violent vibrations, by the repellent corpuscles which compose the atmosphere of the sun and stars: and that, therefore, we have no reason to believe they are gulphs of fire, but, like the rest of the heavenly bodies, inhabitable worlds. From the same principles, he attempts to explain the nature of fire and heat, the various phenomena of the magnet, and the cause of the variation of the needle: and, indeed, it is difficult, if not impossible, by the doctrine of attraction alone, to account for all the phenomena observable in experiments made with magnets, which may now be solved by admitting this doctrine of a repellent fluid; but whether it will be sufficient to account for all the particular phenomena of nature, which are the proper tests of an hypothesis, time and experience alone must determine. The doctor also endeavours to show, that the attractions of cohesion, gravity, and magnetism, are the same, and that by these two active principles, *viz.* attraction and repulsion, all the phenomena of nature may be explained; but as his ingenious treatise on this subject is laid down in a series of propositions, all connected together, it would be impossible to do justice to his arguments without transcribing the whole: we shall therefore refer the curious to the book itself.

According to 'sGravesande and others, when light is reflected from a polished spherical surface, the particles of light do not strike upon the solid parts, and so rebound from them; but are repelled from the surface, at a small distance before they touch it, by a power extended all over the said polished surface. And Sir Isaac Newton observes, that the rays of light are also expelled by the edges of bodies, as they pass near them; so as to make their shadows, in some cases, larger than they would otherwise be.

Repulsion, in chemistry. Sir Isaac Newton demonstrated, that if this law be correct, then the force, by which the particles of air recede from each other, increases or diminishes at the same rate that the distance between the centres of the particles, or atoms, of which it is composed, diminishes or increases; or, which is the same thing, that the repulsion between the particles of gaseous bodies is always inversely as the distance of their centres from each other. Now the distance between the centres of the atoms of elastic fluids always varies as the cube root of their density, taking the word in its common acceptation. Thus, if the density of air, under the mean pressure of the atmosphere, be supposed 1; if it be forced into $\frac{1}{8}$th of its bulk, its density becomes 8. In these two cases we have the distance between the atoms of air inversely as the cube root of 1 to the cube root of 8, or as 1 to 2. So that if air be compressed into $\frac{1}{8}$th of its bulk, the distance between its particles is reduced to one half, and of course the repulsion between them is doubled. If air be rarified 300 times, we have its density reduced to $\frac{1}{300}$th of that of common air. Here we have the distance between the atoms of common and the rarified air, as $\sqrt[3]{3} : \sqrt[3]{300}$, or nearly as 1 : 7. So that when air is rarified 300 times, the distance between its particles becomes almost seven times greater, and of course their repulsion is diminished almost sevenfold

RESCUE, or Rescous, is the taking away and setting at liberty, against law, any distress taken for rent, or services, or damage feasant; but the more general notion of rescous is, the forcibly liberating another from an arrest or some legal commitment. This is a high offence, and subjects the offender not only to an action at the suit of the party injured, but likewise to fine and imprisonment at the suit of the king. If goods are distrained without cause, or contrary to law, the owner may make rescue; but if they are once impounded, even though taken without any cause, the owner may not break the pound and take them out, for then they are in custody of the law.

RESEDA, in botany, a genus of the Dodecandria Triginia class and order. Natural order of Miscellaneæ. Capparides, Jussieu. Essential character: calyx one-leafed, parted; petals laciniate; capsule gaping at the mouth, one-celled. There are thirteen species; none of these plants, except the R. odorata, sweet reseda, or mignonette, are cultivated in gardens, unless for the sake of variety, having little beauty to recommend them. The root of the mignonette is composed of many strong fibres, which run deep into the ground: it has several stems, about a foot long, dividing into many small branches; leaves oblong, of a deep green colour; the flowers are produced in loose spikes at the ends of the branches, on long foot-stalks, having large calyxes; the corrollas are of an herbaceous white colour. It is supposed to be a native of Egypt.

RESIDENCE, is particularly used for the continuance of a parson or vicar on his benefice. By stat. 13 Elizabeth, c. 20, and divers other subsequent statutes, if any beneficed clergyman be absent from his cure above fourscore days in one year, he shall not only forfeit one year's profit of his benefice, to be distributed among the poor of the parish, but all leases made by him of the profits of such benefice, and all covenants and agreements of like nature, shall cease and be void, except in the case of licensed pluralists, who are allowed to demise the living on which they are non-resident to their curates only.

RESIDUAL *figure*, in geometry, the figure remaining after subtracting a lesser from a greater.

Residual *root*, in algebra, a root composed of two parts or members, connected together by the sign —. Thus $x - y$ is a residual root, so called, because its value is no more than the difference between its parts x and y.

RESIDUARY *Legatee*, is he to whom the residue of a personal estate is given by will; and such legatee being made executor with others, shall retain against the rest. If there is no residuary clause in a will, all the property which is not particularly devised goes to the executor, if it is personal; but, if real, to the heir.

RESIGNATION, the giving up a benefice into the hands of the ordinary. Every person who resigns a benefice must make the resignation to his superior; as an incumbent to a bishop; a bishop to an archbishop; and an archbishop to the king, as supreme ordinary.

RESINS. Resinous bodies form a very numerous class of vegetable substances. When volatile oils are exposed to the air, they become thick after a shorter or longer time, and are then found to be converted into a resin. The oil absorbs oxygen from the air, and is deprived of part of its carbon, which combining with the oxygen of the atmosphere, forms carbonic acid. Resinous substances, therefore, are generally considered as volatile oils saturated with oxygen. The general properties of resinous substances are the following. They are solid, brittle, and commonly of a yellowish colour, with some degree of transparency. The taste, resembling volatile oils, is hot and acrid. They have no smell. The specific gravity is from 1.01 to 1.22. All resinous bodies are electrics, and when excited by friction, the electricity is negative; hence it is called resinous electricity. They melt by being exposed to heat, and burn with a yellow flame, giving out a great quantity of smoke. Resins are insoluble in water. Resinous substances are soluble in nitric acid; part is precipitated by the addition of water, and the whole by means of the alkalies. With the assistance of heat they are all soluble in alcohol, and in sulphuric ether. Resins are soluble in some of the fixed oils, and also in volatile oils. Resinous substances have been found to be soluble in the fixed alkalies. We shall enumerate some of the resins which are best known, and which have not already been described in separate articles.

Rosin. This substance is extracted from different species of the fir, and the resinous matter obtained from it has received different names. That procured from the pinus sylvestris is the common turpentine; from the pinus larix, Venice turpentine; and from the pinus balsamea, balsam of Canada. The turpentine is obtained by stripping the bark off the trees; a liquid juice flows out, which gradually hardens. This juice consists of oil of turpentine and rosin. By distilling the turpentine the oil passes over, and the rosin remains behind. By distilling to dryness common rosin is obtained. When water is added, while it is yet fluid, and incorporated by agitation, what is called yellow rosin is formed.

Pitch is a resinous juice obtained from the pinus picea, pitch pine. It is purified by melting and squeezing it through linen bags, and it is then known by the name of white, or Burgundy pitch. White pitch mixed with lamp-black forms black pitch.

Sandarac. This resinous substance is extracted from the juniper. It is a spontaneous exudation from this plant in the form of brown tears, which are semitransparent and brittle. See Balsam, Copal, Guiacum, &c.

RESISTANCE, or Resisting *force*, in philosophy, denotes, in general, any power which acts in an opposite direction to another, so as to destroy or diminish its effect. Hence the force wherewith bodies, moving in fluid mediums, are impeded or retarded, is the resistance of those fluids. Authors have established it as a certain rule, that, whilst the same body moves in the same medium, it is always resisted in the duplicate proportion of its velocity; that is, if the resisted body move in one part of its track with three times the velocity with which it moved in some other part, then its resistance to the greater velocity will be nine times the resistance to the lesser: if the velocity in one place be four times the velocity in another, the resistance to the greater velocity will be sixteen times the resistance to the lesser, and so on. This rule, though very erroneous, when taken in a general sense, is yet undoubtedly very near the truth, when confined within certain limits.

In order to conceive the resistance of fluids to a body moving in them, Mr. Robins distinguishes between those fluids, which being compressed by some incumbent weight, perpetually close up the space deserted by the body in motion, without permitting, for an instant, any vacuity to remain behind it; and those fluids in which, they being not sufficiently compressed, the space left behind the moving body remains for some time empty. These differences in the resisting fluids will occasion very remarkable varieties in the laws of their resistance, and are absolutely necessary to be considered in the determination of the action of the air in shot and shells; for the air partakes of both these affections, according to the different velocities of the projected body. If a fluid were so constituted, that all the particles composing it were at some distance from each other, and there was no action between them, then the resistance of a body moving therein would be easily computed from the quantity of motion communicated to these particles: for instance, if a cylinder moved in such a fluid in the direction of its axis, it would communicate to the particles it met with a velocity equal to its own, and in its own direction, supposing that neither the cylinder nor the parts of the fluid were elastic; whence, if the velocity and diameter of the cylinder be known, and also the density of the fluid, there would thence be determined the quantity of motion communicated to the fluid, which (action and re-action being equal) is the same with the quantity lost by the cylinder; consequently the resistance would be hereby ascertained.

In this kind of discontinued fluid, the particles being detached from each other, every one of them can pursue its own motion in any direction, at least for some time, independently of the neighbouring ones; wherefore, if instead of a cylinder moving in the direction of its axis, a body, with a surface oblique to its direction, be supposed to move in such a fluid, the motion the parts of the fluid will hereby acquire, will not be in the direction of the resisted body, but perpendicular to its oblique surface; whence the resistance to such a body will not be estimated from the whole motion communicated to the particles of the fluid, but from that part of it only which is in the direction of the resisted body. In fluids then, where the parts are thus discontinued in each other, the different obliquities of that surface, which goes foremost, will occasion considerable changes in the resistance; although the section of the solid, by a plain perpendicular to its direction, should in all cases be the same. And Sir Isaac Newton has particularly determined, that in a fluid thus constituted the resistance of a globe is but half the resistance of a cylinder of the same diameter, moving in the direction of its axis with the same velocity.

But though the hypothesis of a fluid, thus constituted, be of great use in explaining the nature of resistances, yet in reality no such fluid does exist within our knowledge: all the fluids with which we are conversant are so formed, that their particles either lie contiguous to each other, or at least act on each other in the same manner as if they did; consequently, in these fluids, no one particle, contiguous to the resisted body, can be moved, without moving at the same time a great number of others, some of which will be distant from it; and the motion thus communicated to a mass of the fluid will not be in any one determined direction, but will in each particle be different, according to the different manners in which it lies in contact with those from which it receives its impulse; whence great numbers of the particles being diverted into oblique directions, the resistance of the moving body, which will depend on the quantity of motion communicated to the fluid in its own direction, will be hereby different in quantity from what it would be in the preceding supposition, and its estimation becomes much more complicated and operose. Sir Isaac Newton, however, has determined, that the resistance to a cylinder, moving in the direction of its axis in such a compressed fluid as we have here treated of, is but one-fourth part of the resistance, which the same cylinder would undergo if it moved with the same velocity in a fluid constituted in the manner we have described in our first hypothesis, each fluid being supposed to be of the same density. But again, it is not only in the quantity of their resistance that these fluids differ, but likewise in the different manner in which they act on solids of different forms moving in them.

We have shown, that in the discontinued fluid, which we first described, the obliquity of the foremost surface of the moving body would diminish the resistance; but in compressed fluids this holds not true, at least not in any considerable degree; for the principal resistance in compressed fluids arises from the greater or lesser facility with which the fluid, impelled by the forepart of the body, can circulate towards its hindermost part; and this being little, if at all, affected by the form of the moving body, whether it be cylindrical, conical, or spherical, it follows, that while the transverse section of the body, and consequently the quantity of impelling fluid, is the same, the change of figure in the body will scarcely affect the quantity of its resistance.

The resistance of bodies of different figures, moving in one and the same medium, has been considered by M. J. Bernoulli, and the rules he lays down on this subject are the following: 1. If an isosceles triangle be moved in the fluid according to the direction of a line which is normal to its base; first with the vertex foremost, and then with its base; the resistances will be as the legs, and as the square of the base, and as the sum of the legs. 2. The resistance of a square moved according to the direction of its side, and of its diagonal, is as the diagonal to the side. 3. The resistance of a circular segment (less than a semicircle) carried in a direction perpendicular to its basis, when it goes with the base foremost, and when with its vertex foremost (the same direction and celerity continuing, which is all along supposed) is as the square of the diameter to the same, less one-third of the square of the base of the segment. Hence the resistances of a semicircle, when its base, and when its vertex go foremost, are to one another in a sesquialterate ratio. 4. A parabola moving in the direction of its axis, with its basis, and then its vertex foremost, has its resistances, as the tangent to an arch of a circle, whose diameter is equal to the parameter, and the tangent equal to half the basis of the parabola. 5. The resistances of an hyperbola, or the semi-ellipsis, when the base and when the vertex go foremost, may be thus computed; let it be as the sum, or difference, of the transverse axis and latus rectum is to the transverse axis, so is the square of the latus rectum to the square of the diameter of a certain circle; in which circle apply a tangent equal to half the basis of the hyperbola or ellipsis. Then say again, as the sum, or difference, of the axis and parameter is to the parameter, so is the aforesaid tangent to another right line. And further, as the sum, or difference, of the axis and parameter is to the axis, so is the circular arch corresponding to the aforesaid tangent, to another arch. This done, the resistances will be as the tangent to the sum, or difference, of the right line thus found, and that arch last mentioned. 6. In general, the resistances of any figure whatsoever, going now with its base foremost, and then with its vertex, are as the figures of the basis to the sum of all the cubes of the element of the basis divided by the squares of the element of the curve line. All which rules, he thinks, may be of use in the fabric or construction of ships, and in perfecting the art of navigation universally. As also for determining the figures of the balls of pendulums for clocks.

As to the resistance of the air, Mr Robins, in his new principles of gunnery, took the following method to determine it: he charged a musket-barrel three times successively with a leaden ball $\frac{3}{4}$ of an inch diameter, and took such precaution in weighing of the powder, and placing it, as to be sure, by many previous trials, that the velocity of the ball could not differ by 20 feet in 1″ from its medium quantity. He then fired it against a pendulum, placed at 25, 75, and 125 feet distance, &c. from the mouth of the piece respectively. In the first case it impinged against the pendulum with a velocity of 1670 feet in 1″; in the second case, with a velocity of 1550 feet in 1″; and in the third case, with a velocity of 1425 feet in 1″; so that in passing through 50 feet of air, the bullet lost a velocity of about 120, or 125 feet in 1″; and the time of its passing through that space being about $\frac{1}{32}$ or $\frac{1}{30}$ of 1″, the medium quantity of resistance must, in these instances, have been about 120 times the weight of the ball; which, as the ball was nearly $\frac{1}{12}$ of a pound, amounts to about 10*lb.* avoirdupoise.

Now if a computation be made, according to the method laid down for compressed fluids in the thirty-eighth Propos. of Lib. 2. of Sir Isaac Newton's Principia, supposing the weight of water to be to the weight of air as 850 to 1, it will be found that the resistance of a globe of three quarters of an inch diameter, moving with a velocity of about 1600 feet in 1″, will not, on those principles, amount to any more than a force of $4\frac{1}{6}$*lb.* avoirdupoise; whence we may conclude (as the rules in that proposition for slow motions are very accurate) that the resisting power of the air in slow motions is less than in swift motions, in the ratio of $4\frac{1}{6}$ to 10, a proportion between that of 1 and 2, and 1 to 3.

Again, charging the same piece with equal quantities of powder, and balls of the same weight, and firing three times at the pendulum, placed at 25 feet distance from the mouth of the piece, the medium of the velocities with which the ball impinged was 1690 feet in 1″. Then removing the piece 175 feet from the pendulum, the velocity of the ball, at a medium of five shots, was 1300 feet in 1″. Whence the ball, in passing through 150 feet of air, lost a velocity of about 390 feet in 1″; and the resistance, computed from these numbers, comes out something more than in the preceding instance, amounting to between 11 and 12 pounds avoirdupoise: whence, according to these experiments, the resisting power of the air to swift motions is greater than in slow ones, in a ratio which approaches nearer to the ratio of 3 to 1, than in the preceding experiments.

Having thus ascertained the resistance to a velocity of near 1700 feet in 1″, he next proceeded to examine this resistance in smaller velocities: the pendulum being placed at 25 feet distance, was fired at five times, and the mean velocity with which the ball impinged was 1180 feet in 1″. Then removing the pendulum to the distance of 250 feet, the medium velocity of five shot at this distance, was 950 feet in 1″; whence the ball, in passing through 225 feet of air, lost a velocity of 230 feet in 1″, and as it passed through that interval in about $\frac{3}{14}$ of 1″, the resistance to the middle velocity will come out to be near $33\frac{1}{2}$ times the gravity of the ball, or 2*lb.* 10 *oz.* avoirdupoise. Now the resistance to the same velocity, according to the laws observed in slower motions, amounts to $\frac{7}{11}$ of the same quantity; whence in a velocity of 1065 feet in 1″, (the medium of 1180 and 950) the resisting power of the air is augmented in no greater proportion than of 11 to 7; whereas in greater degrees of velocity, as before, it amounted very near the ratio of 3 to 1.

That this resisting power of the air to swift motions is very sensibly increased beyond what Sir Isaac's theory for slow motions makes it, seems hence to be evident. It being, as has been said, in musket, or cannon-shot, with their full charge of powder, nearly three times the quantity assigned by that theory.

The resistance of a bullet of three quarters of an inch diameter, moving in air with a velocity of 1670 feet in 1″, amounting, as we said, to *10lb.* the resistance of a cannon ball of *24lb.* fired with its full charge of powder, and thereby moving with a velocity of 1650 feet in 1″, may hence be determined. For the velocity of the cannon ball being nearly the same as the musket-bullet, and its surface above 54 times greater, it follows, that the resistance on the cannon ball will amount to more than *540lb.* which is nearer 23 times its own weight. And from hence it appears how rash and erroneous the opinion of those is, who neglect the consideration of the resistance of the air as of no importance in the doctrine of projectiles. See Robins's Tracts; Hutton's Dictionary, article Resistance.

RESOLUTION, or Solution, in mathematics, is an orderly enumeration of several things to be done, to obtain what is required in a problem.

Resolution, in algebra, or *algebraical resolution*, is of two kinds; the one practised in numerical problems, the other in geometrical ones.

In resolving a numerical problem algebraically, the method is this: First, the given quantities are distinguished from those that are sought; and the former denoted by the initial letters of the alphabet, but the latter by the last letters. 2. Then as many equations are formed as there are unknown quantities. If that cannot be done from the proposition or data, the problem is indeterminate: and certain arbitrary assumptions must be made to supply the defect, and which can satisfy the question. When the equations are not contained in the problem itself, they are to be found by particular theorems concerning equations, ratios, proportions, &c. Since, in an equation, the known and unknown quantities are mixed together, they must be separated in such a manner that the unknown remain alone on one side, and the known ones on the other. This reduction, or separation, is made by addition, subtraction, multiplication, division, extraction of roots, and raising of powers; resolving every kind of combination of the quantities by their counter or reverse ones, and performing the same operation on all the quantities, or terms on both sides of the equation, that the equality may still be preserved.

To resolve a geometrical problem algebraically. The same sort of operations are to be performed as in the former article: besides several others, that depend upon the nature of the diagram, and geometrical properties. As, 1. The thing required or proposed, must be supposed done, the diagram being drawn or constructed in all its parts, both known and unknown. 2. We must then examine the geometrical relations which the lines of the figure have among themselves, without regarding whether they are known or unknown, to find what equations arise from those relations for finding the unknown quantities. 3. It is often necessary to form similar triangles and rectangles, sometimes by producing of lines, or drawing parallels and perpendiculars, and forming equal angles, &c.; till equations can be formed from them, including both the known and unknown quantities.

Resolution, in chemistry, &c. the reduction of a mixed body into its component parts, or first principles, by a proper analysis. The resolution of bodies is effected by divers operations, as distillation, sublimation, fermentation, precipitation, &c. See Distillation, Sublimation, &c.

Some logicians use the term resolution for what is more usually called analysis, or the analytic method.

Resolution *of forces*, or *of motion*, is the resolving or dividing of any one force or motion into several others, in other directions, but which, taken together, shall have the same effect as the single one; and it is the reverse of the composition of forces or motions.

RESPIRATION, in animal economy. The absolute necessity of respiration, or of something analogous, is known to every one; and few are ignorant that in man, and hot blooded animals, the organ by which respiration is performed is the lungs. Now respiration consists in drawing a certain quantity of air into the lungs, and throwing it out again alternately.

Whenever this function is suspended, even for a very short time, the animal dies. The fluid respired by animals is common atmospherical air; and it has been ascertained by experiment, that no other gaseous body with which we are acquainted can be substituted for it. All the known gases have been tried; but they all prove fatal to the animal which is made to breathe them. Gaseous bodies, as far as respiration is concerned, may be divided into two classes:—1. Unrespirable gases. 2. Respirable gases. The gases belonging to the first class are of such a nature, that they cannot be drawn into the lungs of an animal at all; the epiglottis closing spasmodically whenever they are applied to it. To this class belong carbonic acid, and probably all the other acid gases, as has been ascertained by the experiments of Pilatre de Rozier, who went into a brewer's tub while full of carbonic acid gas evolved by fermentation. A gentle heat manifested itself in all parts of his body, and occasioned a sensible perspiration. A slight itching sensation constrained him frequently to shut his eyes. When he attempted to breathe, a violent feeling of suffocation prevented him. He sought for the steps to get out; but not finding them readily, the necessity of breathing increased, he became giddy, and felt a tingling sensation in his ears. As soon as his mouth reached the air, he breathed freely; but for some time he could not distinguish objects; his face was purple, his limbs weak, and he understood with difficulty what was said to him. But these symptoms soon left him. He repeated the experiment often; and always found, that as long as he continued without breathing, he could speak and move about without inconvenience; but whenever he attempted to breathe, the feeling of suffocation came on. For the lungs of animals suffocated by it were found by Pilatre not to give a green colour to vegetable blues. The gases belonging to the second class may be drawn into the lungs, and thrown out again without any opposition from the respiratory organs: of course the animal is capable of respiring them. They may be divided into four subordinate classes:—1. The first set of gases occasion death immediately, but produce no visible change in the blood. They occasion the animal's death merely by depriving him of air, in the same way as he would be suffocated by being kept under water. The only gases which belong to this class are hydrogen and azotic. 2. The second set of gases occasion death immediately; but at the same time they produce certain changes in the blood, and therefore kill, not merely by depriving the animal of air, but by certain specific properties. The gases belonging to this class are carburetted hydrogen, sulphuretted hydrogen, carbonic oxide, and perhaps also nitrous gas. 3. The third set of gases may be breathed for some time without destroying the animal; but death ensues at last, provided their action be long enough continued. To this class belong the nitrous oxide and oxygen gas. 4. The fourth set may be breathed any length of time without injuring the animal. Air is the only gaseous body belonging to this class. See PHYSIOLOGY, and Thomson's Chemistry.

RESPONDEAS *ouster*, is to answer over in an action to the merits of the cause. As if a demurrer is joined upon a plea to the jurisdiction, person, or writ, and it be adjudged against the defendant, it is a *respondeas ouster*.

REST, the continuance of a body in the same place, or its continual application or contiguity to the same parts of the ambient or contiguous bodies; and therefore is opposed to motion. Sir Isaac Newton defines true or absolute rest to be the continuance of a body in the same part of absolute space; and relative rest to be the continuance of a body in the same part of relative space. Thus, in a ship under sail, relative rest is the continuance of a body in the same part of the ship; but absolute, is its continuance in the same part of universal space in which the ship itself is contained. It is one of the laws of nature, that matter is indifferent to motion or rest, as has been shown under the article INERTIA.

REST, in poetry, is a short pause of the voice in reading, being the same with the cæsura, which, in Alexandrian verses, falls on the sixth syllable; but in verses of ten or eleven syllables, on the fourth.

RESTIO, in botany, a genus of the Dioecia Triandria class and order. Natural order of Calamariæ. Essential character: calyx three-leaved, two of the leaflets boat-shaped; corolla three-leaved, leaflets lanceolate, one wider: female, germ three-sided; style one, seldom two or three; stigmas one, two, three, feathered. There are twenty-eight species. These plants are all natives of the Cape of Good Hope, where some of them are used for making ropes, for brooms, or for thatching.

RESULTING *use*, in law, is when an use limited by a deed expires, or cannot vest, it returns back to him who raised it. See USES.

RETAINER *of debts*, an executor, among debts of equal degree, may pay himself first, by retaining in his hands the amount of his debt.

RETARDATION, in physics, the act of diminishing the velocity of a moving body. If bodies of equal bulk, but of different densities, be moved through the same resisting medium, with equal velocity, the medium will act equally on each, so that they will have equal resistances, but their motions wil be unequally retarded, in proportion to their densities. Retarded motion from gravity is peculiar to bodies projected upwards, and this in the same manner as a failing body is accelerated; only in the latter, the force of gravity acts in the same direction with the motion of the body: and in the former in an opposite direction. As it is the same force which augments the motion in the falling, and diminishes it in the rising body, a body will rise till it has lost all its motion; which it does in the same time wherein a body falling would have acquired a velocity equal to that wherewith the body was projected upwards.

RETE *mucosum*, in animal economy, is the mucous substance, situated between the cutis vera and epidermis, its composition cannot be determined with precision, because its quantity is too small to admit of examination. It is known that the black colour of negroes depends upon a black pigment, situated in this substance. Oxymuriatic acid deprives it of its black colour, and renders it yellow. A negro, by keeping his foot for some time in water impregnated with that acid, deprived it of its colour, and rendered it nearly white; but in a few days the black colour returned again with its former intensity. This experiment was first made by Dr. Beddoes, on the fingers of a negro.

RETENTION. Whatever be the effect produced in the mental organs by the impressions on the organs of sense, that effect can be renewed, though in general with diminished vigour, without a repetition of the sensible impressions. In other words, sensible changes produce a tendency to similar changes, which can be repeated without the repetition of the external impressions, and may then be called ideal changes. Less generally sensations leave relicts behind them, which can be perceived without the agency of the external organs of sensation, and which are called ideas. The power or capacity of the mind, by which tendencies to ideal changes are retained, may be called the retentive power.

That tendencies to a repetition of sensorial changes are thus formed, that ideas are thus retained, may be referred to the operation of the associative power, and in the human being they certainly depend upon the same organic causes, whatever those be. But in many animals it is decidedly probable that sensations leave no relicts behind them; and in man there are, equally probably, numerous impressions from external objects, which leave no relicts behind them. Again, these relicts of sensations can re-appear without the agency of external objects. Hence it appears preferable to consider the receiving of sensations, and the retaining of ideas, as two separate, though intimately connected operations, and as implying two separate powers or capacities of the mind. This is not done by Hartley, who appears to refer both to sensation; but it has subjected him to some apparently just, though in reality unfounded animadversions of the great northern philosopher, Dugald Stewart. Speaking of the phenomena of memory as not to be entirely explained by the law of association, he says, (p. 412.) "The association of ideas connects our various thoughts with each other so as to present them to the mind in a certain order, but it presupposes a faculty of retaining the knowledge we acquire." This Hartley knew, and has accordingly a distinct section on the generation of ideas.

Without the retentive power it is obvious that man would be a being of mere sensation, little, if any, superior to the lowest orders of the animal creation, and inferior to many of them. The retentive power provides materials for the agency of the associative power. Without the retentive power the associative power would never be called into exercise, and without the associative power, the relicts of sensation, the effects of the retentive power would be of no utility. The operations of the retentive power can scarcely be separated from those of the associative power, which together constitute the compound faculty called memory, for an account of which see PHILOSOPHY, *mental*, § 105.

We have said that the receiving of sensations, and the retaining the relicts of them, seem to depend upon the same organic causes, whatever they be. In some instances sensible changes perceptibly continue after the sensible objects are removed. Two or three facts, which every one must have noticed, or may notice, will illustrate this principle. If a piece of stick be burnt at one end, and the lighted end be turned quickly round in a circle, the luminous point will appear to the eye as a complete luminous circle; the changes of the optic organs continuing till the image of the luminous point returns to any given point of the retina. Again, the sensible changes produced by sound, perceptibly continue after the external cause ceases. If a sounding body be struck very rapidly with a stick, we do not perceive any interval, and as Hartley observes, the most simple sounds which we hear, being reflected from the neighbouring bodies, consist of a number of sounds succeeding each other at different distances of time, according to the distances of the reflecting bodies. The sensible changes produced by the other senses, also continue some time after the impressions which have been made upon them. If a hard body be pressed upon the palm of the hand, it is not easy to distinguish, for a few seconds, whether it remains or is removed. And tastes continue to be perceived long after the sapid material is withdrawn.

This play of the organs, (which however is rather to be referred to the external than to the mental organs), gives rise, in the case of vision, to a number of very singular and interesting phenomena, by some philosophers called *ocular spectra*. A considerable variety of them are stated by Dr. R. Darwin, of Shrewsbury, at the end of the second part of Darwin's Zoonomia. We shall select a few of the most striking.

Place about half an inch square of white paper on a black hat, and looking steadily on the centre of it for a minute, remove your eyes to a sheet of white paper; after a second or two a dark square will be seen on the white paper, which will be seen for some time. A similar dark square will be seen in the closed eye, if light be admitted through the eyelids. So, after looking at any luminous body of a small size, as at the Sun, for a short time, so as not much to fatigue the eyes, this part of the retina becomes less sensible to smaller quantities of light: hence, when the eyes are turned upon other less luminous parts of the sky, a dark spot is seen, resembling the shape of the luminous body. To the same cause Dr. R. Darwin ascribes those dark coloured floating spots, which are easily perceptible when the eyes are a little weakened by fatigue, and during illnesses which are attended with great debility. He says, that as these spectra are most easily discernible when our eyes are weakened by fatigue, it has frequently happened that people of delicate constitutions have been much alarmed at them, fearing a beginning decay of their sight, and thence have fallen into the hands of ignorant oculists. They are not, however, he observes, the preludes to any disease, and it is only from our habitual inattention to them that we do not see them on all objects every hour of our lives. As the nerves of very weak people, he continues, lose their sensibility by a small duration of exertion, it frequently happens that sick people, in the extreme debility of fevers, are perpetually employed in picking something off from the bed clothes, owing to their mistaking the cause of these dark spots. An Italian artist, a man of strong abilities, relates, that having passed the whole night on a distant mountain, with some companions and a conjuror, and performed many ceremonies to raise the devil, on their return in the morning to Rome, looking up when the sun began to rise, they saw numerous devils run on the tops of the houses as they passed along. So much were the spectra of their weakened eyes magnified by fear, and made subservient to the purposes of fraud or superstition.

Again, make with ink, on white paper, a very black spot about half an inch in diameter, with a tail about an inch in length, so as to represent a tadpole. Look steadily at this spot for about a minute, and on moving the eye a little, the figure of the tadpole will be seen on the white part of the paper, which figure will appear whiter or more luminous than the other part of the paper. This Dr. R Darwin brings as one proof, that when the retina has been subjected to a less excitement, it is more easily brought into action by being subjected to a greater. A surface appears black in consequence of its absorbing all the rays of light; that part of the retina, therefore, which is unemployed while looking at the spot, is afterwards more sensible of the light from the white paper, than those parts which had previously been exposed to it. On closing the eyes after viewing the black spot on the white paper, a red spot is seen of the form of the black spot; for that part of the retina on which the figure of the black spot was formed, being more sensible to the light than the other parts, is capable of being brought into action by the red rays which penetrate the eye-lids. Upon the same principle Dr. R. Darwin accounts for the following fact. A writer in the Berlin Memoirs observes, that when he held a book, so that the sun shone upon his half closed eye-lids, the black letters which he had long inspected, became red. There is a similar story told by Voltaire of a Duke of Tuscany, who was playing at dice with a general of a foreign army, and believing that he saw red spots on the dice, portended dreadful events, and retired in confusion. The observer, after looking for a minute on the black spots of a die, in a bright day, and carelessly closing his eyes, would see red spots corresponding to the black spots on the die, and if they were intense, from the fatigue or weakness of the optic organ, those appearances would continue, and on looking at the die, would be supposed to be upon it, just as before stated; persons in a very weak state often see black spots which they refer to the bed clothes.

RETICULA, or Reticule, in astronomy, a contrivance for the exact measuring the quantity of eclipses. The reticule is a little frame, consisting of thirteen fine silken threads, equidistant from each other, and parallel, placed in the focus of object-glasses of telescopes; that is, in the place where the image of the luminary is painted in its full extent; of consequence, therefore, the diameter of the sun or moon is hereby seen divided into twelve equal parts or digits; so that to find the quantity of the eclipse, there is nothing to do but to number the luminous and the dark parts. As a square reticule is only proper for the diameter, not for the circumference, of the luminary, it is sometimes made circular by drawing six concentric equi-distant circles. This represents the phases of the eclipse perfectly.

RETINA, in anatomy, the expansion of the optic nerve on the internal surface of the eye, whereupon the images of objects being painted, are impressed, and by that means conveyed to the common sensory in the brain, where the mind views and contemplates their ideas. See Optics.

RETORNO *habendo*, in law. See Replevin.

RETORT. See Laboratory.

RETRAXIT, in law, is where the plaintiff or demandant comes in person into the court, and says he will proceed no further; and this is a bar of all other actions of like or inferior nature.

RETRENCHMENT, in the art of war, any kind of work raised to cover a post, and fortify it against the enemy, such as fascines loaded with earth, gabions, barrels of earth, sand-bags, and generally all things that can cover the men and stop the enemy. But retrenchment is more particularly applicable to a foss bordered with a parapet; and a post fortified thus is called post retrenched, or strong post. Retrenchments are either general or particular: general retrenchments are new fortifications made in a place besieged, to cover the besiegers when the enemy become masters of a lodgment on the fortification, that they may be in a condition of disputing the ground inch by inch, and of putting a stop to the enemy's progress, in expectation of relief. Particular retrenchments are such as are made in the bastions, when the enemy are masters of the breach. These can never be made but in new full bastions, for in empty, or hollow ones, there can only be made retirades. The particular retrenchments are made several ways, according to the time they have to cover themselves: sometimes they are made before-hand, which are certainly the best. The parapets of such retrenchments ought to be five or six feet thick, and five feet high, with a large and deep foss, from whence ought to run out small fougades and countermines.

RETROGRADATION, in astronomy, is an apparent motion of the planets, by which they seem to go backwards in the ecliptic, and to move contrary to the order of the signs, as from Aries to Taurus; from Taurus to Gemini, &c. which, from west to east, is said to be direct. When it appears for some days in the same place or point in the heavens, it is said to be stationary; and when it goes in antecendentia, or backwards, or contrary to the order of the signs, which is from east to west, it is said to be retrograde. Saturn continues retrograde about 140 days; Jupiter 120; Mars 73; Venus 42; and Mercury 22. The interval between two retrogradations of the several planets are as follow:

In Saturn	it is about 378 days;	
Jupiter	. . . . . . 408 ——	
Mars	. . . . 780 ——	
Venus	. . . . 585 ——	
Mercury	. . . . . . 115 ——	

RETROMINGENTS, in natural history, a class or division of animals, whose characteristic it is that they stale, or make water, backwards, both male and female.

RETURN, is most commonly used for the return of writs, which is the certificate of the Sheriff, made to the court of what he has done, touching the execution of any writ directed to him; and where a writ is executed, or the defendant cannot be found, or the like, this fact is indorsed on the writ by the officer, and delivered into the court whence the writ issued, at the day of the return thereof, in order to be filed.

RETURNING *stroke*, in electricity, is an expression used by Lord Mahon, (now Earl Stanhope), to denote the effect produced by the return of the electric fluid into a body, from which, under certain circumstances, it has been expelled.

To understand properly the meaning of these terms, it must be premised, that according to the author's experiments, an insulated smooth body, immerged within the electrical atmosphere, but beyond the striking distance of another body, charged positively, is at the same time in a state of threefold electricity. The end next to the charged body acquires negative electricity; the further end is positively electrified; while a certain part of the body, somewhere between its two extremes, is in a natural, unelectrified, or neutral state; so that the two contrary electricities balance each other. It may further be added, that if the body be not insulated, but have a communication with the earth, the whole of it will be in a negative state. Suppose, then, a brass ball, which may be called A, to be constantly placed at the striking distance of a prime conductor, so that the conductor, the instant when it becomes fully charged, explodes into it. Let another large or second conductor be suspended in a perfectly insulated state, further from the prime conductor than the striking distance, but within its electrical atmosphere: let a person, standing on an insulated stool, touch this second conductor very lightly with a finger of his right hand; while with a finger of his left hand he communicates with the earth, by touching very lightly a second brass ball, fixed at the top of a metallic stand, on the floor, which may be called B. Now, while the prime conductor is receiving its electricity, sparks pass (at least if the distance between the two conductors is not too great) from the second conductor to the right hand of the insulated person; while similar and simultaneous sparks pass out from the finger of his left hand into the second metallic ball, B, communicating with the earth. At length, however, the prime conductor, having acquired its full charge, suddenly strikes into the ball, A, of the first metallic stand, placed for that purpose at the striking distance. The explosion being made, and the prime conductor suddenly robbed of its elastic atmosphere, its pressure or action on the second conductor, and on the insulated person, as suddenly ceases, and the latter instantly feels a smart returning stroke, though he has no direct or visible communication (except by the floor) with either of the two bodies, and is placed at the distance of five or six feet from both of them. This returning stroke is evidently occasioned by the sudden re-entrance of the electric fire, naturally belonging to his body and to the second conductor, which had before been expelled from them by the action of the charged prime conductor upon them; and which returns to its former place in the instant when that action or elastic pressure ceases. When the second conductor and the insulated person are placed in the densest part of the electrical atmosphere of the prime conductor, or just beyond the striking distance, the effects are still more considerable; the returning stroke being extremely severe and pungent, and appearing considerably sharper than even the main stroke itself received directly from the prime conductor. Lord Mahon observes, that persons and animals may be destroyed, and particular parts of buildings may be much damaged, by an electrical returning stroke, occasioned even by some very distant explosion from a thunder cloud; possibly at the distance of a mile or more. It is certainly not difficult to conceive, that a charged extensive thunder cloud must be productive of effects similar to those produced by the prime conductor; but perhaps the effects are not so great, nor the danger so terrible, as it seems to have been apprehended. If the quantity of electric fluid naturally contained, for example, in the body of a man, were immense or indefinite, then the estimate between the effects producible by a cloud, and those caused by a prime conductor, might be admitted; but surely no electrical cloud can expel from a body more than the natural quantity of electricity which this contains. On the sudden removal, therefore, of the pressure by which this natural quantity had been expelled, in consequence of the explosion of the cloud into the earth, no more (at the utmost) than his whole natural stock of electricity can re-enter his body, provided it be so situated, that the returning fire of other bodies must necessarily pass through his body. But perhaps we have no reason to suppose that this quantity is so great, as that its sudden re-entrance into his body should destroy or injure him. See "Mahon's Electricity."

RETZIA, in botany, so named in honour of Anders Jahan Retzius, Professor of Natural History; a genus of the Pentandria Monogynia class and order. Natural order of Campanaceæ. Convolvuli, Jussieu. Essential character: corolla cylindrical, villose on the outside; stigma bifid; capsule two-celled, many-seeded. There is but one species, *viz.* R. spicata; it is found on the highest mountains, near the Cape of Good Hope.

REVENUE, *public*, the portion of the general income of a state, which is appropriated to the payment of national expenses. Different nations have adopted different modes of raising a public revenue, but the rent derived from land, being obviously a fund of a more permanent nature than most others, has usually been one of the earliest resources, and has sometimes been the principal source of public revenue, particularly in ancient times. From the produce or rent of the public lands, the republics of Greece and Italy derived, for a long time, the greater part of the revenue which defrayed the necessary expenses of the commonwealth; and the rent of the crown-lands constituted the greater part of the revenue of the ancient sovereigns of Europe. The introduction of a different mode of warfare, and the greater duration of modern wars, increased considerably the public expenditure, and rendered it necessary to raise a much greater revenue. In the ancient republics of Greece and Italy, every citizen was a soldier, who both prepared himself for service, and served at his own expense; and in the ancient monarchies of Europe, the people, when they served in the field, were, by the condition of their feudal tenures, to be maintained, either at their own expense, or at that of their immediate lords, without bringing any new charge upon the sovereign. The other necessary expenses of government were very moderate. The administration of justice, instead of being a cause of expense, was a source of revenue. The labour of the country people, for three days before and after harvest, was thought a sufficient provision for maintaining all the bridges, highways, and other public works, which the commerce of the country was supposed to require. In those days, the principal expense of the sovereign seems to have consisted in the maintenance of his own family and household. The officers of his household, accordingly, were then the great officers of state. The Lord Treasurer received his rents; the Lord Steward and Lord Chamberlain looked after the expense of his family; the care of his stables was committed to the Lord Constable and the Lord Marshal; his houses were all built in the form of castles, and the keepers of those houses or castles might be considered as a sort of military governors, who seem to have been the only military officers it was necessary to maintain in time of peace. In these circumstances, the rent of a considerable landed estate might, upon ordinary occasions, very well defray all the usual expenses of government, and whenever extraordinary circumstances caused a greater expense, the sum necessary to make it good was drawn from the people by some arbitrary and often very unequal imposition.

The ordinary revenue of the early kings of England, consisted of the following branches:

1. Rents and profits of the crown lands. This must have been considerable, as it appears from Domesday-book, that there were appropriated to the use of the crown 1422 manors, besides other lands and quitrents. This ancient branch of the King's revenue has, however, of late years become of very small amount, as the lands originally reserved by the crown, or which came to it afterwards by forfeiture, have been almost entirely granted away.

2. Profits from military tenures. As a great part of the lands in England were subject to knight-service, the profits incident to this tenure were very great, besides the extraordinary contributions to which they were liable, for making the King's eldest son a knight, and for marrying his eldest daughter.

3. The custody of the lay-revenues, lands, and tenements of bishoprics, during their vacancy; and, before the dissolution of abbeys, the custody of the temporalities of such as were of royal foundation. Many of the kings were induced to keep the sees a long time vacant, in order to enjoy their temporalities.

4. First-fruits and tenths of all spiritual preferments. The former was the whole of the first year's produce of the preferment, according to a valuation made in 38 Henry III. and afterwards increased in 20 Edward II. The tenths were the tenth part of the whole annual profit of each living, by the same valuation. These revenues were paid to the Pope, till annexed to the crown by 26 Henry VIII. c. 3. when a new valuation was made, by which the clergy are at present rated, and which forms what is commonly called the King's Books. These revenues are now vested in trustees for ever, as a fund for the augmentation of poor livings, and form what is usually called Queen Anne's Bounty.

5. Purveyance and pre-emption, or a right of buying up provisions and other necessaries, for the use of the royal household, at an appraised valuation, in preference to all other persons, and even without the consent of the owner; also of forcibly impressing carriages and horses for the King's use, at a settled price. The purveyors greatly abused their authority, and were of little advantage to the crown; Charles II. therefore, at his restoration, agreed to resign this prerogative, with the military tenures; and the Parliament, in lieu thereof, settled on him and his successors for ever, a tax on beer and ale, afterwards commonly called the hereditary excise.

6. Fines and forfeitures of various descriptions; also fees to the crown, in a variety of legal matters.

7. The right to all shipwrecks; to treasure-trove; to royal fish, that is, whales and sturgeons, when thrown ashore, or caught near the coast; to all mines of silver or gold; to waifs, or goods stolen and thrown away by the thief in his flight; and estrays, or animals found wandering, and the owner unknown; and to deodands, and forfeitures of lands and goods for offences. These rights, producing little profit, have since been mostly granted away to the lords of manors and other liberties.

8. Escheats of lands, upon the defect of heirs to succeed to the inheritance, in which case they reverted to the King.

9. The custody of idiots and lunatics, the profits of whose lands were received by the King, an allowance being made to them for necessaries.

From these sources, the produce of the remaining branches of which is now very insignificant, the Kings of England derived the whole of their ordinary revenue, till commerce raised the produce of the customs into importance, and the Parliament ventured to grant the principal part of their produce to the King, for life. Upon extraordinary occasions, Henry II. and some of his successors, had recourse chiefly to scutages, which were a composition by those who held knight's fees, in lieu of the military service to which they were bound, and seem to have been at first mere arbitrary compositions, as the King and the persons liable could agree: hydage, and talliage, were taxes of the same nature, upon other lands, and upon cities and boroughs. Tenths and fifteenths were originally the real tenth or fifteenth of all the moveables belonging to the subject; the amount was uncertain, being levied by new assessments on every fresh grant, till the 8 Edward III. when a new assessment was made and recorded in the Exchequer, which was the real value at that period of every city, borough, and town in the kingdom, and by this the fifteenths were afterwards levied, according to the specific sums therein stated, which were usually raised in the different places by a common rate on all the inhabitants. Subsidies were a grant introduced about the time of Richard II. and Henry IV.; they were a tax not immediately imposed upon property, but upon persons in respect to their reputed estates, after the nominal rate of four shillings in the pound for lands, and two shillings and eight pence for goods; aliens paid in a double proportion. This assessment was made according to an ancient valuation, which was so low, that one subsidy, according to Sir Edward Coke, did not amount to more than *70,000l.* It was the rule never to grant more than one subsidy and two-fifteenths at a time; but this rule was broken through on the Spanish invasion in 1588, when the Parliament gave two subsidies and four fifteenths. This mode of taxation fell into disuse during the civil wars in the reign of Charles I. when the Parliament introduced weekly and monthly assessments, at a fixed sum upon each county, which was levied by a pound rate, both upon lands and personal estates. The commonwealth afterward introduced excise duties, and derived some profit from the establishment of the post-office, both of which have been since improved into very productive sources of revenue.

At the period of the revolution, most of the ancient branches of the King's revenue had either been formally relinquished, or had greatly declined in their produce, and the parliamentary grants had for some years past consisted almost entirely of custom and excise duties, with occasional poll-taxes and hearth-money. The total amount of the several branches of which the public revenue then consisted, will appear by the following statement, which was formed upon the average produce of four years.

Amount of the Public Revenue in 1688.

	L.	s.	d.
Subsidy of tonnage and poundage	577,507	12	10½
Hereditary and temporary excise	610,486	10	9
Hearth-money, about	200,000	0	0
Post Office, about	55,000	0	0
Duties on wines and vinegar	172,900	11	8½
Duties on tobacco and sugar	148,861	8	0
Duties on French linens, brandies, &c.	93,710	8	1
Wine licences, seizures, &c.	56,969	4	4
Total L	1,915,435	15	9

This was the whole of the public revenue, except the small duties of ten shillings per ton on wine, &c. first granted in 1666, and appropriated for defraying the expenses of coinage; and a duty of eighteen pence per chaldron on coals, appropriated for completing St. Paul's Church. This revenue, small as it now appears, must have been at least fully adequate to all the national expenses, if an account laid before the Parliament is to be depended upon, according to which the annual expenditure of James II. amounted, at a medium, to only 1,609,365*l.* 2*s.* 9*d.*

The heavy expenses incurred during the reign of William III. and the introduction of the funding system, caused a variety of new taxes to be imposed, and considerable additions to be made to those which previously existed. The hearth-tax was abolished, and the land-tax was levied by a new assessment, which has continued ever since. The malt-tax, the tax on hawkers and pedlars, on hackney-coaches, with many other new taxes, were introduced, which, with the augmentation of the customs and excise, raised the total amount of the public revenue, at the death of King William, to about double its amount at his accession. During the succeeding reigns, an almost infinite number of taxes have been imposed, in order to render the revenue adequate to the payment of the interest on the great accumulation of public debt, and to support a constantly increasing expenditure. The produce of different duties formerly constituted separate funds, appropriated to specific purposes; thus the several taxes which were rendered perpetual by 3 George I. c. 7, formed a fund called the general fund, distinct from the aggregate fund, and South Sea fund, before established; but, of late years, the whole produce of all the branches of the public revenue has been brought into one fund, called the consolidated fund.

The various duties constituting the total public revenue of Great Britain, are arranged under the following heads:

1. The Customs, which consist of duties on goods imported, on goods exported, on goods carried coastways, and a tonnage duty. The total gross produce of this branch of the revenue, in the year ending 5th January, 1808, was 12,638,985*l.* 0*s.* 5½*d.* which being subject to various deductions for drawbacks, bounties, charges of management, &c. rendered the net produce applicable to national purposes, 10,193,172*l.* 19*s.* 5¼*d.*

2. The Excise, which consists principally of duties on malt, and malt-liquors of every kind, including the distillery; many other articles are, however, likewise included, as candles, leather, soap, starch, tea, coffee, wine, tobacco, salt, glass, printed goods, and bricks and tiles. The total gross amount of this productive source of revenue, in the year ending 5th January, 1808, was 25,941,630*l.* 13*s.* 8¾*d.* which was reduced, by allow-

ances, drawbacks, and charges of management, to 24,169,716*l.* 13*s.* 0½*d.*

3. Stamp Duties, laid on deeds and documents of almost every description. This mode of taxation was introduced into England in the year 1671, and revived in 1694, when a particular set of commissioners were first appointed for managing these duties; the produce was at first of small amount, but new duties being imposed, to which numerous additions have been since made, it has gradually increased, and in the year ending 5th January, 1808, the gross amount was 4,543,971*l.* 17*s.* 5½*d.* This amount is subject to various deductions, as, the charges of management, discounts, and other parliamentary allowances, the cost of parchment and paper for the country distributors, an allowance to the two universities on almanacks, and other incidental expenses, which reduced the net produce to 4,458,738*l.* 14*s.* 0¾*d.*

4. Land and Assessed Taxes. The land tax for many years differed from all other branches of the public revenue (except the old malt duty) in being granted annually; it was, however, regularly continued from year to year, never being wholly taken off, but it varied with respect to the rate at which it was imposed, having been usually reduced during peace, and increased again in time of war, to answer in part the increased expenditure. From 1776 to 1798, it was regularly continued at 4*s.* in the pound, at which rate it was supposed to produce 1,989,673*l.* 7*s.* 10¼*d.* for England, and 47,954*l.* 1*s.* 2*d.* for Scotland, making in the whole 2,037,627*l.* 9*s.* 0¼*d.*; there was, however, a constant deficiency, to the amount, at an average, of about 235,000*l.* per annum, varying according to the regularity with which the tax was collected, and the amount of the different charges to which it was liable. In 1799 a scheme was adopted for the redemption of the land tax, for which purpose an act was passed, making the tax perpetual; it was then offered for sale to the proprietors of the lands upon which it was charged, or, if they declined it, to any other person who chose to become a purchaser. The consideration to be given in either case was not to be in money, but in three per cent. stock; the object of the scheme being to absorb a large quantity of floating stock, and thus facilitate the raising of new loans. It was estimated that this measure would transfer about eighty millions of stock to government, but the terms offered were by no means such as to induce a general approval of it, and the total amount of stock transferred for land-tax, redeemed on the first of February, 1808, was only 22,976,829*l.* 10*s.* 4*d.*, of course a very considerable portion of the tax still remained unredeemed. The assessed taxes consist of the duties on houses, windows, servants, carriages, horses, and horse-dealers, dogs, hair powder, and armorial bearings. The gross produce of the land and assessed taxes, in the year ending January 5th, 1808, was 6,909,190*l.* 12*s.* 9¾*d.*; and as the balances in hand at the beginning of the year exceeded the charges of management and other payments, the total net amount, applicable to national purposes, was 7,073,530*l.* 10*s.* 8⅓*d.*

5. The Post Office. King James I. originally erected a post office for the conveyance of letters to foreign parts, previously to which an establishment of this kind had existed for the conveyance of inland letters. Some improvements were made in the management of it during the time of the commonwealth, and soon after the restoration a new general post office was established, the revenue derived from which was at first of small amount, but has since gradually increased, both from the increase of commercial intercourse, and the additional rates of postage which have since been imposed. In 1715, the gross produce of the inland office was 145,227*l.*; in the year 1744, it amounted to 198,226*l.*; and the gross amount of both the inland and foreign offices, to 235,492*l.* In 1764, it amounted to 281,535*l.*; at which time an act was passed for preventing abuses of the privilege of franking, which, with a further restriction at a subsequent period, has considerably improved this source of revenue. The total gross produce for the year, ending January 5th, 1808, was 1,493,490*l.* 11*s.* 9*d.*, and the net produce 1,277,538*l.* 11*s.* 4½*d.*

6. Sixpence in the pound on pensions and salaries. This deduction originated from a debt of the civil list in the reign of George I. To satisfy this debt an act was passed for raising half a million at five per cent. interest, to be charged upon a deduction of sixpence in the pound on all salaries, fees, and wages, payable in respect of offices of profit granted or derived from the crown. About three years after it was found necessary to raise half a million more, for the same purpose, and the former sum,

bearing five per cent. interest, was then paid off, the whole sum of 1,000,000*l.* being raised by way of lottery, at an interest of three per cent. per annum. This debt is now charged on the consolidated fund, and consequently the duty established for the payment of its interest forms part of the income of the fund. The gross produce for the year ending the 5th of January, 1808, was 72,207*l.* 12*s.* 2¼*d.*, and the net produce 71,353*l.* 0*s.* 5¼*d.*

7. One shilling in the pound on pensions and salaries. This is a duty of a similar nature with the foregoing, and was first imposed by 31 George II. c. 22. It extends to all salaries, fees, and perquisites, pensions, or gratuities, payable out of any revenue belonging to his Majesty in Great Britain, exceeding the value of 100*l.* a year. Its gross amount in the year ending the fifth of January, 1808, was 61,057*l.* 2*s.* 1*d.* and including a balance in hand at the beginning of the year, the net amount was 62,685*l.* 5*s.* 8*d.*

8. Hackney coaches. In 1694, the license of hackney coaches first became a branch of the public revenue. It has increased, both from the number licensed being greater than formerly, and from the duty imposed upon them having been raised very considerably, but it can never become of much importance; it produced in the year ending the 5th of January, 1808, 28,751*l.* 15*s.* gross, and 26,455*l.* 2*s.* 5½*d.* net.

9. Hawkers and pedlars. In the year 1697, these itinerant merchants were first made subject to a particular tax, which could never be of much consequence as an object of revenue; and will probably fall off, as new towns and villages are built in different parts of the country. The gross amount in the year ending the 5th of January, 1808, was 13,231*l.* 0*s.* 4*d.*, the net produce 10,325*l.* 9*s.* 5*d.*

In addition to these several branches of the public revenue, there are some small branches of the old hereditary revenue still remaining. These consist chiefly of alienation fines, post fines, seizures of uncustomed and prohibited goods, compositions, profers, and the crown lands, of which the last is by far the most important.

Total net Produce of the Permanent and Annual Taxes constituting the Ordinary Public Revenue of Great Britain, and of the additional Taxes imposed during the continuance of War, for one Year, ending the 5th of January, 1808.

ORDINARY REVENUES.	Net Produce applicable to National Objects and to Payments into the Exchequer.			Expense per cent. of collecting the net Produce.		
	L.	s.	d.	L.	s.	d.
Customs	7,462,380	4	10¾	7	16	11
Excise (including the annual duties)	17,896,145	14	2	3	7	3
Stamps	4,458,738	14	0¾	2	18	5
Land and Assessed Taxes	7,073,530	10	8¾	4	0	4
Post Office	1,277,538	11	4½	29	2	9
6*d.* in the Pound on Pensions, &c.	71,353	0	5¼	0	12	9
1*s.* in the Pound on Pensions, &c.	62,685	5	8	0	13	11
Hackney Coaches	26,455	0	5½	9	19	4
Hawkers and Pedlars	10,325	9	5	29	17	9
Small branches of the Hereditary Revenue	91,422	14	7½			
Permanent and Annual Duties	38,430,575	7	10			
WAR TAXES.						
Customs	2,730,792	14	6½			
Excise	6,273,570	18	10½			
Property Tax	9,864,189	4	10			
Arrears of Income Duty	23,072	19	0			
Arrears under Aid and Contribution Act	2,888	11	2¼			
Total Revenue . . . . L.	57,325,089	16	3¼			

Notwithstanding the sum annually drawn from the public in taxes has been raised to the above vast amount, it is still thought necessary to have recourse to the profit of lotteries, which, with the permanent and annual duties above stated, and a few small incidental receipts, forms the total public income in time of peace. In years of war, it is almost invariably found necessary to raise a large additional sum by way of loan, which, being added to the debt previously existing, it becomes necessary to augment the revenue appropriated to the payment of the interest thereon by the imposition of new taxes.

The net produce of the several branches, after the payment of certain bounties, pensions, and other charges, is paid into the Exchequer, to be applied to the services to which it is appropriated. The public accounts at the Exchequer, both of the revenue and expenditure, were, till within a few years, kept in a peculiar character, in use no where else, and which, in the course of time, had become so unintelligible, even to the officers themselves, that it was usual to write all high numbers in common figures under the characters. It is a curious circumstance, that this obscure species of arithmetic was defective in having no characters to express high numbess, as millions, so far were the framers of it from having any idea of the amount to which the public revenue was to be extended.

REVERBERATION, in chemistry, denotes a kind of circulation of the flame by means of a reverberatory, or the return of the flame from the top of the furnace back to the bottom, chiefly used in calcination. Reverberation is of two kinds: the first with a close fire, that is, a reverberatory furnace, where the flame has no vent at top, being covered with a dome or capital, which repels its action back on the matter or the vessel that contains it with increased vehemence. After this manner is refining, the distillation of acids, spirits, &c. performed. Reverberation with an open fire is that performed in a furnace or reverberatory, whose registers are all open, used in calcination, &c. See next article.

REVERBERATORY, or Reverberating Furnace, a chemical furnace built close all around, and covered at the top with a capital of brick or tiles, so as not to give any vent to the heat or flame, but to determine it to reverberate or turn back from the brick-work with new force upon the matter placed at bottom. When the fire has no vent or passage at top, it is a whole reverberatory. When the middle of the capital is open, and only the sides close, so that there is only a half circulation of the flame, it is called an half reverberatory. The reverberatory furnace is chiefly used in the fusion and calcination of metals and minerals, and on other occasions where the most intense heat is required, as in assaying, &c. Whence it is also called the melting furnace, and assaying furnace.

REVERSION, a sum of money, estate, annuity, or any other kind of property, the possession of which is not to be obtained till after the expiration of a certain period of time, or till some event, as the failure of a life or lives, has happened. The present value of such property depends greatly on the current interest of money, for if money produced only three per cent. interest, a person giving 1000*l.* for a reversionary estate relinquishes an annuity of 30*l.*, but if he could make five per cent. interest of his money, he gives up an annuity of 50*l.* and consequently in the latter case he would expect a greater reversion than the former. The true value of a reversion therefore is that present sum, which if improved at a given rate of interest, would at the period when the reversion comes into possession amount to its then actual value. This, with respect to sums receivable at the end of a certain number of years, is easily found by Table II. article Interest.

Thus, if a person is entitled to 500*l.* at the end of ten years, and wishes to know its present worth: the value of one pound to be received at the end of this term is, by the Table, 613913, which multiplied by 500 gives 306*l.* 19*s.* 1*d.* for the present value of the reversion. In a similar manner the present worth of the reversion of an annuity or estate after a certain number of years may be found by Table II. article Annuities.

Example 1. What is the present value of an annuity of 21*l.* for the term of 30 years, but which is not to commence till the expiration of 7 years from the present time? The present value of an annuity of one pound for 30 years is, by the Table, 15,372451, which multiplied by 21 gives 322,8214; but as each payment of the annuity is to be received 7 years later than if it commenced immediately, this sum must be multiplied by the value of one pound to be received at the end of 7 years, or, .710681, which gives 229*l.* 8*s.* 5*d.* for the present worth of the reversion.

Example 2. What is the present worth of a perpetual annuity of *50l.* to commence at the expiration of a lease of which 5 years are unexpired? The value of a perpetual annuity commencing immediately is, at 5 per cent. interest, 20 years purchase; the value of an annuity for 5 years is, by the Table, 4,329477; the latter subtracted from the former, and the remainder multiplied by 50, gives *783l. 10s. 6d.* the value of the reversion.

Reversionary interests depending on a life or lives, particularly when several lives are concerned, form more intricate questions; but the cases which most commonly occur may be resolved by the following problems.

Problem 1. A sum of money is to be received at the death of a person, who is now of a given age; what is the value thereof in present money?

Subtract the value of the life from the perpetuity; then, as the perpetuity is to the remainder, so is the proposed sum to its value in present money.

Example. Let the age be 30 years, and the given sum *500l.* Then the value of the life being 13,072 and the perpetuity 20, it will be, as 20 : 6.928 : : *500l.* : *173l. 4s.* the value sought.

Problem 2. To find the value of the reversion of one life after another.

From the value of the life in expectation subtract the value of the two joint lives; the remainder will be the required value of the reversion.

Example. Let the age of the life in possession be 55 years, that of the life in expectation 20 years, and the annuity *100l.* Then, by Table V. (Article Annuities) the value of the two joint lives will be 8,216, which subtracted from 14,007, the value of the life in expectation, leaves 5,791 years purchase for the value of the reversion; which multiplied by the annuity, gives *579l. 2s.* its value in present money.

Problem 3. To find the value of the reversion of two lives after one.

From the value of the longest of the three lives subtract the value of the life in possession, the remainder will be the value of the reversion.

Example. Let the age of the life in possession be 40 years, and the ages of the two lives in expectation be 20 and 65 years; in this case, the value of the three lives being 15,902, and that of the life in possession 11,837, the answer will be 4,065 years purchase: so that, if the annuity was to be *500l.* the value of the reversion would be *2032l. 10s.*

Problem 4. To find the value of an annuity certain for a given term after the extinction of any given life or lives.

Subtract the value of the life or lives from the perpetuity, and reserve the remainder: then say as the perpetuity, is to the present value of the annuity certain, so is the said reserved remainder to a fourth proportional, which will be the number of years purchase required.

Example. Suppose A and his heirs are entitled to an annuity certain for 14 years, to commence at the death of B, aged 25.—What is the present value of A's interest in this annuity?—The value of the life of B, is 13,567, which subtracted from 20 (the perpetuity) leaves 6,433 for the remainder: therefore, as 20 is to 9,198, the value of an annuity certain for 14 years, so is 6,433 to 3,183, the number of years purchase required.

Problem 5. B, who is of a given age, will, if he lives till the decease of A, whose age is also given, become possessed of an estate of a given value; what is the worth of his expectation in present money?

Find the value of an annuity on two equal joint lives, whose common age is equal to the age of the oldest of the two proposed lives, which value subtract from the perpetuity, and take half the remainder; then say, as the expectation of duration of the younger of the two lives is to that of the older, so is the said half remainder to a fourth proportional; which will be the number of years purchase required when the life of B in expectation i the older of the two; but if B be the younger, then add the value so found to that of the joint lives A and B, and let the sum be subtracted from the perpetuity, which gives the answer in this case.

Example 1. Suppose the age of A to be 20, and that of B 30 years; and the annual value of the estate *50l.* Then the value of two equal joint lives ,aged 30 being 10,255, and the perpetuity 20, the difference will be 9,745, the half of which is 4,872. Therefore, as 33,43, the expectation of A, is to 28,27 the expectation, of B, so is 4,872 to 4,119 years purchase, which being multiplied by 50, the given annual value, we have *205l. 19s.* for the required value of B's expectation.

Example 2. Let the age of A be 30, that of B 20 years; and the rest as in the preceding example. Then, the value of the joint lives is 10,707, which being added to 4,119 found above, the sum is 14,826; and this subtracted from 20,the perpetuity, and multiplied by 50, gives 258*l.* 14*s.* for the value in this case.

Problem 6 To find the value of a given estate at the death of B, provided that should happen after the death of A.

Find the value of an annuity upon the longest of two equal lives, whose common age is that of the older of the two lives, A and B, which value subtract from the perpetuity and take half the remainder. Then, as the expectation of duration of the younger of the lives is to that of the older, so is the said half remainder to the number of years purchase required, when B is the older of the two. But if B be the younger, then to the number of years purchase thus found add the value of an annuity on the longest of the lives, A and B, and subtract the sum from the perpetuity for the answer in this case.

Example 1. Let the age of A be 30, and that of B 60 years; the given estate 120*l.* per annum. Then the value of an annuity on the longest of two lives aged 60 each will be found to be 10,896, which taken from 20, the perpetuity, leaves 9,104 for the remainder. Therefore it will be as 28,27, the expectation of A, is to 13,21, the expectation of B, so is 4,552 the half remainder, to 2,127, the number of years purchase required, which, being multiplied by 120, gives 255*l.* 4*s.* 9*d.* for the present value.

Example 2. Let the age of A be 60 and that of B 30 years; then, to the number of years purchase found in the preceding example, add 14,172, the value of an annuity on the longest of the two lives, the sum is 16,299, and this subtracted from 20, the perpetuity, and multiplied by 120, gives 444*l.* 2*s.* 4*d.* for the value in this case.

The solutions of the two last problems comprehend all the cases of survivorship between two lives for their whole duration; but an expectation dependent on survivorship is sometimes restricted to a term of years less than the whole duration of the lives. Those who have occasion for the rules for resolving questions of this description, or of the various cases which may arise when three or more lives are concerned, are referred to Mr. T. Simpson's Doctrine of Annuities, Dr. Price's Treatise on Reversionary Payments, or Mr W. Morgan's Treatise on Annuities and Assurances.

Reversionary interests being a species of property of which purchasers are not always readily found, those who have occasion to dispose of an interest of this kind generally sell it by public auction, in which mode it very seldom happens that more than two thirds of the true calculated value is obtained.

Reversion *of series,* in algebra, a kind of reversed operation of an infinite series.

Reversion, in law, is that part of an estate, or interest, which remains to the original grantor, or his heirs, after the particular or less estate which he has granted shall expire. Thus, if A, having the fee, grant an estate for life, or in tail, to B, A still has an estate in fee, in reversion, expectant upon the failure or determination of the particular estate of B. It differs from a remainder, in being the remnant of the estate in the hands of the original grantor; but a remainder is something granted out by the grantor. See Remainder.

REVIEW. In the military acceptation of the term, an inspection of the appearance and regular disposition of a body of troops, assembled for that purpose. At all reviews, the officers should be properly armed, ready in their exercise, salute well, in good time, and with a good air; their uniform genteel, &c. The men should be clean and well dressed; their accoutrements well put on; very well sized in the ranks; the serjeants expert in their duty, drummers perfect in their beatings, and the fifers play correct. The manual exercise must be performed in good time, and with life; and the men carry their arms well; march, wheel, and form with exactness. All manœuvres must be performed with the utmost regularity, both in quick and slow time. The intention of a review is, to know the condition of the troops, to see that they are complete, and perform their exercise and evolutions well.

Review, *bill of,* in chancery, is where a cause has been heard and the decree signed and enrolled, and some error in law appears upon the decree, or new matter is discovered in time after the decree made, a bill of review is then had.

REVISE. See Printing.

REVIVOR, *bill of,* is where a bill has been exhibited in Chancery, against one who answers, and before the cause is heard, or if heard, before the decree enrolled either party dies. The cause is then said to die also, and a bill of revivor must be brought, that the former proceedings may stand revived, and the cause be finally determined.

REVOCATION, in law, a destroying or making void a deed or will which existed before the act of revocation.

Some things may be revoked, of course, though they are made irrevocable by express words; as a letter of attorney, a submission to an award, and a testament, or last will.

By the statute of frauds, 29 Charles II. c. 3. no devise of lands shall be revocable, otherwise than by some other will, or codicil, in writing, or other writing declaring the same, signed in the presence of three witnesses. But still such a devise may be revoked by destroying the will, or by any other revocation by act of law; such as granting away the estate to another by deed.

REVOLUTION, in astronomy, is the period of a planet or comet, &c, or its course from any point of its orbit, till it return to the same again. Planets have a twofold revolution: one about their axis, called their diurnal rotation, which constitutes their day; the other, about the Sun, called their annual revolution, constituting their year.

REVOLUTION, in geometry, the motion of rotation of a line about a fixed point or centre, or of any figure about a fixed axis, or upon any line or surface. Thus the revolution of a given line about a fixed centre, generates a circle; and that of a right-angled triangle about one side, as an axis, generates a cone; and that of a semicircle about its diameter generates a sphere or globe.

RHABDOLOGY, in arithmetic, the doctrine of Neper's rods. See NEPER.

RHAMNUS, in botany, *buck-thorn*, a genus of the Pentandria Monogynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: calyx tubular: corolla scales defending the stamens inserted into the calyx; berry. There are forty-two species.

RHAPIS, in botany, a genus of the Appendix Palmæ. Natural order of Palms. Essential character: calyx trifid; corolla trifid; stamens six; pistil one. There are two species, *viz.* R. flabelliformis, creeping rooted rhapis, or ground rotan; and R. arundinacea, simple-leaved rhapis.

RHEEDIA, in botany, so named in memory of Henry Rheede Van Draakenstein, a genus of the Polyandria Monogynia class and order. Natural order of Guttiferæ, Jussieu. Essential character: calyx none; corolla four-petalled; berry three-sided. There is but one species, *viz.* R. lateriflora.

RHETICUS (GEORGE JOACHIM), in biography, a noted German astronomer and mathematician, was born at Feldkirk, in Tyrol, the 15th of February, 1514. After imbibing the elements of the mathematics at Tiguri, with Oswald Mycone, he went to Wittemberg, where he diligently cultivated that science. Here he was made master of Philosophy in 1535, and professor in 1537. He quitted this situation, however, two years after, and went to Fruenberg to put himself under the assistance of the celebrated Copernicus, being induced to this step by his zeal for astronomical pursuits, and the great fame which Copernicus had then acquired. Rheticus assisted this astronomer for some years, and constantly exhorted him to perfect his work, De Revolutionibus, which he published after the death of Copernicus, *viz.* in 1543, folio, at Norimberg, together with an illustration of the same in a narration, dedicated to Schoner. Here too, to render astronomical calculations more accurate, he began his very elaborate canon of sines, tangents, and secants, to fifteen places of figures, and to every ten seconds of the quadrant, a design which he did not live quite to complete. The canon of sines, however, to that radius, for every ten seconds, and for every single second in the first and last degree of the quadrant, computed by him, was published in folio, at Franckfort, 1613, by Pitiscus, who himself added a few of the first sines computed to twenty-two places of figures. But the larger work or canon of sines, tangents, and secants, to every ten seconds, was perfected and published after his death, *viz.* in 1596, by his disciple, Valentine Otho, mathematician to the Electoral Prince Palatine.

After the death of Copernicus, Rheticus returned to Wittemberg, *viz.* in 1541 or 1542, and was again admitted to his office of professor of mathematics. The same year, by the recommendation of Melancthon, he went to Norimberg, where he found certain manuscripts of Werner and Regiomontanus. He afterwards taught mathematics at Leipsic. From Saxony he departed a second time, for what reason is not known, and went to Poland; and from thence to Cassovia, in Hungary, where he died December the 4th, 1576, near sixty-three years of age.

His Narratio de Libris Revolutionum Copernici, was first published at Gedunum, in quarto, 1540, and afterwards added to the additions of Copernicus's work. He also composed and published Ephemerides, according to the doctrine of Copernicus, till the year 1551.

Rheticus also projected other works, and partly executed them, though they were never published, of various kinds, astronomical, astrological, geographical, chemical, &c. as they are more particularly mentioned in his letter to Peter Ramus, in the year 1568, which Adrian Romanus inserted in the preface to the first part of his idea of mathematics.

RHETORIC, from the Greek word ϱεω. to speak, may be defined the art of speaking with persuasion.

This art, like all others, is the result of observations and experiments made by men of good capacities and of enlightened minds. After multiplied and often defective essays, those principles are at length discovered, which distinguish between the good and the bad, between the faulty and the perfect. These principles, when reduced to method, and well arranged, save succeeding enquirers much pains and trouble, considerably shorten the road to knowledge, and materially assist in the formation of a correct judgment. As in respect to poetry, it is contended, that though accurate rules of criticism will not bestow genius, they will check redundancy and bombast, and detect all the errors into which the competitors for the laurel are too apt to be betrayed, so with regard to the precepts of rhetoric it may safely be asserted, that though they will not generate that energy of mind which rises to the highest flights of eloquence, they will effectually warn the orator against incongruity in the disposition of his matter, absurdity in argument, and the false glitter of ornament which amuses instead of convincing, or those injudicious attempts to interest the feelings which excite ridicule rather than sympathy.

This will be the more manifest if we consider that the foundation of eloquence is right reason, and that its exercise implies the possession of that faculty both in the speaker and the hearer. It was well observed by the Stagyrite, that rhetoric is nearly allied to logic.

In displaying the utility of the art of rhetoric, Quintilian expresses himself in the following forcible terms: "If in any thing the Creator has distinguished us from the rest of the animals, it is by the gift of speech. They surpass us in strength, in patience, in size, in swiftness, and especially in independence of foreign aid. Guided by instinct, they soon learn by its instructions to walk, to feed themselves, and to swim. Their protection against the cold, and their weapons of defence, are provided for them by nature. But what pains and labour does it cost man to procure all these things. Reason is our inheritance, and seems to associate us to immortal beings. But how feeble would reason be, were it not for the faculty of expressing our thoughts by speech, which is the faithful interpreter of reason. This is what is wanting to the inferior animals much more than understanding, of which it cannot be justly said that they are absolutely destitute. If then we have received nothing from the Deity better than the use of speech, what is there which we ought to cultivate with greater industry? What object is more worthy of our ambition than that of rising above other men by that faculty, which alone raises them above the level of the brutes?"

A still greater dignity will attach to the acquirement of eloquence, and consequently to the science of rhetoric, if it be considered that eloquence and freedom go hand in hand. It is in free states, and under popular governments alone, that oratory can flourish. When the people are appealed to on the subject of state affairs; when political measures are to be enforced by the enlightening of their judgements, or by the excitement of their passions; the greatest talents are exercised in studying the art of persuasion, and the result is found in the most wonderfnl efforts of human ability. But when brute force predominates, and the people bow beneath the yoke of tyranny, the voice of reason is stilled, and eloquence is mute.

The ancient rhetoricians distinguish oratorical composition into three species; *viz.* the demonstrative, the deliberative, and the judicial.

The first of those species is chiefly conversant in bestowing praise or blame, and comprehends in its definition the panegyric and the funeral eulogy, which were so much in use among the ancients. In the former class may be enumerated Isocrates's Panegyric on Evagoras King of Salamis, Cicero's Oration on the pardoning of Marcellus, his Philippics against Mark Antony, and Pliny's Panegyric on Trajan. Of the latter specimens may be found in the funeral orations composed by Thucydides and Plato, to commemorate the virtues of the Athenians who fell at the commencement of the Peloponnesian war. Nor have the moderns been wanting in excellent specimens of this species of eloquence. The funeral discourses of the most celebrated French and English preachers, the *éloges* pronounced upon eminent men before the French Academy, the generality of modern pulpit compositions, and the occasional commendatory or vituperative speeches which have at various times been uttered in the British Parliament, will afford rich subjects of study to him who wishes to become acquainted with the principles of demonstrative eloquence.

Deliberative eloquence comprehends a most extensive field, embracing as its object the whole extent of public affairs; such, for instance, as war, and peace, political negotiations, domestic interests, foreign alliances, the regulation of trade and commerce, and in general all matters connected with legislation and government. This species of eloquence cannot be cultivated in any other than a free state. The will of an arbitrary monarch supersedes its use, or terrifies it to silence. It is therefore to the "high and palmy state" of Athens and of Rome that we must look for its energies as exhibited in ancient times, and we shall find its proudest memorials in the works of Demosthenes and Cicero. In more modern times, it has, by the operation of political causes, been almost exclusively confined to the limits of our own island. And whilst the parliamentary speeches of Chatham, of Burke, of Fox, and of Pitt, remain upon record, Britain may dispute the meed of deliberative eloquence with either of the haughty republics of antiquity.

Judicial eloquence comprehends in its purview the whole extent of judicial proceedings, both civil and criminal; that is to say, the attack and defence of persons and of property. In ancient times the business of judicial pleading was not confined to one class of men. The Roman orator was at all times ready to impeach a state criminal, or to plead in defence of the life, the honour, or the fortune of his friend. These were the illustrious days of forensic eloquence, when the first characters of the republic displayed their abilities at the bar; when Cicero and Hortensius, in amicable rivalry, gave full scope to their superlative talents. But degraded as the profession of an advocate is now in some respects acknowledged to be, yet in the proceedings of a British court of justice, there have for a long series of years, been evinced proofs of the most searching sagacity, the soundest judgment, and the most ready wit.

In regular orations of every species there will generally be found the following subdivisions. The exordium, or introduction; the statement of the subject; the narrative, or explanation; the reasoning, or argument; the pathetic part; and, lastly, the peroration, or conclusion.

The object of the exordium is to conciliate the good will of the hearers, to awake their attention, and to render them open to persuasion. The topics by which these purposes may best be effected will suggest themselves to the good sense of the speaker, as arising from the character and peculiar prejudices of his auditors, from his own relative situation, from the peculiar circumstances of the times, or from the nature of his cause.

In the proposition of the subject, the qualities chiefly to be aimed at are clearness and distinctness. These qualities are indeed of the most essential importance, and the attainment of them is well worth the utmost care and pains. In debates of every kind, that speaker is listened to with the greatest pleasure, who is able briefly and plainly to give the most accurate account of the points principally in question.

As the narrative, or explanation of facts, is to be the ground-work of all the future reasonings of the orator, it is obviously his duty to recount them in such a manner as may be most favourable to his cause; to place in the most striking light every circumstance which is to his advantage, and to soften such as make against him. He must also exercise consummate judgment, so that his narration may be at once concise and full, copious and distinct. In short, a perfect narration is one, from which nothing can be taken without rendering it obscure, and to which nothing can be added without weakening its force.

In his arguments, a speaker should, as Quintilian expresses it, possess logic as a philosopher, and employ it as an orator. He should follow the lucid order of nature in their disposition, and express them in such a style and manner as to give them their full force. He should take care not to multiply them to too great an extent, and to bring into a conspicuous point of view those which are the most weighty and cogent.

In the pathetic part of his discourse, which generally introduces and pervades the peroration, the ancient orator collected all the might of his abilities to strike as it were a finishing stroke. But Quintilian, with his usual judgment, warns his pupil against dwelling upon this topic too long. "Time," says he, "soon calms real griefs; how much more easily must it dissipate the illusory impressions which act only upon the imagination. Let not then the pathetic strain be too long continued. If this precept be not well observed, the auditor is fatigued; he resumes his tranquillity, and recovering from the transitory emotion, he returns under the influence of reason. We ought not, then, to suffer his feelings to cool; and when we have carried them as far as they can go, we ought to stop, and not to deceive ourselves with the idea, that the mind will for any long space of time be sensible to emotions which are foreign to it."

When Roman eloquence was in its most flourishing state, this oratorical subdivision was an object of assiduous study; and in order to excite the feelings of the audience, the orator had frequent recourse to sensible objects. The weeping relatives of the defendant, the wounds which an accused person had received in fighting the battles of his country, a dagger, or a bloody robe: these exhibitions were frequently resorted to, in order to excite compassion, or to rouse indignation. They are, however, so inconsistent with modern usages, and especially with the cool and phlegmatic temperament of our countrymen, that the most consummate prudence and skill can alone adopt any of them with effect. Where a Burke has failed, he must be a bold man who would repeat the experiment.

The precise nature of the conclusion of any discourse must be determined in a great measure by the nature of that discourse, and the circumstances in which it is delivered. Sometimes it may be expedient to compress in it a repetition of the substance of a long train of antecedent argument; on some occasions it should assume the humble tone of pathos, and on others it should rise into the dignity of confidence: but in all cases, as Dr. Blair properly remarks, "it is a matter of importance to bring our discourse just to a point; neither ending abruptly and unexpectedly, nor disappointing the hearers, when they look for the close, and continuing to hover round the conclusion till they become heartily tired of us. We should endeavour to go off with a good grace; not to end with a languishing and drawling sentence; but to close with dignity and spirit, that we may leave the minds of the hearers warm, and dismiss them with a favourable impression of the subject and of the speaker."

RHEUM, in botany, *rhubarb*, a genus of the Enneandria Trigynia class and order. Natural order of Holoraceæ. Polygoneæ, Jussieu. Essential character: calyx none; corolla six-cleft, permanent; seed one, three-sided. There are seven species, among which we shall notice the R. palmatum, officinal rhubarb: the root is perennial, thick, of an oval shape, sending off long tapering branches; externally it is brown, internally of a deep yellow colour; stem erect, round, hollow, jointed, from six to eight feet in height; root leaves numerous, large, rough, of a roundish figure, deeply cut into lobes and irregularly pointed segments; on long foot-stalks; stem leaves one at each joint, from a membranaceous sheath, successively smaller upwards; flowers surrounding the branches in numerous clusters, forming a kind of spike; corolla of a greenish white colour. It is a native of China and Tartary. At the end of six or seven years, when the plant seems to arrive at its most perfect state, one pound of rhubarb may be obtained from every five pounds of the green roots, besides an equal or larger proportion of roots fit for family use.

RHEXIA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Calycanthemæ. Melastomæ, Jussieu. Essential character: calyx four-cleft; petals four, inserted into the calyx; anthers declining; capsule four-celled, within the belly of the calyx. There are thirteen species: all these plants are found wild in America.

RHINANTHUS, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx four-cleft, ventricose; capsule two-celled, blunt, compressed. There are eight species.

RHINOCEROS, in natural history, a genus of mammalia of the order Feræ. Generic character: horn solid, perennial, conical, seated on the nose, but not adhering to the bone This quadruped is exceeded in size only by the elephant. Its usual length, not including the tail, is twelve feet; and the circumference of its body nearly the same. Its nose is armed with a horny substance, projecting, in the full grown animal, nearly three feet, and is a weapon of defence, which almost secures it from every attack. Even the tiger, with all his ferocity, is but very rarely daring enough to assail the rhinoceros. Its upper lip is of considerable length and pliability, acting like a species of snout, grasping the shoots of trees and various substances, conveys them to the mouth, and it is capable of extension and contraction at the animal's convenience. The skin is, in some parts, so thick and hard as scarcely to be penetrable by the sharpest sabre, or even by a musket-ball. These animals are to be found in Bengal, Siam, China, and in several countries of Africa; but are far less numerous than the elephant, and of sequestered solitary habits. The female produces only one at a birth; and at the age of two years the horn is only an inch long, and at six, only of the length of nine inches. The rhinoceros is not ferocious unless when provoked, when he exhibits paroxisms of rage and madness, and is highly dangerous to those who encounter him. He runs with great swiftness, and rushes through brakes and woods with an energy to which every thing yields. It is generally, however, quiet and inoffensive. Its food consists entirely of vegetables, the tender branches of trees, and succulent herbage, of which it will devour immense quantities. It delights in retired and cool situations, near lakes and streams, and appears to derive one of the highest satisfactions from the practice of rolling and wallowing in mud; in this respect bearing a striking resemblance to the hog.

This animal was exhibited, by Augustus, to the Romans, and is supposed to be the unicorn of the scripture, as it possesses the properties ascribed to that animal, of magnitude, strength, and swiftness, in addition to that peculiarity of a single horn, which may be considered as establishing their identity. This animal can distinguish, by its sight, only what is directly before it, and always, when pursued, takes the course immediately before him, almost without the slightest deviation from a right line, removing every impediment. Its sense of smelling is very acute, and also of hearing, and, on both these accounts, the hunters approach him against the wind. In general, they watch his lying down to sleep, when, advancing with the greatest circumspection, they discharge their muskets into his belly. The flesh is eaten both in Africa and India.

R. bicornis, or the two-horned rhinoceros, is similar in size and manners to the former, and is principally distinguished from it by having two horns on its nose; the first being always the largest, and sometimes a foot and a half in length. These horny substances are said to be loose when the animal reposes, or is calm, but to be erected irremoveably when he is highly agitated; a circumstance asserted by Dr. Sparman, through ridiculed by Mr. Bruce. It is, however, observed by Dr. Shaw, that, on inspection of the horns and the skin on which they are seated, they do not appear firmly attached to the bone of the cranium. This animal, after having devoured the foliage of trees, rips up their trunks, and dividing them with his horns into a sort of laths, fills his immense jaws with these fruits of his labour, and masticates them with as much facility as an ox does grass. Its swiftness is great considering its bulk, but its security arises not so much from speed as from its directing its course to thickets and woods, where sapless trees are broken by its violence, and green ones, after yielding to it, recoil upon the pursuers, and strike them from their horns sometimes with fatal consequences. In an open plain the horse speedily overtakes him, on which he makes a thrust with his horn at the horse, which the latter easily evades by its agility. A man at this moment drops from behind the chief horseman, with a spear, and, as the rhinoceros sees only immediately before him, wounds him in the tendons of his heels, and thus totally disables him from further motion. He is also occasionally taken by night while rolling himself in mire, in which he appears to experience a rapture which deprives him of all suspicion and vigilance; while thus abandoning himself to transport, the hunters approach and fix a mortal wound, by their spears or muskets, in his belly. See Mammalia, Plate XVIII. fig. 5.

RHINOMACER, in natural history, a genus of insects of the order Coleoptera. Antennæ setaceous, seated on the snout; four feelers, growing thicker towards the end, the last joint truncate. There are three species, found in Italy and Sweden.

RHIZOBOLUS, in botany, a genus of the Polyandria Tetragynia class and order. Essential character: calyx, half five-cleft; petals five; germ four-lobed, superior; nuts four, one-celled, one-seeded. There are two species, *viz.* R butyrosus, and R. tuberculosus, both natives of Guiana.

RHIZOPHORA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Holoraceæ. Caprifolia, Jussieu. Essential character: calyx four-parted; corolla four-parted; seed one, very long, fleshy at the base. There are six species, of which R. mangle, or mangrove tree, commonly attains the height of fifty feet; it is generally found on the borders of the sea, in whose waters alone it seems to thrive, and there only in such places as have a soft and yielding bottom; its larger branches frequently emit soft and weakly appendicles, having the appearance of so many slender, leafless branches, always bending downwards; but as these are softer, and furnished each with a large column of a lax, spongy pith in the centre, they grow more luxuriantly than the other parts of the tree, and reach the mud in a short time, where they throw out a numberless series of slender fibres, which in time become roots, to supply the stem more copiously with nourishment, whilst they become so many props or limbs to the parent tree; the trunk seldom grows to any considerable thickness; the bark is excellent for tanning leather; it performs this operation more perfectly in six weeks, than oak bark will do in ten. The mangrove is a native both of the East and West Indies, of the Society and Friendly Islands, the New Hebrides, and New Caledonia, in the South Seas.

RHODIOLA, in botany, a genus of the Dioecia Octandria class and order. Natural order of Succulentæ. Sempervivæ, Jussieu. Essential character: male, calyx four-parted; corolla four petalled; nectary four: female, calyx four-parted; corolla four-petalled; nectary four; pistils four; capsules four, many-seeded. There are two species, *viz.* R. rosea, common, or yellow rose-wort, and R. biternata.

RHODODENDRUM, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Bicornes. Rhododendra Jussieu. Essential character: calyx five parted; corolla funnel-form; stamina declined; capsule five-celled. There are nine species.

RHODORA, in botany, a genus of the Decandria Monogynia class and order. Natural order of Bicornes. Rhododendra, Jussieu. Essential character; calyx five-toothed; petals three, unequal; stamina declined; capsule five-celled.— There is only one species, *viz.* R. canadensis, a native of Newfoundland, from which place it was introduced by Sir Joseph Banks.

RHOEADEÆ, in botany, the name of the twenty-seventh order in Linnæus' Fragments of a Natural Method, consisting of the poppy, and a few genera which resemble it in habit and structure. The plants, in this order, upon being cut, yield plentifully a juice which is white in the poppy, and yellow in others. See Poppy.

RHOMB *spar*, in mineralogy, a species of the calx genus, of a greyish colour passing to yellow: it is never massive, but always in regular middle-sized rhombs; the lustre is splendent, and between vitreous and pearly; it is brittle, easily frangible: specific gravity 2.5; it is infusible without addition. With acids, it produces very little effervescence, even when pulverized. Constituent parts:

Carbonate of lime	52
Carbonate of magnesia	45
Oxide of iron and manganese	3
	100

It is found in Switzerland, Sweden, and in chlorite rocks, on the banks of Loch Lomond in Scotland.

RHOMBOIDES, in geometry, a quadrilateral figure, whose opposite sides and angles are equal, but is neither equilateral nor equiangular.

RHOMBUS, in geometry, an oblique-angled parallelogram, or a quadrilateral figure, whose sides are equal and parallel, but the angles unequal, two of the opposite ones being obtuse, and the other two acute. To find the area of a rhombus upon the base, let fall the perpendicular, which is the altitude of the figure; then multiply the base by the altitude, the product will be the area.

RHUBARB. This is the root of the rheum palmatum, and perhaps also of some other species of rheum, brought chiefly from the northern parts of China, by the way of Russia, though of late it has been cultivated also in Britain. The root is large, of an oblong or roundish shape; of a dark brown colour externally, with black and reddish streaks: internally it is reddish-yellow, and, when fresh, contains a juice of the same colour. No accurate chemical analysis of rhubarb has yet been made; but, from the experiments of Neumann, it appears that nearly one-half of it is soluble in water, and that alcohol scarcely takes up any thing from the residue. From the properties of the watery extract, enumerated by that laborious chemist, we may infer, with some probability, that it consists chiefly of an extractive and bitter principle, and that it contains some tannin. A small quantity of greenish yellow, resinous matter, seems also to be present. Scheele separated from the root about one-sixth of its weight of oxalate of lime. But this salt is not taken up by water. See MATERIA MEDICA, and PHARMACY.

RHUMB, in navigation, a verticle circle of any given place, or the intersection of such a circle with the horizon; in which last sense rhumb is the same with a point of the compass.

RHUMB *line*, is also used for the line which a ship describes when sailing in the same collateral point of the compass, or oblique to the meridians.

RHUS, in botany, *sumach*, a genus of the Pentandria Trigynia class and order. Natural order of Dumosæ. Terebintaceæ, Jussieu. Essential character: calyx five-parted; petals five; berry one-seeded. There are thirty-four species.

RIBES, in botany, the *currant* and *gooseberry*, a genus of the Pentandria Monogynia class and order. Natural order of Pomaceæ. Cacti, Jussieu. Essential character: petals five, inserted with the stamens into the calyx; style bifid; berry many seeded, inferior. There are seventeen species, *viz.* ten of the currant, and seven of the gooseberry; all these shrubs are too well known to need a particular description in this work.

RICCIA, in botany, so named in honour of Pietro Francisco Riccio; a genus of the Cryptogamia Hepaticæ class and order. Generic character: male, flowers sessile on the surface of the frond; calyx and corolla none: female, flowers on the same, or, according to Micheli, on a distinct plant; calyx none, except a vesicular cavity, within the substance of the leaf; corolla none. Linnæus has five species, natives of Europe. Withering reckons the same number, all natives of Britain.

RICHARDIA, in botany, so named from Richardson; a genus of the Hexandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: calyx six-parted; corolla one-petalled, sub-cylindric; seeds three. There is only one species, *viz.* R. scabra, a native of Vera Cruz.

RICHERIA, in botany, so named in memory of Pierre Richer de Belleval, Professor of Botany at Montpelier; a genus of the Dioecia Pentandria class and order. Essential character: capsule corticate, six-valved, three celled; seeds solitary, pendulous, below the tip of the columella; style trifid. There is but one species, *viz.* R grandis, a native of Montserrat.

RICINUS, in botany, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: calyx five-parted; corolla none: male, stamens numerous: female, styles three, bifid; capsule three-celled; seed one. There are six species.

RICOTIA, in botany, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosæ, or Cruciformes. Cruciferæ, Jussieu. Essential character: silique one-celled, oblong, compressed, with flat valves. There is but one species, *viz.* R. ægyptiaca, Egyptian ricotia.

RIDE, in the sea-language, is a term variously applied: thus, a ship is said to ride, when her anchors hold her fast, so that she does not drive by the force either of the wind or tide. A ship is said to ride across, when she rides with her fore and main yards hoisted up to the hounds, and both yards and arms topped alike. She is said to ride well, when she is built so as not to over-beat herself in a head sea, the waves over-raking her from stem to stern. To ride athwart, is to ride with her side to the tide. To ride betwixt wind and tide, is to ride so as the wind has equal force over her one way, and the tide the contrary way. If the wind has more power over the ship than the tide, she is said to ride wind-road, or to ride a great wind. And she is said to ride a-portoise, when the yards of a ship are struck down upon the deck.

RIDER, is a schedule, or small piece of parchment, added to some part of a record; as when, on the third reading of a bill in Parliament, a new clause is added, that is tacked to the bill, on a separate piece of parchment, and is called a rider.

RIDING *armed*, with dangerous and unusual weapons, is an offence at common law.

RIFLE, a fire-arm, which has the inside of its barrel cut with from three to nin or ten spiral grooves, so as to make it resemble a female screw, varying from a common screw only in this, that its grooves or rifles are less deflected, and approach more to a right line; it being now usual for the grooves with which the best rifled barrels are cut, to take about one whole turn in a length of thirty inches. The number of these grooves differ according to the size of the barrel, and fancy of the workman; and their depth and width are not regulated by any invariable rule. The method of loading them is as follows: when the proper quantity of powder (one drachm avoirdupois) is put down at the muzzle, and a piece of calico or linen is gently rammed down over it as a wad, a circular piece of strong calico is greased on one side, and laid on the mouth of the piece, with the greased side downwards; and a bullet of the same size as the bore of the piece before the grooves were cut, being placed upon it, is then forced gently down the barrel with it; by which means, the calico incloses the lower half of the bullet; and, by its interposition between the bullet and the grooves, prevents the lead from being cut by them, and, by means of the grease, slides down, without its being necessary to use any violent efforts, which would destroy the circular shape of the bullet. In order to understand the cause of the superiority of a rifle-barrel gun over one with a smooth barrel, it will be necessary to refer to Mr. Robin's discovery of the cause of the irregularities which occur in the flight of projectiles from smooth barrels, which we shall give in his own words, "Tracts on Gunnery," p. 196, &c. "Almost every projectile, besides the forces we have hitherto considered, namely, its gravitation, and that resistance of the air which directly opposes its motion, is affected by a third force which acts obliquely to its motion, and in a variable direction; and which, consequently, deflects the projectile from its regular track, and from the vertical plane in which it began to move; impelling it sometimes to one side, and sometimes to the other, occasioning thereby very great inequalities in the repeated ranges of the same piece, though each time loaded and pointed in the same manner; and this force, operating thus irregularly, I conceive to be the principal source of all that uncertainty and confusion in the art of gunnery, which hath hitherto been usually ascribed to the difference of powder. The reality of this force, and the cause which produces it, will, I hope, appear from the following considerations: It will easily be granted, I suppose, that no bullet can be discharged from the pieces generally in use, without rubbing against their sides, and thereby acquiring a whirling motion, as well as a progressive one; and as this whirl will, in one part of its revolution, conspire in some degree with the progressive motion, and in another part be equally opposed to it, the resistance of the air on the fore-part of the bullet will be hereby affected, and will be increased in that part where the whirling motion conspires with the progressive, and diminished where it is opposed to it. And, by this means the whole effort of the resistance, instead of being in a direction opposite to the direction of the body, will become oblique thereto, and will produce those effects already mentioned. If it were possible to predict the position of the axis, round which the bullet should whirl, and if that axis were unchangeable during the whole flight of the bullet, then the aberration of the bullet, by this oblique force, would be in a given direction, and the incurvation produced thereby, would regularly extend the same way, from one end of its track to the other. For instance, if the axis of the whirl were perpendicular to the horizon, then the deflection would be to the right or left; if that axis were horizontal, and perpendicular to the direction of the bullet, then the deflection would be upwards or downwards. But as the first position of this axis is uncertain, and as it may perpetually shift in the course of the bullet's flight, the deviation of the bullet is not necessarily in one certain direction, nor tending to the same side in one part of its track that it does in another; but it more usually is continually changing the tendency of its deflection, as the axis round which it whirls must frequently shift its position to the progressive motion by many inevitable accidents."

RIGGING *of a ship*, is all her cordage and ropes, belonging to her masts, yards, &c. A ship is said to be well rigged, when all her ropes are of a fit size and proportion: and she is said to be over-rigged, when her ropes are too large, which is of great prejudice to her sailing, and is apt to make her heel.

RIGHT, in geometry, signifies the same with straight: thus, a straight line is called a right one.

Right, in general signification, includes not only a right, for which a writ of right lies, but also any claim or title, either by virtue of a condition, mortgage, or the like, for which no action is given by law, but only an entry. A writ of right is the most ancient remedy in the law, for the recovery of lands, and is not barred till sixty years have elapsed since the claimant or his ancestor was disseized, or ousted of possession.

RING, in astronomy and navigation, an

instrument used for taking the sun's altitude, &c. It is usually of brass, about nine inches diameter, suspended by a little swivel, at the distance of 45° from the point of which is a perforation, which is the centre of a quadrant of 90° divided in the inner concave surface. To use it, let it be held up by the swivel, and turned round to the sun, till its rays, falling through the hole, make a spot among the degrees, which marks the altitude required. This instrument is preferred before the astrolabe, because the divisions are here larger than on that instrument. See Astrolabe.

Ring, *of Saturn*, is a thin, broad, opaque circular arch, encompassing the body of that planet, like the wooden horizon of an artificial globe, without touching it, and appearing double when seen through a good telescope. See Saturn.

Rings *of colours*, in optics, a phenomenon first observed in thin plates of various substances, by Boyle, and Hooke, but afterwards more fully explained by Sir Isaac Newton. Mr. Boyle having exhibited a variety of colours in colourless liquors, by shaking them till they rose in bubbles, as well as in bubbles of soap and water, and also in turpentine, procured glass blown so thin as to exhibit similar colours; and he observes, that a feather of a proper shape and size, and also a black ribband, held at a proper distance between his eye and the sun, showed a variety of little rainbows, as he calls them, with very vivid colours. Dr. Hook, about nine years after the publication of Mr. Boyle's Treatise on Colours, exhibited the coloured bubbles of soap and water, and observed, that though at first it appeared white and clear, yet as the film of water became thinner, there appeared upon it all the colours of the rainbow. He also described the beautiful colours that appear in thin plates of Muscovy glass; which appeared, through the microscope, to be ranged in rings surrounding the white specks or flaws in them, and with the same order of colours as those of the rainbow, and which were often repeated ten times. He likewise took two thin pieces of glass, ground plane and polished, and putting them one upon another, pressed them till there began to appear a red coloured spot in the middle; and pressing them closer, he observed several rings of colours encompassing the first place, till at last all the colours disappeared out of the middle of the circles, and the central spot appeared white. The first colour that appeared was red, then yellow, then green, then blue, then purple; then again red, yellow, green, blue, and purple; and again in the same order; so that he sometimes counted nine or ten of these circles, the red immediately next to the purple; and the last colour that appeared before the white was blue; so that it began with red, and ended with purple. These rings, he says, would change their places, by changing the position of the eye, so that the glasses remaining the same, that part which was red in one position of the eye, was blue in a second, green in the third, &c.

Sir Isaac Newton, having demonstrated that every different colour consists of rays which have a different and specific degree of refrangibility, and that natural bodies appear of this or that colour, according to their disposition to reflect this or that species of rays, pursued the hint suggested by the experiments of Dr. Hook, with regard to thin transparent substances. Upon compressing two prisms hard together, in order to make their sides touch one another, he observed, that in the place of contact they were perfectly transparent, which appeared like a dark spot, and when it was looked through, it seemed like a hole in that air, which was formed into a thin plate, by being impressed between the glasses. When this plate of air, by turning the prisms about their common axis, became so little inclined to the incident rays, that some of them began to be transmitted, there arose in it many slender arcs of colours, which increased, as the motion of the prisms was continued, and bended more and more about the transparent spot, till they were completed into circles, or rings, surrounding it; and afterwards they became continually more and more contracted. He then took two object-glasses of a telescope, the one plano-convex, the other a little convex on both sides, he placed one of the faces of this upon the plane face of the former, and pressed the two glasses at first gently, and then, by degrees, more closely against one another. The effect of this gradual pressure was an appearance in the plate of air between the glasses of different coloured circles, which had the point of contact for the common centre, and which increased in number according to the greater degree of pressure, in such a manner, that the circle which appeared last always surrounded the point of contact, and on a still further pressure extended its circumference, while it contracted itself breadthwise, to form a kind of ring round a new circle that arose near its middle. The pressure having been carried to a certain term, Newton stopped, and observed as follows. At the point of contact was a black spot that was encompassed by several series of colours. The order of the colours from the centre to the borders of the two glasses was this: in the first series, blue, white, yellow, and red; in the second, violet, blue, green, yellow, and red; in the third, purple, blue, green, yellow, and red; in the fourth, green and red; in the fifth, greenish blue and red; in the sixth, greenish blue, and pale red; in the seventh, greenish blue, and reddish white. Beyond this number, the tints of which were regularly paler, the colour became white. Newton measured the diameters of the annular bands, formed of these different colours, by taking the points where they had most lustre; and he found that the squares of those diameters were to one another as the terms of the ascending progression, 1, 3, 5, 7, 9, 11, &c.; from which it results, that the intervals between the two glasses, relatively to the corresponding points, followed the same progression. From these proportions, it was merely necessary to ascertain the absolute length of a single diameter, to know the lengths of all the others, as well as the different thickness of the plates of air at the points where the different colours were seen. He drew up a table of these degrees of thickness, by which it appears, that the most intense blue, for example, that of the first series, is expressed by a thickness of 0.000024 of an inch, supposing the visual ray to be nearly perpendicular to the two glasses. Sir Isaac Newton having measured also the diameters of the rings at the intermediate places where the colours were obscure, found that their squares were to one another as the even numbers 2, 4, 6, 8, 10, 12, &c.; and hence the intervals between the glasses, at the corresponding points, observed a similar progression. The diameters of the rings increased or diminished, as the visual ray was more or less inclined to the surface of the two glasses, so that the greatest contraction took place when the eye was situated perpendicularly above the glasses. The diameters also retained the same proportions to one another.

From other curious observations on these rings, made by different kinds of light thrown upon them, he inferred, that the thicknesses of the air between the glasses, where the rings are successively made, by the limits of the seven colours, red, orange, yellow, green, blue, indigo, and violet, in order, are one to another as the cube roots of the squares of the eight lengths of a chord, which sound the notes in an octave, sol, la, fa, sol, la, mi, fa, sol; that is, as the cube roots of the squares of the numbers 1, $\frac{8}{9}, \frac{5}{6}, \frac{3}{4}, \frac{2}{3}, \frac{3}{5}, \frac{9}{6}, \frac{1}{2}$. These rings appeared of that prismatic colour, with which they were illuminated, and by projecting the prismatic colours immediately upon the glasses, he found that the light, which fell on the dark spaces between the coloured rings, was transmitted through the glasses without any change of colour. From this circumstance he thought that the origin of these rings is manifest; because the air between the glasses is disposed according to its various thickness, in some places to reflect, and in others to transmit the light of any particular colour, and in the same place to reflect that of one colour, where it transmits that of another.

In examining the phenomena of colours made by a denser medium surrounded by a rarer, such as those which appear in plates of Muscovy glass, bubbles of soap and water, &c. the colours were found to be much more vivid than the others, which were made with a rarer medium surrounded by a denser. From the preceding phenomena it is an obvious deduction, that the transparent parts of bodies, according to their several series, reflect rays of one colour and transmit those of another; on the same account that thin plates, or bubbles, reflect or transmit those rays; and this Sir Isaac Newton supposed to be the reason of all their colours. Another inference is, that the particles even of those bodies which we call opaque, are in reality transparent, which persons who are in the habit of using the microscope must continually perceive. See NEWTON'S OPTICS: see also COLOUR, &c.

RIOT, *rout*, and *unlawful assembly*. When three persons, or more, assemble themselves together, with an intent mutually to assist one another, against any who shall oppose them in the execution of some enterprise of a private nature, with force or violence, against the peace, or to the manifest terror of the people, whether the act intended were of itself lawful or unlawful, if they only meet for such a purpose or intent, though they shall after depart of their own accord without doing any thing, this is an unlawful assembly. By 34 Edward III. c. 1, it is enacted, that if a justice find persons riotously assembled, he alone has not only power to arrest the offenders, and bind them to their good behaviour, or imprison them if they do not offer good bail; but he may also authorize others to arrest them, by a bare verbal command, without other warrant; and by force thereof, the persons so commanded may pursue and arrest the offenders in his absence, as well as presence. It is also said, that after any riot is over, any one justice may send his warrant to arrest any person who was concerned in it, and that he may send him to gaol till he shall find sureties for his good behaviour. The punishment of unlawful assemblies, if to the number of twelve, may be capital, according to the circumstances which attend them; but from the number of three to eleven, it is by fine and imprisonment only. The same is the case in riots and routs by the common law, to which the pillory, in very enormous cases, has been sometimes superadded.

By the act 1 George II. st. 2, c. 5, every justice, mayor, sheriff, &c. shall, upon notice of a riot, or unlawful, tumultuous assembly of twelve persons, proceed to the place, and make proclamation for them to depart, upon the pains of that act commonly called the riot-act. If any person shall wilfully oppose or hurt any person going to make proclamation, and prevent the same, he shall be guilty of felony, without benefit of clergy. If twelve continue together after proclamation, for one hour, it is felony, in like manner. And every justice, &c. shall apprehend persons, and if the rioters are killed, the justice, &c. shall not answer for it. A riot, though of fewer persons than twelve, to destroy any church, chapel, meeting, or dwelling-house, out-house, &c. is a capital felony: and the hundred shall answer the damages, as in case of robbery.

If two justices go out to quell a riot, they may assemble the *posse comitatus*, and every person capable of travelling is, upon being warned, to join them, on pain of imprisonment. 13 Henry IV. c. 7, s. 1, 2, 11, 5. c. 8, s. 2.

RISBAN, in fortification, a flat piece of ground, upon which a fort is constructed for the defence and security of a port or harbour. It likewise means the fort itself. The famous Risban, of Dunkirk, was built entirely of brick and stone; having within its walls excellent barracks, a large cistern well supplied with water, magazines for stores, provisions, and ammunition. A ready communication was kept up with the town by means of the *jettée*, which corresponded with the wooden bridge that joined the entrance into the fort. The rampart was capable of receiving forty-six pieces of ordnance, which were disposed in three different alignements or tiers, owing to the triangular figure of the fort; so that a fire could be kept up on all sides.

RITTERA, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Leguminosæ. Essential character: calyx four-leaved; petals one, lateral; legume one celled, two-valved. There are five species.

RIVER, a current, or stream of fresh water, flowing in a bed or channel, from its source, into the sea. When a stream is not large enough to bear boats, or small vessels laden, it is called a rivulet or brook. The great, as well as the middle-sized rivers, proceed either from a confluence of brooks and rivulets, or from lakes; but no river of considerable magnitude flows from one spring, or one lake, but is augmented by the accession of others. Thus the Wolga receives above two hundred rivers and brooks, before it discharges itself into the Caspian Sea; and the Danube receives no less, before it enters the Euxine Sea. Some rivers are much augmented by frequent rains, or melted snow. In the country of Peru and Chili, there are small rivers, that only flow in the day; because they are only fed by the snow upon the mountains of the Andes, which is then melted by the heat of the sun. There are also several rivers upon both sides the extreme parts of Africa, and in India, which, for the same reason, are greater by day than by night. The rivers also in these places are almost dried up in summer, but swell and overflow their banks in winter, or in the wet season. Thus the Wolga in May and June is filled with water, and overflows its shelves and islands, though at other times of the year it is so shallow, as scarcely to afford a passage for loaded ships. The Nile, the Ganges, the Indus, &c. are so much swelled with rain or melted snow, that they overflow their banks, and these deluges happen at different times of the year, because they proceed from various causes. Those that are swelled with rain are generally highest in winter, because it is usually then more frequent than at other times of the year; but if they proceed from snow, which, in some places, is melted in the spring, in others, in summer, or between both, the deluges of the rivers happen accordingly. Again, some rivers hide themselves under ground, and rise up in other places, as if they were new rivers. Thus the Tigris, meeting with mount Taurus, runs under it, and flows out at the other side of the mountain: also, after it has run through the lake Tospia, it again immerges, and being carried about eighteen miles under ground, breaks out again, &c. The channels of rivers, except such as were formed at the creation, Varenius thinks, are artificial. His reasons are, that, when a new spring breaks out, the water does not make itself a channel, but spreads over the adjacent land; so that men were necessitated to cut a channel for it, to secure their grounds. He adds, that a great number of channels of rivers are certainly known from history to have been dug by men. The water of most rivers flow impregnated with particles of metals, minerals, &c. Thus some rivers bring sands intermixed with grains of gold; as in Japan, Peru, and Mexico, Africa, Cuba, &c. particularly in Guinea is a river, where the negroes separate the gold-dust from the sand, and sell it to the Europeans, who traffic thither for that very purpose. The Rhine in many places is said to bring a gold mud. As to rivers that bring grains of silver, iron, copper, lead, &c. we find no mention of them in authors, though, doubtless, there are many, and it may be to them that mineral waters owe many of their medicinal virtues.

Modern philosophers endeavour to reduce the motion and flux of rivers to precise laws; and with this view they have applied geometry and mechanics to the subject; so that the doctrine of rivers is become a part of the new philosophy.

The authors, who have most distinguished themselves in this branch, are the Italians, and among them more especially Gulielmini, and Ximenes.

Rivers, says Gulielmini, usually have their sources in mountains or elevated grounds; in the descent from which it is mostly that they acquire the velocity, or acceleration, which maintains their future current. In proportion as they advance further, this velocity diminishes, on account of the continual friction of the water against the bottom and sides of the channel, as well as from the various obstacles they meet with in their progress, and from their arriving at length in plains, where the descent is less, and consequently their inclination to the horizon greater.

When the acquired velocity is quite spent, through the many obstacles, so that the current becomes horizontal, there will then nothing remain to propagate the motion, and continue the stream, but the depth, or the perpendicular pressure of the water, which is always proportional to the depth. And this resource increases, as the occasion for it increases; for in proportion as the water loses of the velocity acquired by the descent, it rises and increases in its depth.

It appears from the laws of motion, pertaining to bodies moved on inclined planes, that when water flows freely upon an inclined bed, it acquires a velocity, which is always as the square root of the quantity of descent of the bed. But in an horizontal bed, opened by sluices or otherwise, at one or both ends, the water flows out by its gravity alone.

The greatest velocity of a river is about the middle of its depth and breadth, or that point which is the furthest possible from the surface of the water, and from the bottom and sides of the bed or channel. Whereas, on the contrary, the least velocity of the water is at the bottom and sides of the bed, because there the resisance arising from friction is the greatest, which is communicated to the other parts of the section of the river inversely as the distances from the bottom and sides. To find whether the water of a river almost horizontal, flows by means of the velocity acquired in its descent, or by the pressure of its depth, set up an obstacle perpendicular to it; then if the water rise and swell immediately against the obstacle, it runs by virtue of its fall; but if it first stop a little while, in virtue of its pressure.

Rivers, according to this author, almost always make their own beds. If the bottom have originally been a large declivity, the water, hence falling with a great force, will have swept away the most elevated parts of the soil, and carrying them lower down, will gradually render the bottom more nearly horizontal.

The water, having made its bed horizontal, becomes so itself, and consequently rakes with the less force against the bottom, till at length that force becomes only equal to the resistance of the bottom, which is now arrived at a state of permanency, at least for a considerable time; and the longer, according to the quality of the soil, clay and chalk resisting longer than sand or mud.

On the other hand, the water is continually wearing away the brims of its channel, and this with the more force, as, by the direction of its stream, it impinges more directly against them. By this means it has a continual tendency to render them parallel to its own course. At the same time that it has thus rectified its edges, it has widened its own bed, and thence becoming less deep, it loses part of its force and pressure: this it continues to do till there is an equilibrium between the force of the water and the resistance of its banks, and then they will remain without further change. And it appears, by experience, that these equilibriums are all real, as we find that rivers only deepen and widen to a certain pitch.

The union of two rivers into one makes the whole flow the swifter, because, instead of the friction of four shores, they have only two to overcome, and one bottom instead of two; also the stream being further distant from the banks, goes on with the less interruption; besides, that a greater quantity of water, moving with a greater velocity, digs deeper in the bed, and of course retrenches of its former width. Hence also it is, that rivers by being united, take up less space on the surface of the earth, and are more advantageous to low grounds, which drain their superfluous moisture into them, and have also less occasion for dykes to prevent their overflowing.

A very good and simple method of measuring the velocity of the current of a river, or canal, is the following. Take a cylindrical piece of dry light wood, and of a length something less than the depth of the water in the river; about one end of it let there be suspended as many small weights, as may keep the cylinder in a vertical or upright position, with its head just above water. To the centre of this end fix a small straight rod, precisely in the direction of the cylinder's axis; to the end that, when the instrument is suspended in the water, the deviations of the rod from a perpendicularity to the surface of it, may indicate which end of the cylinder goes foremost, by which may be discovered the different velocities of the water at different depths; for when the rod inclines forward, according to the direction of the current, it is a proof that the surface of the water has the greatest velocity; but when it reclines backward, it shows that the swiftest current is at the bottom; and when it remains perpendicular, it is a sign that the velocities at the top and bottom are equal. This instrument, being placed in the current of a river or canal, receives all the percussions of the water throughout the whole depth, and will have an equal velocity with that of the whole current from the surface to the bottom at the place where it is put in, and by that means may be found, both with exactness and ease, the mean velocity of that part of the river for any determinate distance and time. But to obtain the mean velocity of the whole section of the river, the instrument must be put successively both in the middle and towards the sides, because the velocities at those places are often very different from each other. Having by this means found the several velocities, from the spaces run over in certain times, the arithmetical mean proportional of all these trials, which is found by dividing the common sum of them all by the number of the trials, will be the mean velocity of the river or canal. And if this medium velocity be multiplied by the area of the transverse section of the waters at any place, the product will be the quantity running through that place in a second of time.

If it be required to find the velocity of the current only at the surface, or at the middle, or at the bottom, a sphere of wood loaded, or a common bottle corked with a little water in it, of such a weight as will remain suspended in equilibrium with the water at the surface or depth which we want to measure, will be better for the purpose than the cylinder, because it is only affected by the water of that sole part of the current where it remains suspended.

It follows from what has been said in the former part of this article, that the deeper the waters are in their bed in proportion to its breadth, the more their motion is accelerated; so that their velocity increases in the inverse ratio of the breadth of the bed, and also of the magnitude of the section; whence, in order to augment the velocity of water in a river or canal, without augmenting the declivity of the bed, we must increase the depth of the channel, and diminish its breadth. And these principles are agreeable to observation; as it is well known, that the velocity of flowing waters depends much more on the quantity and depth of the water, and on the compression of the upper parts on the lower, than on the declivity of the bed; and therefore the declivity of a river must be made much greater in the beginning than toward the end of its course, where it should be almost insensible.

RIVINA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: calyx four-leaved, permanent; berry containing one lens-shaped seed. There are four species.

ROAD, an open way, or public passage, forming a communication between one place and another. The Romans took the most pains in forming roads, and the labour and expenses they were at in rendering them spacious, firm, straight, and smooth, is incredible. They usually strengthened the ground by ramming it, laying it with flints, pebbles, or sand, and sometimes with a lining of masonry, rubbish, bricks, &c. bound together with mortar. In some places in the Lionois, F. Menestrier observes that he has found huge clusters of flints cemented with lime, reaching ten or twelve feet deep, and making a mass as hard and compact as marble, and which, after resisting the injuries of time for 1600 years, is still scarce penetrable by all the force of hammers, mattocks, &c. and yet the flints it consists of are not bigger than eggs. The most noble of the Roman roads was the Via Appia, which was carried to such a vast length, that Procopius reckons it five days journey to the end of it, and Leipsius computes it at 350 miles: it is 12 feet broad, and made of square free-stone, generally a foot and a half on each side; and though this has lasted for above 1800 years, yet in many places it is for several miles together as entire as when it was first made.

The ancient roads are distinguished into military roads, double roads, subterraneous roads, &c. The military roads were grand roads, formed by the Romans for marching their armies into the provinces of the empire; the principal of these Roman roads in England are, Watling-street, Ikenild-street, Foss-way, and Erminage-street.—Double roads, among the Romans, were roads for carriages, with two pavements, the one for those going one way, and the other for those returning the other: these were separated from each other by a causeway raised in the middle, paved with bricks, for the conveniency of foot passengers; with borders and mounting stones from space to space, and military columns to mark the distance. Subterraneous roads are those dug through a rock, and left vaulted; as that of Puzzoli near Naples, which is nearly half a league long, and is 15 feet broad, and as many high.

Road, in navigation, is a place of anchorage at some distance from shore, where vessels usually moor, to wait for a wind or tide proper to carry them into harbour, or to set sail. When the bottom is firm, clear of rocks, and sheltered from the wind, it is called a good road; and when there is but little land on any side, it is termed an open road.

The roads in his Majesty's dominions are free to all merchant vessels belonging to his subjects and allies. Captains and masters of ships, who are forced by storms, &c. to cut their cables, and leave their anchors in the roads are obliged to fix marks, or buoys, on pain of forfeiting their anchors, &c. Masters of ships coming to moor in a road must cast anchor at such a distance, as that the cables, &c. do not mix, on pain of answering the damages; and when there are several vessels in the same road, the outermost to the sea-ward is obliged to keep a light in his lanthorn in the night-time, to apprise vessels coming in from sea.

ROASTING, in metallurgy, the separation of volatile bodies from those which are more fixed, by the combined action of air and fire; and is generally the first process in the separation of metals from their ores: it differs from sublimation only in this, that in this operation the volatile parts are dissipated, when resolved into vapours: whereas, in that they are preserved.

ROBBERY, is a felonious taking away of another man's goods from his person, or presence, against his will, putting him in fear, on purpose to steal the same. The value is immaterial.

If a man force another to part with his property, for the sake of preserving his character from the imputation of having been guilty of an unnatural crime, it will amount to a robbery, even though the party was under no apprehension of personal danger. If any thing is snatched suddenly from the head, hand, or person of any one, without any struggle on the part of the owner, or without any evidence of force or violence being exerted by the thief, it does not amount to robbery. But if any thing be broken or torn in consequence of the sudden seizure, it would be evidence of such force as would constitute a robbery; as where a part of a lady's hair was torn away by snatching a diamond pin from her head, and an ear was torn by pulling off an ear-ring; each of these cases was determined to be a robbery.

By 7 George II. c. 21, if any person shall, with any offensive weapon, assault, or by menaces, or in any forcible or violent manner, demand any money or goods, with a felonious intent to rob another, he shall be guilty of felony, and be transported for seven years.

If any person, being out of prison, shall commit any robbery, and afterwards discover two or more persons who shall commit any robbery, so as two or more be convicted, he shall have the King's pardon for all robberies he shall have committed before such discovery.

High-way robbery differs from robbery only in this, that there is a reward of 40*l.* for the apprehending of the offender, and the horse which the robber rides is forfeited.

ROBERGIA, in botany, so named in honour of Laurentius Roberg, a genus of the Decandria Pentagynia class and order. Natural order of Terebintaceæ, Jussieu. Essential character: calyx five-parted; petals five; drupe with a one-seeded nut, and a two-valved shell. There is but one species, *viz.* R. frutescens, a native of the woods of Guiana.

ROBINIA, in botany, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx four-cleft; legume gibbous, elongated. There are seventeen species.

ROBINS (Benjamin), in biography, an English mathematician and philosopher, of great genius and eminence, was born at Bath, in Somersetshire, 1707. His parents were of low condition, and quakers; and, consequently, neither able from their circumstances, nor willing from their religious profession, to have him much instructed in that kind of learning which they are taught to despise as human. Nevertheless he made an early and surprising progress in various branches of science and literature, particularly in the mathematics; and his friends being desirous that he might continue his pursuits, and that his merit might not be buried in obscurity, wished that he could be properly recommended to teach that science in London. Accordingly, a specimen of his abilities, in this way, was sent up thither, and shown to Dr. Pemberton, the author of the "View of Sir Isaac Newton's Philosophy;" who thence conceiving a good opinion of the writer, for a further trial of his skill, sent him some problems, which Robins resolved very much to his satisfaction. He then came to London, where he confirmed the opinion which had been preconceived of his abilities and knowledge.

But though Robins was possessed of much more skill than is usually required in a common teacher; yet being very young, it was thought proper that he should employ some time in perusing the best writers upon the sublimer parts of the mathematics, before he should undertake publicly the instruction of others. In this interval, besides improving himself in the modern languages, he had opportunities of reading, in particular, the works of Archimedes, Apollonius, Fermat, Huygens, De Witt, Slusius, Gregory, Barrow, Newton, Taylor and Cotes. These authors he readily understood, without any assistance, of which he gave frequent proofs to his friends: one was, a demonstration of the last proposition of "Newton's Treatise on Quadratures," which was thought not undeserving a place in the Philos. Trans. for 1727.

Not long after an opportunity offered him of exhibiting to the public a specimen also of his knowledge in natural philosophy. The Royal Academy of Sciences at Paris had proposed, among their prize questions in 1724 and 1726, to demonstrate the laws of motion in bodies impinging on one another. John Bernoulli here condescended to be a candidate; and as his dissertation lost the reward, he appealed to the learned world by printing it in 1727. In this piece he endeavoured to establish Leibnitz's opinion of the force of bodies in motion, from the effects of their striking against springy materials: as Poleni had before attempted to evince the same thing, from experiments of bodies falling on soft and yielding substances. But as the insufficiency of Poleni's arguments had been demonstrated in the Philos. Trans. for 1722; so Robins published in the "Present State of the Republic of Letters," for May 1728, a confutation of Bernoulli's performance, which was allowed to be unanswerable.

Robins now began to take scholars. About this time he quitted the dress and profession of a quaker; and, probably, without reflecting very much upon the subject of religion, he soon shook off the prejudices of his early habits. But though he professed to teach the mathematics only, he would frequently assist particular friends in other matters; for he was a man of universal knowledge; and the confinement of this way of life not suiting his disposition, which was active, he gradually declined it, and went into other courses that required more exercise Hence he tried many laborious experiments in gunnery; believing that the resistance of the air had a much greater effect on swift projectiles than was generally supposed. And hence he was led to consider those mechanic arts that depend upon mathematical principles, in which he might employ his invention; as the constructing of mills, the building of bridges, draining of fens, rendering of rivers navigable, and making of harbours. Among other arts of this kind, fortification very much engaged his attention; in which he met with opportunities of perfecting himself, by a view of the principal strong places of Flanders, in some journies he made abroad with persons of distinction.

On his return home from one of these excursions, he found the learned here amused with Dr. Berkeley's treatise, printed in 1734, entitled "The Analyst," in which an examination was made into the grounds of the Doctrine of Fluxions, and occasion thence taken to explode that method. Robins was, therefore, advised to clear up this affair, by giving a full and distinct account of Newton's doctrines, in such a manner as to obviate all the objections, without naming them, which had been advanced by Berkeley, and accordingly he published, in 1735, a Discourse concerning the Nature and Certainty of Sir Isaac Newton's Method of Fluxions, and of Prime and Ultimate Ratios. This is a very clear, neat, and elegant performance; nevertheless some persons, even among those who had written against the Analyst, taking exception at Robin's manner of defending Newton's doctrine, he afterwards wrote two or three additional discourses.

In 1738, he defended Newton against an objection, contained in a note at the end of a Latin piece, called "Matho, sive Cosmotheoria puerilis," written by Baxter, author of the "Inquiry into the Nature of the Human Soul:" and the year after he printed Remarks on Euler's Treatise of Motion, on Smith's System of Optics, and on Jurin's Discourse of Distinct and Indistinct Vision, annexed to Dr. Smith's work.

In the mean time Robins's performances were not confined to mathematical subjects; for, in 1739, there came out three pamphlets upon political affairs, which did him great honour. The first was entitled, "Observations on the present Convention with Spain;" the second, "A Narrative of what passed in the Common-Hall of the Citizens of London, assembled for the Election of a Lord Mayor;" the third, "An Address to the Electors and other Free Subjects of Great Britain, occasioned by the late Succession; in which is contained a particular account of all our negociations with Spain, and their treatment of us for above ten years past." These were all published without our author's name; and the first and last were so universally esteemed, that they were generally reputed to have been the production of the great man himself, who was at the head of the opposition to Sir Robert Walpole. They proved of such consequence to Mr. Robins, as to occasion his being employed in a very honourable post; for the patriots at length gained ground against Sir Robert, and a Committee of the House of Commons being appointed to examine into his past conduct, Robins was chosen their Secretary. But after the Committee had presented two reports of their proceedings, a sudden stop was put to their further progress, by a compromise between the contending parties.

In 1742, being again at leisure, he published a small treatise, entitled "New Principles of Gunnery;" containing the result of many experiments he had made, by which are discovered the force of gunpowder, and the difference in the resisting power of the air to swift and slow motions. To this treatise was prefixed a full and learned account of the progress which modern fortification had made from its first rise; as also of the invention of gunpowder, and of what had already been performed in the theory of gunnery. It seems that the occasion of this publication was the disappointment of a situation at the Royal Military Academy at Woolwich. On the new modelling and establishing of that Academy, in 1741, our author and the late Mr. Muller, were competitors for the place of Professor of Fortification and Gunnery. Mr. Muller held then some post in the Tower of London, under the Board of Ordnance, so that, notwithstanding the great knowledge and abilities of our author, the interest which Mr. Muller had with the Board of Ordnance, carried the election in his favour. Upon this disappointment Mr. Robins, indignant at the affront, determined to show them, and the world, by his military publications, what sort of a man he was that they had rejected.

Upon a discourse containing certain experiments being published in the Philos. Trans. with a view to invalidate some of Robin's opinions, he thought proper in an account he gave of his book in the same Transactions, to take notice of those experiments: and in consequence of this, several dissertations of his, on the resistance of the air, were read, and the experiments exhibited before the Royal Society, in 1746 and 1747; for which he was presented with the annual gold medal by that society.

In 1748, came out "Anson's Voyage round the World;" which, though it bears Walter's name in the title page, was, in reality, written by Robins. Of this voyage the public had for some time been in expectation of seeing an account, composed under that commander's own inspection: for which purpose the Reverend Richard Walter was employed, as having been Chaplain on board the Centurion the greatest part of the expedition. Walter had accordingly almost finished his task, having brought it down to his own departure from Macao for England; when he proposed to print his work by subscription. It was thought proper, however, that an able judge should first review and correct it, and Robins was appointed; when, upon examination, it was resolved that the whole should be written entirely by Robins, and that what Walter had done being mostly taken, verbatim, from the journals, should serve as materials only. Hence it was that the whole of the introduction, and many dissertations in the body of the work, were composed by Robins, without receiving the least hint from Walter's manuscripts, and what he had transcribed from it regarded chiefly the wind and weather, the currents, courses, bearings, distances, offings, soundings, moorings, the qualities of the ground they anchored on, and such particulars as usually fill up a seaman's account. No production of this kind ever met with a more favourable reception, four large impressions having been sold off within a year: it was also translated into most of the European languages; and it still supports its reputation, having been repeatedly reprinted in various sizes. The fifth edition, at London, in 1749, was revised and corrected by Robins himself; and the ninth edition was printed there in 1761.

Thus becoming famous for his elegant talents in writing, he was requested to compose an apology for the unfortunate affair at Preston-Pans in Scotland. This was added as a preface to the report of the proceedings and opinion of the board of general officers, on their examination into the conduct of Lieutenant General Sir John Cope, &c. printed at London in 1749; and this preface was esteemed a master-piece of its kind.

Robins had afterwards, by the favour of Lord Anson, opportunities of making further experiments in gunnery; which have been published since his death, in the edition of his works by his friend Dr. Wilson. He also not a little contributed to the improvements made in the Royal Observatory at Greenwich, by procuring for it, through the interest of the same noble person, a second mural quadrant, and other instruments; by which it became perhaps the completest observatory of any in the world.

His reputation being now arrived at its full height, he was offered the choice of two very considerable employments. The first was, to go to Paris as one of the commissaries for adjusting the limits in Acadia; the other to be engineer general to the East India Company, whose forts being in a most ruinous condition, wanted an able person to put them into a proper state of defence. He accepted the latter, as it was suitable to his genius, and as the Company's terms were both advantageous and honourable.

He designed, if he had remained in England, to have written a second part of the voyage round the world, as appears by a letter from Lord Anson, to him, dated Bath, October 22, 1749, as follows.

"Dear Sir, when I last saw you in town, I forgot to ask you, whether you intended to publish the second volume of my voyage before you leave us; which I confess I am very sorry for. If you should have laid aside all thoughts of favouring the world with more of your works, it will be much disappointed, and no one in it more than your very obliged humble servant,

"ANSON."

Robins was also preparing an enlarged edition of his New Principles of Gunnery; but, having provided himself with a complete set of astronomical and other instruments for making observations and experiments in the Indies, he departed hence at Christmas in 1749; and after a voyage, in which the ship was near being cast away, he arrived at India in July following. There he immediately set about his proper business with the greatest diligence, and formed complete plans for Fort St. David, and Madras, but he did not live to put them into execution. For the great difference of the climate from that of England being beyond his constitution to support, he was attacked by a fever in September the same year; and though he recovered out of this, yet about eight months after he fell into a languishing condition, in which he continued till his death, which happened the 29th of July 1751, at only 44 years of age.

By his last will, Mr. Robins left the publishing of his mathematical works to his honoured and intimate friend Martin Folkes, Esq. President of the Royal Society, and to Dr. James Wilson; but the former of these gentlemen being incapacitated by a paralytic disorder, some time before his death, they were afterwards published by the latter in 2 vols. 8vo, 1761. To this collection, which contains his mathematical and philosophical pieces only, Dr. Wilson has prefixed an account of Mr. Robins, from which this memoir is chiefly extracted. He added also a large appendix, at the end of the second volume, containing a great many curious and critical matters in various interesting parts of the mathematics.

It is but justice to say, that Mr. Robins was one of the most accurate and elegant mathematical writers that our language can boast of; and that he made more real improvements in artillery, the flight and the resistance of projectiles, than all the preceding writers on that subject. His new principles of gunnery were translated into several other languages, and commented upon by several eminent writers. The celebrated Euler translated the work into the German language, accompanied with a large and critical commentary; and this work of Euler's was again translated into English in 1714, by Mr. Hugh Brown, with notes, in one volume quarto.

ROBINSONIA, in botany, a genus of the Icosandria Monogynia class and order. Essential character: calyx five-toothed; petals five; berry striated, two-celled; cells one-seeded; seeds villose. There is but one species, *viz.* R. melianthifolia, a native of Guiana.

ROCHEFORTIA, in botany, so named in memory of De Rochefort, a genus of the Pentandria Digynia class and order. Natural order of Dumosæ. Rhamni, Jussieu. Essential character: calyx five-parted; corolla one petalled, funnel-form, inferior, with the aperture open; fruit two-celled, many-seeded. There are two species, *viz.* R. cuneala, and R. ovata, both natives of Jamaica.

ROCK, a stony mass, forming a portion of the substance of this globe. Rocks are in general disposed in mountanic ranges; but in some few instances are found existing in immensely large separate masses.

The obvious differences existing in the appearances and composition of different rocks and mountains have long induced mineralogists to consider them as formed at very distant periods from each other, and even to suppose that those of the latter formation frequently derived the materials of which they were composed from the disintegration of the previously existing and much more ancient rocks. Hence arose their division into primeval, or primitive: and secondary, or epizootic; and in consequence of the prevalence of the opinion of the primitive rocks supplying the materials of those of secondary formation, the latter were further separated into original and derivative. The secondary rocks were also considered as otherwise differing in their origin; some being supposed to be marigenous, and others alluvial.

The celebrated Werner considers all rocks, with respect to their origin, to be aquatic or ignigenous. The aquatic are divided, agreeable to the period, and the particular mode of their formation, into, 1. Primitive, being chemical precipitates, bearing no traces of organized beings, and formed in the early chaotic state of the earth. 2. Transition, formed, as the term implies, during the transition of the earth into a habitable state. 3. Floëtz rocks, disposed in flat or horizontal strata, after the creation of animals and vegetables; the remains of which are often found in the substance of these rocks: as the primitive are of purely chemical, so the two latter are of partly chemical, and partly mechanical formation. 4. Alluvial, formed by the component parts of previously existing rocks, separated by the influence of air, water, and change of temperature, and deposited in beds. 5. Volcanic rocks, which, according to their originating from true volcanoes, or from pseudo-volcanoes, are considered as volcanic, or pseudo-volcanic.

Mountain rocks are simple, as when formed of limestone, clay-slate, serpentine, or any other simple fossil; and compound, when formed by the aggregations of simple fossils. The compound rocks are either cemented, formed of various parts brought together and connected by a cement, as in sand-stones, pudding-stones, and brecciæ ; or are aggregated, being composed of parts existing originally on the spot where the masses are now found, and connected together by their original structure. They are also considered as simple aggregated, when one, as a base, includes the other; when the contained portion is in the form of grains or crystals, the structure is termed porphyritic; and when of a vesicular form, amygdaloidal: the double aggregated is when a smaller structure is contained in a larger, as granular slaty; or when the two structures exist near or beside each other; when the one not including the other is pointed out by a conjunction, as porphyritic and amygdaloidal.

The mountain masses themselves are either of a stratified or of a seamed structure. When the masses composing the rock are of one species, and disposed parallel to each other, those masses are termed strata ; but when the mountain mass is composed of different species of rocks, thus disposed, it is said to be formed of beds. In the seamed structure, the seams of stratification, though parallel in one direction, intersect each other in another. The masses thus divided by these intersecting seams, may be considered as distinct concretions, and may be instanced in the columnar formed. Straight and much thicker masses are also thus formed, by what is termed the tabular seamed structure, and large globular masses result from the large globular or massive structure.

By a rock formation, Mr. Jameson understands "a determinate assemblage of similar or dissimilar rock masses, which are characterised by external and internal relations, as an independent whole, that is, as an unity in the series of rock formations." When the mass is uniform throughout, it constitutes a simple formation ; but when dissimilar, a compound formation ; and when these formations are repeated, the whole is denominated a series or suite of formations. When individual beds occur in different principal formations, as primitive trap in gneiss, mica-slate, &c. forming single independent wholes, which always continue the same, notwithstanding the difference of rocks in which they are imbedded, and still form members of a series of formations, they are considered as independent formations. The inclination of a stratum is the angle which the stratum forms with the horizon, and is determined by the quadrant. The dip is the point of the compass towards which the stratum inclines. The direction is the angle which the stratum makes with the meridian, and is determined by the compass. It is always at right angles to the dip.

The primitive rocks are chiefly composed of substances, which chiefly consist of the siliceous and argillaceous earths. 1. Granite, the moor-stone of Cornwall, is a granular rock composed of felspar, mica, and quartz, united in various proportions.—Schorl, garnet, tin-stone, adularia, chlorite, and rock crystal, are among the accidental minerals which occur in this rock : it sometimes exists in large distinct globular, and sometimes in columnar concretions : it is sometimes stratified, but seldom contains any foreign beds. 2. Gneiss, is a stratified rock, formed of the same component parts as granite, but the mica exists in larger proportion than in granite : it sometimes contains schorl, and, but more rarely, garnet and hornblende: its structure passes from that which approaches to the granular structure of granite, to the undulated, and even the slaty structure. It is very frequently metalliferous, there being few metals which are not found in it. 3. Mica slate is likewise a distinctly stratified rock, which rests on gneiss: it is composed of mica and quartz, disposed in a slaty structure : it frequently contains garnets, and sometimes hornblende, schorl, and tourmaline, kyanite, rutile, and felspar. Like gneiss it is frequently metalliferous, the ores generally occurring in beds; whereas in gneiss the ore is most frequently found in veins. 4. Clay-slate is a simple rock, and follows the foregoing in the series of primitive rocks: it sometimes contains schorl, tourmaline, garnet, horneblende, chiastolite, and actynolite. There appear to be four different kinds of clay-slate, chiefly distinguishable by their colours: yellowish grey, which connects clay-slate with mica slate; dark and bluish grey, used as roof-slate ; greenish grey, and lastly bluish and reddish grey, containing a few scales of mica. The rocks peculiar to this formation are, whet-slate, roof-slate, chlorite-slate, talc-slate, alum-slate, drawing-slate, pot-stone, and flinty-slate. This, like those already mentioned, is a widely extended rock, and is also one of the most metalliferous. 5. Primitive lime-stone, is a simple mountain rock, which is more or less distinctly stratified, and is frequently metalliferous; its colours are various, and its structure is always granular. Quartz and mica frequently occur in it accidentally: it also sometimes contains hornblende, actynolite, asbestos, serpentine, talc, steatite, tremolite, garnet, calcareous spar, and slate-spar. 6. Primitive trap, is a mountain which seems intimately connected with clay-slate. The term trap had been long used without a definite signification; but Werner has resricted its application to rocks, principally containing hornblende, and black iron-clay; the iron-clay first appearing in the transition, and increasing in rocks of the newer periods. There are three distinct species of primitive trap. Common hornblende rock, under which are comprised, hornblende rock, and horneblende slate. Hornblende with felspar, a subordinate kind of which is greenstone, which has the following varieties: common greenstone, a granular aggregate of hornblende and felspar. Porphyritic greenstone is the former, containing crystals of felspar. Greenstone porphyry, is the black porphyry of the ancients; crystals of felspar are here also included, but the granular structure of the basis is hardly discoverable. Green porphyry, in which the granular structure is no longer visible, and crystals of compact felspar are included. The second species of primitive trap is greenstone slate, composed of hornblende and compact felspar, arranged in a slaty structure; and the third is an intimate mixture of hornblende with felspar, including mica in scales. It is found in beds in gneiss and mica-slate. 7. Serpentine is a simple mountain rock, indistinctly stratified. A great variety of other mineral bodies are found in it, and it is sometimes indeterminately mixed with limestone, forming what is termed *verde antico*. 8. Porphyry is a compound rock, formed of one substance in the form of grains or crystals, imbedded in another as its basis. The base is clay-stone, hornstone, compact felspar, pitch-stone, pearl-stone, or obsidian: the imbedded crystals are of quartz or felspar. There appears to be two formations of porphyry; the oldest consists principally of hornstone and felspar porphyry; and the newer of clay, pitchstone, pearl-stone, and obsidian porphyry. 9. Sienite is a compound, granular, aggregated rock, formed of felspar and hornblende, and sometimes containing quartz and black mica. The hornblende distinguishes this rock from granite; but the felspar, which is almost always red, and seldom inclining to green, is the most abundant and essential portion of the rock; a circumstance which distinguishes it from greenstone, in which the felspar predominates, and is of a greenish colour; whilst in sienite it is red or reddish. 10. Topaz rock is composed of quartz, topaz schorl, and a small portion of lithomarge: the stratification of this rock is uncommonly distinct. 11. Quartz rock is a simple mountain rock, composed of small and flattish granular distinct concretions. This, as well as the former rock, is not very frequently met with, nor is of considerable extent. 12. Primitive flinty-slate is a simple rock, of which there exist two subspecies; common flinty slate, and Lydian stone. It is met with in considerable beds in clay-slate. 13. Primitive gypsum is a simple rock, which is distinguishable from the newer gypsum, by its being mixed with mica and clay-slate. 14. White stone is a rock, which is sometimes of a slaty, and sometimes of a granular structure, and is chiefly composed of compact felspar, with a small proportion of mica.

Whilst the primitive mountains were still covered with water, it is supposed that a considerable rising of the waters took place, from which were deposited rocks of porphyry, sienite and pitch-stone. These contain very little mechanical deposition, no petrifactions, and little or no carbonaceous matter. These rocks are considered as the second porphyry and sienite formations.

The rocks which are considered as transition rocks are, 1. Transition limestone, differing from the primitive in its variety of colours, and by its containing the remains of marine animals; and from the floëtz in its minute granular structure giving a splintery or flat conchoidal fracture. 2. Transition trap; under which species we have transition green stone, distinguished by being less crystalline than the primitive, and more so than the floëtz; and transition amygdaloid. 3. Grey wacké, which is more abundant than the two preceding, and also marks a particular period in the formation of rocks, it possessing the appearance of mechanical deposition. There are two kinds, grey wacké and grey wacké slate: the former is a sand-stone, differing from those of later formation, in being composed of portions of sand of larger size in grey coloured clay-slate; the latter obtains its slaty structure, in a great measure, from the smallness of the sandy particles. This rock is extremely abundant in metals, and is very generally distributed. 4. Transition flinty-slate. 5. Transition gypsum. The two latter do not appear to be decidedly distinguished from those of the other periods.

The floëtz rocks, formed by risings of the waters after the creation of animals and vegetables, seldom reach to a very great height: those of what is termed the newest floëtz trap formation form, however, an exception; since they cover the summits of very high mountains, and show their formation to have been at a different period, and when the waters were higher than when the other floëtz rocks were formed. Of these rocks lime-stone is the most prevalent; and in the rocks of this formation bituminous fossils, and the petrifactions of vegetables and animals, are very numerous, and in great variety.

The rocks of this class are the following: 1. The first sand-stone formation, which is called the old red sand-stone; the grains are usually quartz and flinty slate, cemented by iron-shot clay. 2. Variegated sand-stone, or second sand-stone formation; which is marked with, and is also disposed in, layers of different colours. 3. Third sand-stone formation; which is always white, and appears to be of much later formation than those just mentioned. 4. Partial sand-stone formation. 5. Floëtz lime-stone, is a simple rock, and is more distinctly stratified than any other rock. Two distinct formations are described; the first floëtz lime-stone, and the second floëtz, or shell lime-stone. 6 Floëtz gypsum is also a simple rock, and is more or less distinctly stratified. Of these rocks also there appears to be, beside others, two principal formations. 7. Rock-salt formation. It is mostly found in short, but thick beds, in clay in a state between common and indurated clay. 8. Chalk is reckoned one of the newest of the floëtz formations. It generally contains flint, and the petrifactions of marine animals. 9. Floëtz trap is supposed by Mr. Jameson to result from a formation different from that which Werner has named the newest floëtz trap. 10. Coal formation. Werner describes three formations of coal; the oldest, or independent coal formation; that which occurs in the newest floëtz trap formation; and that which occurs in alluvial land. 11. Newest floëtz trap formation, which includes several rocks, particularly basalt, wacké, grey-stone, porphyry-slate, and trap-tuff, which are its peculiar and characteristic rocks. Those which occur in it, as well as in the other floëtz formations, are green-stone, amygdaloid, pitch-stone, obsidian, pumice, compact felspar, clay-stone; gravel, sand, and clay; sand-stone, clay iron-stone, lime-stone, iron-clay, and coal. The form, and other visible characters, of many of the mountain rocks are frequently sufficient to point out their nature to the attentive observer. Granite is characterised by its very high and precipitous cliffs and peaks; gneiss is less lofty, and its summits are less steep and abrupt; and the mountains of mica slate are still less lofty, and bear more of a rounded form. Clay-slate mountains are generally less lofty than those already noticed, and their cliffs are still less steep and rough. Primitive lime-stone sometimes presents lofty peaks, like those of granite; but the mountains containing it in general assume the characters of gneiss, mica-slate, or clay-slate, with which it is in general found. Rocks of primitive trap are generally lofty, steep, and conical. "No rock," Mr. Jameson observes, "presents a greater variety of external appearance than the sand-stone. Its vallies are deep, rocky, and romantic; its hills are conical, steep, and cliffy; and it often presents grand colossal pillars, which, from their number, and variety of their shape, form most striking rocky scenes." Floëtz lime-stone assumes very different forms from those already particularised, being extended in large, flat hills, intersected by steep vallies. Chalk in some situations forms hills of considerable height, which are generally rounded, with an extensive base.

The position, extent, and direction of the several strata of different formations, either taken with or without reference to the fundamental rock, yield very convincing testimony in favour of the opinions delivered by the celebrated Werner respecting the formation of the earth. (See Geology.) Previously to viewing the illustration of his theory in the formation of a suite of rocks, it may be necessary to particularize some of the peculiarities in the formation of different rocks, and to show the different terms by which they are expressed. The formations themselves are distinguished as universal or partial, and as unbroken or broken. The strata are considered as conformable, or unconformable, with the direction of the fundamental rock; and overlying, when lying over the ends of the strata of the fundamental rock. They are said to be straight, when disposed in one direction on the fundamental rock; when they turn round it, leaving the top uncovered, mantle-formed; and when they also cover its extremities, saddleformed. When concave, they are termed basin-shaped; and if the concavity is long, trough-shaped. Their upper extremities, appearing at the surface of the earth, are termed the outgoings of the strata: the outermost of the circles formed by these is the oldest in the concave (the basin and trough-shaped), and newest in the convex (the mantle and saddle-shaped). When detached portions occur on the summits of hills, they are called caps; when filling up hollow spaces, upfillings; and when only on one side of a mountain, shield-formed.

It has been here said, according to the theory of Werner, that one class of mountains was deposited, by chemical formation, from an aqueous solution, previous to the creation of vegetables and animals: that to these succeeded another class, in which materials mechanically separated were discoverable, formed during the passage of this globe into a habitable state; and that during the existence of animals and vegetables in considerable number, another (the latest) class was produced, in which mechanical deposits and remains of organized bodies exist in considerable quantity. Of these different classes of rocks, it may be expected, that the rocks of the earliest period would be found invested in various modes by those of later formation, and disposed in the order of their separation from the waters from which they derived their origin.

The rocks which exist in the Hartz appear to be beautifully illustrative of this successive deposition. In the centre a vast mass of granite rises through the other strata, and round this clay-slate is disposed in mantle-shaped strata. Gneiss and mica-slate not existing in this country, transition limestone succeeds to the clay-slate, and then grey wacké and grey wacké slate: the whole being wrapped round the granite in mantle-shaped strata, and invariably with lower and lower outgoings, corresponding to the newer and newer strata. To these the floëtz rocks succeed, the oldest of the floëtz resting on the newest of the transition; and the different floëtz rocks resting on each other according to their relative age. Last of all, the alluvial rocks are found in the lowest situations. We have thus, as Mr. Jameson observes, all the series of rocks, from the granite to the alluvial, marked with a diminishing level, in proportion to the newness of the strata.

The system of Werner, formed upon a most comprehensive view of the several phenomena observable in the formation of the crust of this globe, has been here adopted, from Professor Jameson's perspicuous description of it, on account of its so exactly corresponding with the appearances which masses of rocks every where present to our view. The present outline, though perhaps sufficiently correct, is, however, by no means pretended to supersede the study of the work alluded to; since an accurate knowledge of the subject can only be yielded by the study of the more highly finished performance itself.

ROCKET. See PYROTECHNY.

ROD, a land measure of sixteen feet and a half; the same with perch and pole.

ROELLA, in botany, so named in honour of William Roell, a genus of the Pentandria Monogynia class and order. Natural order of Campanaceæ. Campanulaceæ, Jussieu. Essential character: corolla funnel-form, with the bottom closed by staminiferous valves; stigma bifid; capsule two-celled, cylindrical, inferior. There are five species, all natives of the Cape of Good Hope.

ROHRIA, in botany, so named in honour of Julius von Rohor, a genus of the Triandria Monogynia class and order. Essential character: calyx bell-shaped, five-parted: corolla five-petalled, unequal; stigmas three, revolute; capsule. There is but one species, *viz.* R. petioliflora, a native of the woods of Guiana.

ROGUE. See VAGRANT.

ROHAULT (JAMES), in biography, a French philosopher, was the son of a rich merchant at Amiens, where he was born in 1620. He cultivated the languages and belles lettres in his own country, and then was sent to Paris to study philosophy. He seems to have been a great lover of truth, at least what he thought so, and to have sought it with much impartiality. He read the ancient and modern philosophers; but Des Cartes was the author who most engaged his attention. Accordingly, he became a zealous follower of that great man, and drew up an abridgment and explanation of his philosophy with great clearness and method. In the preface to his Physics, for so his work is called, he makes no scruple to say, that "the abilities and accomplishments of this philosopher must oblige the whole world to confess, that France is at least as capable of producing and raising men versed in all arts and branches of knowledge as ancient Greece." Clerselier, well known for his translation of many pieces of Des Cartes, conceived such an affection for Rohault, on account of his attachment to this philosopher, that he gave him his daughter in marriage against all the remonstrances of his family.

Rohault's Physics were written in French, but have been translated into Latin by Dr. Samuel Clarke, with notes, in which the Cartesian errors are corrected upon the Newtonian system. The fourth and best edition of Rohault's Physics, by Clarke, is that of 1718, in 8vo. He wrote also "Elemens des Mathematiques," "Traité des Mechanique," and "Entretiens sur la Philosophie." But these dialogues are founded and carried on upon the principles of the Cartesian philosophy, which has now little other merit than that of having corrected the errors of the ancients. Rohault died in 1675, and left hehind him the character of an amiable, as well as a learned and philosophic man.

His posthumous works were collected and printed in two neat little volumes, first at Paris, and then at the Hague, in 1690. The contents of them are, 1. The first six books of Euclid. 2. Trigonometry. 3. Practical Geometry. 4. Fortification. 5. Mechanics. 6. Perspective. 7. Spherical Trigonometry. 8. Arithmetic.

ROLANDRA, in botany, so named in honour of Daniel Rolander, a pupil of Linnæus, who travelled to Surinam; a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: florets bundled into a head with scales interposed; calyx partial, two-valved, one-flowered; corollets hermaphrodite; down none. There is but one species, *viz.* R. argentea, a native of the West Indies.

ROLLING *mill*, in mechanics, a machine for working metals into plates, or bars, which are required of an even thickness. In the Plate Rolling-Mill, are three elevations of a machine for this purpose, A B, D E, in all these figures is a massive frame of cast iron, consisting of two distinct cheeks, A B and D E, which are connected together by being both affixed to an iron plate, F F, bolted down upon two ground sills, G G, supported on masonry, and forming the foundation for the whole machine; each cheek has an oblong mortice, *a b*, through it; a strong iron screw, *d*, is screwed through the upper end of each cheek, and has a wheel on the top of it, with teeth, to receive a handspike to turn it by. I K are the two rollers made of cast iron, and very truly turned in a lathe; they have pivots, *i l*, *k m*, at each end, turned at the same time, and with the greatest accuracy; these pivots are supported on bearings of brass in the cheeks; those of the lower roller, K, fit in the bottom of the mortices, *a b*, (fig. 1 and 3) through the cheeks; the upper ones, *e e*, are moveable, sliding up and down in the mortices by the action of the screw, *d*. The weight of the upper roller, when nothing is between the rollers, is sustained by an iron strap, *n*, at each end, embracing the pivots, and going through the brass bearing, *ee*. Its ends are tapped, and have nuts screwed upon them to prevent their return through the ends of the collar, *p*, which fits in a groove cut round the screw, *d*, so that it cannot come off; the collar is made in two halves, which are held together by the ends of the strap, *n*, going through both at the place where they overlap each other; by this means the upper bearings are firmly connected with the screws, to rise and fall with them; and at the same time, the pivots of the upper roller are held up to their bearings by the straps, *n*, going under them. The end of the pivots of the rollers are formed into squares beyond the bearings, and the pivots of one end of each roller have two cog wheels, L M, fitted on them; they are shown faceways, (in fig. 1) and are both alike; they cause the two rollers to move with an equal velocity; the other square, *k*, on the lower roller, is fitted into a box, M, by which it is joined to a strong shaft, O, which communicates a rotatory motion to the rollers. This shaft receives its power from a water-wheel, steam engine, horses, or other first moving power: *s* is a small trough made of iron plate, punched full of holes, it is supplied with water by a pipe, *n*, and constantly drops a small quantity of water upon the rollers, and thus keeps them cool when they are rolling hot work: *w* is a bar of iron fixed between the two cheeks by wedges, the upper side is on a level with the top of the lower roller; a small distance above this is another iron bar, *x*, parallel to the former; between these the article intended to be rolled is introduced to the rollers.

Rolling mills are chiefly used for drawing out iron bars after they have been manufactured into bar iron by the forge hammer; the rollers leave a smoother surface, and make a bar of more even thickness, than the hammer can be made to do; the iron hoops for barrels are also made in this machine; its operation is exceeding simple; a furnace is placed close to the machine where the iron bars are to be rolled; are heated to a white heat; a workman stands between the furnace and the mill, and takes a bar from the furnace with a pair of pincers, and puts its end between the bars, *w* and *x*, advancing it forwards until the rollers take it between them and draw it forwards, spreading it as it goes both in length and breadth; another workman, behind the machine, receives the bar as it comes through, and conveys it away, to make room for the next. The small stream of water brought by the pipe, *r*, cools and hardens the iron as it is rolled without plunging in water. The rollers can be set nearer or further apart by turning the screws, *d d*, to make thicker or thinner work. The iron will pass through the rollers at the rate of three and a half or four inches per second, and thus will do a great quantity of work; but the power required to turn them, when they have large and heavy work in them, is immense; for the same reason the frame of the machine must be exceedingly strong and well put together.

ROLLS, are parchment, on which all the pleadings, memorials, and acts of courts, are entered and filed with the proper officer, and then they become records of the court.

ROMAN *Catholics*, in church history, a name given to those christians who believe the doctrines and submit to the discipline of the church of Rome. They are also called Papists, from *papa*, father, because the Bishop of Rome is not only styled supreme, but œcumenical, or universal bishop; and they think they are entitled to the appellation of Catholics, because, as they assert, the Romish Church is not only *a* true church, but *the* only true church; having all the marks of the true church: viz. unity, holiness, universality, and apostolicity. Whether the Church of Rome has any exclusive right to these four assumed marks it is not our business to inquire.

The Roman or Latin Church is a system of goverment, whose jurisdiction extends to a great part of the known world; though its authority has been circumscribed within narrower limits since the era of the reformation; and has been, particularly of late years, gradually decaying in every country in Europe.

Of the origin of this most extraordinary power there are various accounts extant It appears, however, that after the Roman Empire became christian, it was greatly corrupted, till the empire fell, and made way for the dominion and grandeur of the Bishop of Rome, under whom the corruption rose to an amazing height. Early in the fourth century, in which the fathers, Cyril, Basil, Gregory, and Ambrose, flourished, was instituted the monastic life. Notwithstanding the piety and sanctity to which this institution made pretensions, a manifest love of power, and riches, was predominant; and that, at best, the monastic life laid the foundation of that superstructure of mystery, intolerance, and superstition, which in subsequent periods of the church made such havock with the peace and happiness of mankind. It was from this time that the church became modelled by assuming priests; the simplicity of truth was obscured by mystery; and the kingdom of Christ became a kingdom of this world. The popes, as bishops of Rome, having laid the foundation of that monarchical power to which they afterwards rose, one of the first and most essential steps was the creation of the dignity of Patriarch, afterwards confirmed by the Council of Nice. Thus the hierarchy became formed according to the constitution of the Roman Empire. After this it was resolved, that the precedence and authority of bishops over others should be determined by the rank of the cities where they resided; and of consequence, in process of time, as it could be effected, the Bishop of Rome must have the supremacy; and this was managed with so much art, as to be confirmed in the next council without its appearing previously to have been made a point of.

Constantine the Great, who became a christian, A. D. 312, took the cause of religion into his hands, and defended his new friends against the rage of their heathen adversaries with so much success, that he restored peace and tranquillity to the christian world. When the church, under this Emperor and his successors, enjoyed the protection of the civil powers, the christians began to compare their present with their past condition, and called to mind the sufferings of their predecessors, and the patience and fortitude which they had exerted, particularly in the last and severest persecution. These considerations raised in them a high, and indeed in some degree a just veneration for the martyrs. But it did not stop here; what was at first only a pious veneration, soon rose into a kind of adoration; and it was discovered that considerable profit might be gained by the sale of bones and reliques, that it were honourable, not to say miraculous, to possess, and meritorious to preserve. Athanasius and Gregory, Nazienzen and Chrysostom, used all their power and eloquence to increase the popular veneration and invocation of saints, the love of monkery, and the belief of miracles wrought by monks and reliques.

The period of intellectual vassalage now commenced; and trick and finesse were soon discovered, by avaricious and ambitious priests, to be far more profitable than the truth as it is taught by Jesus.

It was about this time that the Council of Nice assembled, "by the grace of God, and favour of Constantine, the prince beloved of God," to crush by numbers, clamour, and authority, what proved too stubborn or too firm to yield to their arguments. By the arbitrary decision of three hundred and thirteen out of three hundred and eighteen bishops, it was proved, that the Son is consubstantial and of the same substance with the Father; and moreover, that whosoever should dare to assert that this expression is unscriptural, he should, without further ceremony, be deemed a heretic, be cut off from communion with the church in this world, and without doubt should perish everlastingly in the world to come! After they had thus decided, and had banished Arius, and his followers, who determined to abide by the language of Scripture, these domineering priests sent letters of self-commendation to their friends in Egypt, Lybia, and Pentapolis. Having rewarded the priests, and recommended to them peace and harmony, Constantine dismissed the council, and wrote to several churches, recommending and enjoining universal conformity to the council's decrees, both in doctrines and ceremonies; using this, among other arguments, that what they had decreed was the will of God, and that the argument of so great a number of bishops could be by no other than the immediate inspiration of the Holy Ghost. That the Nicene doctors were inspired, whoever considers the nature and extent of their anathemas and depositions, together with the subsequent persecutions, of which this council was the foundation, can have no doubt; whether their inspiration was by the Holy Ghost, is another question.

The scriptural christians, being now the weaker party, not relishing neither the decrees of the Nicene fathers, nor the letters of Constantine, most unhappy consequences very soon took place. The orthodox emperor, finding his admonitions disregarded, resolved, in the madness of his zeal, to try the efficacy of more forcible motives; and accordingly issued sundry edicts against all who should dare to oppose his will, or slight the decrees of the Council of Nice; at the same time ordering that the books of their opponents should be burnt; and if any kept them in their possession, or endeavoured to counteract his edict, they should, on conviction thereof, suffer death.

Thus the authors of the Nicene Creed first brought in the punishment of heresy with death, and persuaded the emperor to destroy those whom he could not easily convert. The scriptures were now no longer the rule of faith and manners; but orthodoxy and heterodoxy were decided by vote, and agreed upon, not by the number and weight of arguments, but by the number and power of emperors, priests, and councils.

The next council that was held, was composed of bishops possessing opinions somewhat different from those of their predecessors, because Constantine II. happened to be favourable to the Arians. The side of orthodoxy was now changed; but fulminations and damnations still adhered to the decrees of the council, against all those who should dare to oppose them. This alternate shifting of hands continued through the whole of this century. It was in this century also that painted crosses and the making of pilgrimages became fashionable.

The fifth century gave birth to an established union of the temporal and spiritual jurisdiction of the popes; though as yet no one had the hardihood to declare himself either infallible or supreme. The prohibiting priests to marry, baptizing with godfathers and godmothers, the sign of the cross in baptism, and some other less important matters, were introduced in this century.

The bulk of ecclesiastical historians fix the year 606 for the title of universal bishop, being conferred on the Pontiff of Rome. This dignity had been assumed by the bishop of Constantinople in the preceding century, but was now confirmed to Boniface III.; who, being elected Pope, prevailed on the Emperor Phocas to take the title of universal bishop from the Bishop of Constantinople, and grant it to him, and his successors, by his absolute decree; which passed for that purpose.

Now it was that popery became established and general; from this period therefore we may date the appellation of Roman Catholic. Without, however, minutely detailing the origin of those various doctrines and ceremonies by which the church of Rome has long been distinguished, we will proceed to give a succinct account of the belief and practice of this very large and respectable portion of the christian world. We cannot perhaps do this better than by laying before the reader

A Summary of the Doctrine, Discipline, and Ceremonies of the Church of Rome, as contained in Pope Pius IV.'s Creed.

"Art. I. I believe in one God, the Father Almighty, maker of heaven and earth, and of all things visible and invisible. The one true and living God in three persons, Father, Son, and Holy Ghost.

"II. I believe in one Lord Jesus Christ, the only-begotten Son of God, begotten of the Father before all worlds, God of God, light of light, very God of very God, begotten not made, being of one substance with the Father, by whom all things were made.

"III. Who for us men, and for our salvation, came down from heaven, and was incarnate of the Holy Ghost of the Virgin Mary, and was made man.

"IV. And was crucified also for us under Pontius Pilate; he suffered and was buried.

"V. And the third day rose again, according to the scriptures.

"VI. He ascended into heaven, sits at the right hand of the Father.

"VII. And is to come again with glory to judge both the living and the dead, of whose kingdom there shall be no end.

"VIII. I believe in the Holy Ghost, the Lord and giver of life, who proceeds from the Father and the Son, who with the Father and the Son is adored and glorified; who spake by the prophets.

"IX. I believe in one holy, catholic, and apostolic church.

"X. I acknowledge one baptism for the remission of sins.

"XI. I look for the resurrection of the dead.

"XII. I believe in the life of the world to come. Amen.

"XIII. I most firmly admit and embrace the apostolical and ecclesiastical traditions, and all other observations and constitutions of the same church.

"XIV. I do admit the holy scriptures in the same sense that Holy Mother Church doth, whose business it is to judge of the true sense and interpretation of them, and I will interpret them according to the unanimous consent of the fathers.

"XV. I do profess and believe that there are seven sacraments, truly and properly so called, instituted by Jesus Christ our Lord, and necessary for the salvation of mankind, though not all of them to every one, *viz.* baptism, confirmation, eucharist, penance, extreme unction, orders, and matrimony; and that they do confer grace; and that of these, baptism, confirmation, and orders, cannot be repeated without sacrilege. I also receive and admit the received and approved rites of the catholic church, in her solemn administration of all the aforesaid sacraments.

"XVI. I embrace and receive every thing that hath been defined and declared by the holy Council of Trent, concerning original sin and justification.

"XVII. I do also profess, that in the mass there is offered unto God a true, proper, and propitiatory sacrifice for the quick and the dead; and that, in the most holy sacrament of the eucharist, there is truly, really and substantially, the body and blood, together with the soul and divinity of our Lord Jesus Christ; and that there is a conversion made of the whole substance of the bread into the body, and of the whole substance of the wine into the blood; which conversion the whole Catholic church call Transubstantiation.

"XVIII. And I believe that under one kind only, whole and entire, Christ is taken and received.

"XIX. I do firmly believe, that there is a purgatory, and that the souls kept prisoners there do receive help by the suffrage of the faithful. That the souls of the patriarchs and holy men, who departed this life before the crucifixion of Christ, were kept as in prison, in an apartment of hell, without pain. That Christ did really go into local hell, and delivered the captive souls out of this confinement. The fathers assert, that our Saviour descended into hell, went thither specially, and delivered the souls of the fathers out of that mansion.

"XX. I do believe that the saints reigning together with Christ are to be worshipped and prayed unto, and that they do offer prayers unto God for us, and that their relics are to be had in veneration.

"XXI. I do firmly believe, that the images of Christ, of the blessed Virgin, the mother of God, and of other saints, ought to be had and retained, and that due honour and veneration ought to be paid unto them.

"XXII. I do affirm, that the power of indulgences was left by Christ in the church, and that the use of them is very beneficial to Christian people.

"XXIII. I do acknowledge the holy catholic and apostolic Roman church to be the mother and mistress of all churches; and I do promise and swear true obedience to the bishop of Rome, the successor of St. Peter, the prince of the apostles, and vicar of Jesus Christ.

"XXIV. I do undoubtedly receive and profess all other things that have been delivered, defined by the sacred canons and œcumenical councils, and especially by the holy synod of Trent; and all other things contrary hereunto, and all heresies condemned, rejected, and anathematised, by the church, I do likewise condemn, reject, and anathematise."

This bull, as it is called, bears date on the ides of November, 1564, and concludes in the usual manner, with threats of the indignation of God, and of his blessed apostles St. Peter and St. Paul, against all who dare to infringe or oppose it. Whether this profession of faith would now be subscribed by every Roman Catholic, we will not take upon us to say; but it is certain, that it has received the sanction and confirmation of the council of Trent, the last general council, and has been explained and vindicated by Bossuet and other Catholic writers. We should not omit to notice the truly ingenious publication of the late worthy Dr. Alexander Geddes, entitled "A Modest Apology for the Roman Catholics of Great Britain." In this singular publication, the author has laboured hard to prove that a very great resemblance exists (even so much so as to leave little to prevent a cordial coalition) between the doctrines and discipline of the two churches of Rome and of England. This dissenting Catholic seems to speak of the Romish Church in terms not much like what her friends have usually employed on similar occasions; and very plainly informs us, that the enervation of ancient church discipline; the fabrication of false decretals; the multiplication of appeals, dispenses, exemptions, immunities, and enormous privileges; the rage of idle pilgrimages; the base traffic of indulgences; the propagation of lying legends, feigned miracles, and apocryphal revelations; the doctrines of the Pope's infallibility, temporal jurisdiction, and deposing power, are so many large crops of spiritual cockle, that have been, at different times, "while men slept," sown by the enemy in the wide field of the Catholic world. This representation is certainly curious, at least, as coming from the pen of a professed Roman Catholic priest. If the English Catholics differ materially from their brethren in other countries, where is the unity and catholicity of the Romish faith?

We must now conclude this article with a brief statement of the decline and present state of the papal power in Europe.

The deadly blow which this gigantic power received in the sixteenth century we have already treated of in the article Reformation.

From the effects of that blow the Roman Catholic interests have never yet recovered. It was a deep and deadly wound to the usurpations of tyranny, and the towering pride of ecclesiastical domination. In the article to which we have already alluded, the reader will find a brief enumeration of the countries which received the doctrines of the reformation, as well also of those countries where the principles of religious liberty had made but little progress. These latter were principally France, Spain, Italy, and Poland. In each of these countries the spirit of reform has, more or less, manifested itself since the era of the reformation. In the first of these countries particularly, the authority of the supreme head of the church has, since the commencement of the revolution, received an alarming diminution. Indeed, the liberties of the Gallican church had always depended upon two maxims: 1. That the Pope has not authority to command any thing in general or particular, in which the civil rights of the kingdom are concerned. 2. That though the Pope's supremacy is owned in spiritual matters; yet his power is limited and regulated by the decrees and canons of ancient councils in the realm. These maxims in the Gallican church have been superseded by the Concordat; and still more by events of a very recent date. When the French revolution first broke out, the clergy in that country suffered every species of insult and cruelty that an infuriate rabble or more refined councils could invent. Their tythes and revenues were taken from them, and the possessions of the church were considered as national property. The religious orders were dissolved, and their estates confiscated. When the National Assembly attempted to impose upon the clergy what they denominated the civil constitution of the clergy, a refusal to submit to it, and to that of taking an oath to maintain it, was attended with the most alarming consequences. One hundred and thirty-eight bishops and archbishops, and sixty-eight curates, or vicars, were on this account driven from their sees and parishes. Numbers of these unfortunate men were massacred in the streets, while hundreds of them sought refuge in this and other countries. Notwithstanding these proceedings, on the 28th of May, 1795, a decree was obtained for the freedom of religious worship; and on the following June the churches in Paris were re-opened, and divine service was again performed with great ceremony. The clergy have never since been molested in France; but their power and influence were greatly diminished: for though the Modereés, or Brissotine party, recalled them, no establishment was made for them, until Bonaparte, as First Consul, procured the Pope's consent to the Concordat, which the old Catholics assert surrendered all their rights and privileges of the church to the secular head.

By degrees the Pope of Rome has continued to lose his influence in France. The number of Catholic clergy is now very considerably reduced; and all the religious orders in France, the Sisters of Charity excepted, are abolished, together with all public processions, pilgrimages, &c. The French General, Bonaparte, drove the late Pope, Pius VI. from Rome, and compelled him to take shelter in a Carthusian monastery, about two miles from Florence, where he died, August 19th, 1799. The French army who took possession of Rome, made no ceremony in abolishing many of those rites which for centuries had been regarded as sacred. A new Pope, however, has been elected, who has taken the name of Pius VII. This pontiff at present resides at Rome, the seat of his ancestors, and has often officiated in the Vatican. But his power is gone, probably for ever. Bonaparte has lately seized on his temporal dominions, and driven his friends and counsellors, the Cardinals, from his presence. On the 19th of April, 1808, a most curious and interesting state paper was published by the Pope, entitled "Answer of his Eminence Cardinal Grabrielli, first Secretary of State, to the Note of his Excellency M. Champagny, addressed to M. Le Fevre, Charge d'Affaires from the Emperor of France." We lament that our limits will not permit us to preserve the whole of this curious document in our pages. We may, however, remark, that this paper is in answer to a demand which the French ruler had made upon his Holiness, to enter into an offensive and defensive league with the other powers of Italy, against all the enemies of France, and also that the Pope should dismiss from his court the Cardinals. To these demands his Holiness replies in a spirited but highly pathetic strain. He declares in one part of his paper, that "His Holiness, unlike other princes, is invested with a two-fold character, namely, of Sovereign Pontiff, and of Temporal Sovereign, and has given repeated evidence that he cannot, by virtue of this second qualification, enter upon engagements, which would lead to results militating against his first and most important office, and injuring the religion of which he is the head, the propagator, and the avenger."

The French Emperor had declared, that in case the Pope would not accede to his demands, he would seize upon the temporal dominions of the Holy See. To which his Holiness replies, that "If, in spite of all this, his Majesty shall take possession, as he has threatened, of the papal dominions, respected by all, even the most powerful monarchy, during a space of ten centuries and upwards, and shall overturn the government, his Holiness will be unable to prevent this spoliation; and can only, in bitter affliction of heart, lament the evil which his Majesty will commit in the sight of God, trusting in whose protection, his Holiness will remain in perfect tranquillity, enjoying the consciousness of not having brought on this disaster by imprudence or by contumacy, but to preserve the independence of that sovereignty, which he ought to transmit uninjured to his successors, as he received it; and to maintain in its integrity, that conduct which may secure the universal concurrence of all princes, so necessary to the welfare of religion." What the final result of these negociations will be time only can determine; this, however, is certain, at present, that the Roman Pontiff has lost his power and authority in France. Nor are his prospects much more favourable in other countries. There is scarcely a Catholic State in Europe that does not every year relax in its observance of the Romish laws, and in obedience to the Holy See. The terrors of the Inquisition no longer exist; the thunders of the Vatican are ceased or disregarded; some of the most offensive maxims of popery are not only destroyed by the liberal spirit of the times, but even publicly disavowed by numerous and respectable bodies of Catholics: in short, little now remains of the Romish faith and practice, especially in our own country, that ought to give serious offence to liberal Protestants of the Church of England; there is indeed nothing remaining among these people of a nature dangerous to the peace and happiness of the community at large.

The question concerning the Catholic Emancipation in England and in Ireland being as yet undecided, we must omit any further notice of it; at the same time most ardently longing that the period may soon commence, when no difference of opinion whatever, no variation in our worship, shall prove a barrier to the full exercise of all those rights, both civil and religious, to which all men are born, and to which all good and peaceable men have an equal claim. See Papists.

RONDELETIA, in botany, so named in honour of Guilleaume Rondelet, a famous physician and natural historian, of Montpelier; a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: corolla funnel-shaped; capsule two-celled, inferior, many-seeded, roundish, crowned. There are fourteen species.

ROOD, a quantity of land equal to forty square perches, or the fourth part of an acre.

ROOT, in mathematics, a quantity considered as the basis or foundation of a higher power; or one which, being multiplied into itself any number of times, produces a square, cubic, biquadratic, &c. quantity; called the second, third, fourth, &c. power of the root, or quantity, so multiplied into itself: thus a is the square root of $a \times a$, or a^2; and 4 the square root of $4 \times 4 = 16$. Again, a is the cube root of $a \times a \times a = a^3$; and 3 the cube root of $3 \times 3 \times 3 = 27$: and so on. The roots of powers are expressed by placing the radical sign $\sqrt{}$ over them, with a number denoting what kind of root they are: thus the square or second root of 16 is expressed by $\sqrt[2]{16}$, and the cube or third root of 27 by $\sqrt[3]{27}$; and, in general, the nth root of a, raised to the power, m, is expressed by $\sqrt[n]{a^m}$. When the root of a compound quantity is wanted, the vinculum of the radical sign must be drawn over the whole: thus the square root of $a^2 + 2ab + b^2$ is expressed by $\sqrt[2]{a^2 + 2ab + b^2}$; and it ought to be observed, that when the radical sign has no number above it, to denote what root is wanted, the square root is always meant; as $\sqrt{a^2}$, or $\sqrt{16}$, is the square root of a^2, or the square root of 16.

ROPE, hemp, hair, &c. spun into a thick yarn, and then several strings of this yarn twisted together by means of a wheel. When made very small, it is called a cord, and when very thick, a cable. All the different kinds of this manufacture, from a fishing-line, or whip-cord, to the cable of a first-rate ship of war, go by the general name of cordage. Ropes are made of every substance that is sufficiently fibrous, flexible, and tenacious, but chiefly of the inner barks of plants. The Chinese, and other orientals, even make them of the ligneous parts of several plants, such as certain bamboos and reeds, the stems of the aloes, the fibrous covering of the cocoa-nut, the filaments of the cotton pod, and the leaves of some grasses. But the barks of plants are the most productive of fibrous matter, fit for this manufacture. Those of the linden-tree, of the willow, the bramble, the nettle, are frequently used; but hemp and flax are the best; and of these, the hemp is preferred, and employed in all cordage exceeding the size of a line, and even in many of this denomination. Hemp is very various in its useful qualities; the best in Europe comes to us through Riga, to which port it is brought from very distant places southward.

Rope *making*, is an art of very great importance; and there are few that better deserve the attention of the intelligent observer. Hardly any art can be carried on without the assistance of the rope-maker. Cordage makes the very sinews and muscles of a ship; and every improvement which can be made in its preparation, either in respect to strength or pliableness, must be of immense service to the mariner, and to the commerce and the defence of nations. The aim of the rope-maker is to unite the strength of a great number of fibres, and the first part of his process is spinning of rope-yarns, that is, twisting the hemp in the first instance. This is done in various ways, and with different machinery, according to the nature of the intended cordage. We shall confine our description to the manufacture of the larger kinds, such as are used for the standing and running rigging of ships. An alley, or walk, is inclosed for the purpose, about two hundred fathoms long, and of a breadth suited to the extent of the manufacture. It is sometimes covered above. At the upper end of this rope-walk is set up the spinning-wheel. The band of the wheel goes over several rollers, called whirls, turning on pivots in brass holes. The pivots at one end come through the frame, and terminate in little hooks. The wheel, being turned by a winch, gives motion in one direction to all those whirls The spinner has a bundle of dressed hemp round his waist, with the two ends meeting before him. The hemp is laid in this bundle in the same way that women spread the flax on the distaff. There is great variety in this; but the general aim is to lay the fibres in such a manner, that as long as the bundle lasts there may be an equal number of the ends at the extremity, and that a fibre may never offer itself double, or in a bight. The spinner draws out a proper number of fibres, twists them with his fingers, and having got a sufficient length detached, he fixes it to the hook of a whirl. The wheel is now turned, and the skein is twisted, becoming what is called rope-yarn, and the spinner walks backwards down the rope-walk. The part already twisted, draws along with it more fibres out of the bundle. The spinner aids this with his fingers, supplying hemp in due proportion as he walks away from the wheel, and taking care that the fibres come in equally from both sides of his bundle, and that they enter always with their ends, and not by the middle, which would double them. He should also endeavour to enter every fibre at the heart of the yarn. This will cause all the fibres to mix equally in making it up, and will make the work smooth, because one end of each fibre is by this means buried among the rest, and the other end only lies outward; and this, in passing through the grasp of the spinner, who presses it tight with his thumb and palm, is also made to lie smooth. A good spinner endeavours always to supply the hemp in the form of a thin flat skein, with his left hand, while his right is employed in grasping firmly the yarn that is twining off, and in holding it tight from the whirl, that it may not run into loops or kinks. It is evident, that both the arrangement of the fibres and the degree of twisting, depend on the skill and dexterity of the spinner, and that he must be instructed, not by a book, but by a master. The degree of twist depends on the rate of the wheel's motion, combined with the retrograde walk of the spinner. We may suppose him arrived at the lower end of the walk, or as far as is necessary for the intended length of his yarn. He calls out, and another spinner immediately detaches the yarn from the hook of the whirl, gives it to another, who carries it aside to the reel; and this second spinner attaches his own hemp to the whirl-hook. In the mean time, the first spinner keeps fast hold of the end of his yarn; for the hemp, being dry, is very elastic, and if he were to let it go out of his hand, it would instantly untwist, and become little better than loose hemp. He waits, therefore, till he sees the reeler begin to turn the reel, and he goes slowly up the walk, keeping the yarn of an equal tightness all the way, till he arrives at the wheel, where he waits with his yarn in his hand till another spinner has finished his yarn. The first spinner takes it off the whirl-hook, joins it to his own, that it may follow it on the reel, and begins a new yarn. The second part of the process is the conversion of the yarns into what may, with propriety, be called a rope, cord, or line. That we may have a clear conception of the principle which regulates this part of the process, we shall begin with the simplest possible case, the union of two yarns into one line.

When hemp has been split into very fine fibres by the hatchel, it become exceedingly soft and pliant, and after it has lain for some time in the form of fine yarn, it may be unreeled and thrown loose, without losing much of its twist. Two such yarns may be put on the whirl of a spinning wheel, and thrown like flaxen yarn, so as to make sewing thread. It is in this way, indeed, that the sailmakers' sewing thread is manufactured, and when it has been kept on the reel, or on balls or bobbins for some time, it retains its twist as well as its uses require. But this is by no means the case with yarns spun for great cordage. The hemp is so elastic, the number of fibres twisted together is so great, and the diameter of the yarn (which is a sort of lever, on which the elasticity of the fibre exerts itself,) is so considerable, that no keeping will make the fibres retain this constrained position.

The end of a rope-yarn being thrown loose, it will immediately untwist, and this with considerable force and speed. It would, therefore, be a fruitless attempt to twist two such yarns together; yet the ingenuity of man has contrived to make use of this very tendency to untwist not only to counteract itself, but even to produce another and a permanent twist, which requires force to undo it, and which will recover itself when this force is removed. Every person must recollect, that when he had twisted a packthread very hard with his fingers between his two hands, if he slackens the thread by bringing his hands nearer together, the packthread will immediately curl up, running into loops or kinks, and will even twist itself into a neat and firm cord. The component parts of a rope are called strands, and the operation of uniting them with a permanent twist is called laying or closing, the latter term being chiefly appropriated to cables and other very large cordage.

The process for laying or closing large cordage is this: the strands of which the rope is composed consist of many yarns, and require a considerable degree of hardening. This cannot be done by a whirl driven by a wheel-band; it requires the power of a crank turned by the hand. The strands, when properly hardened, become very stiff, and when bent round the top, are not able to transmit force enough for laying the heavy and unpliant rope which forms beyond it. The elastic twist of the hardened strands must, therefore, be assisted by an external force. All this requires a different machinery and a different process. At the upper end of the walk is fixed up the tackle-board, this consists of a strong oaken plank, called a breast board, having three or more holes in it, fitted with brass or iron plates. Into these are put iron cranks, called heavers, which have hooks or forelocks, and keys, on the ends of their spindles. They are placed at such a distance from each other, that the workmen do not interfere with each other while turning them round. This breast board is fixed to the top of strong posts, well secured by struts, or braces, facing the lower end of the walk. At the lower end is another breast board, fixed to the upright post of a sledge, which may be loaded with stones or other weights. Similar cranks are placed in the holes of this breast board; the whole goes by the name of the sledge. The top necessary for closing large cordage is too heavy to be held in the hand; it therefore has a long staff, which has a truck on the end: this rests on the ground, but even this is not enough in laying great cables. The top must be supported on a carriage, where it must lie very steady, and it needs attendance, because the master workman has sufficient employment in attending to the manner in which the strands close behind the top, and in helping them by various methods. The top is therefore fixed to the carriage, by lashing its staff to the two uprights posts. A piece of soft rope, or strap, is attached to the handle of the top by the middle, and its two ends are brought back and wrapped several times tight round the rope, in the direction of its twist, and bound down. This greatly assists the laying of the rope by its friction, which both keeps the top from flying too far from the point of union of the strands, and brings the strands more regularly into their places. The first operation is warping the yarns. At each end of the walk are frames called warping frames, which carry a great number of reels or winches, filled with rope-yarn. The foreman of the walk takes off a yarn end from each, till he has made up the number necessary for his rope or strand, and bringing the ends together, he passes the whole through an iron ring fixed to the top of a stake driven into the ground, and draws them through: then a knot is tied on the end of the bundle, and a workman pulls it through this ring, till the intended length is drawn off the reels. The end is made fast at the bottom of the walk, or at the sledge, and the foreman comes back along the skein of yarns, to see that none are hanging slacker than the rest. He takes up in his hand such as are slack, and draws them tight, keeping them so till he reaches the upper end, where he cuts the yarns to a length, again adjusts their tightness, and joins them altogether in a knot, to which he fixes the hook of a tackle, the other block of which is fixed to a firm post, called the warping post. The skein is well stretched by this tackle, and then separated into its different strands. Each of these is knotted apart at both ends. The knots at their upper ends are made fast to the hooks of the cranks in the tackle-board, and those at the lower ends are fastened to the cranks in the sledge. The sledge itself is kept in its place by a tackle, by which the strands are again stretched in their places, and every thing adjusted, so that the sledge stands square on the walk, and then a proper weight is laid on it. The tackle is now cast off, and the cranks are turned at both ends, in the contrary direction to the twist of the yarns (in some kinds of cordage the cranks are turned the same way with the spinning twist.) By this the strands are twisted and hardened up, and as they contract by this operation, the sledge is dragged up the walk. When the foreman thinks the strands sufficiently hardened, which he estimates by the motion of the sledge, he orders the heavers at the cranks to stop. The middle strand at the sledge is taken off from the crank; this crank is taken out, and a stronger one put in its place. The other strands are taken off from their cranks, and are all joined on the hook which is now in the middle hole; the top is then placed between the strands, and being pressed home to the point of their union, the carriage is placed under it, and it is firmly fixed down: some weight is taken off the sledge. The heavers now begin to turn at both ends; those at the tackle-board continue to turn as they did before, but the heavers at the sledge turn in the opposite direction to their former motion, so that the cranks at both ends are now turning one way. By the motion of the sledge-crank the top is forced away from the knot, and the rope begins to close. The heaving at the upper end restores to the strands the twist which they are constantly losing by the laying of the rope. The workmen judge of this by making a chalk mark on intermediate points of the strands, where they lie on the stakes which are set up along the walk for their support. If the twist of the strands is diminished by the motion of closing, they will lengthen, and the chalk mark will move away from the tackle-board; but if the twist increases by turning the cranks at the tackle-board, the strands will shorten, and the mark will come nearer to it. As the closing of the rope advances, the whole shortens, and the sledge is dragged up the walk. The top moves faster, and at last reaches the upper end of the walk, the rope being now laid.

In the mean time, the sledge has moved several fathoms from the place where it was when the laying began. These motions of the sledge and top must be exactly adjusted to each other. The rope must be of a certain length, therefore the sledge must stop at a certain place. At that moment the rope should be laid; that is, the top should be at the tackle-board. In this consists the address of the foreman. He has his attention directed both ways. He looks at the strands, and when he sees any of them hanging slacker between the stakes than the others, he calls to the heavers at the tackle-board to heave more upon that strand. He finds it more difficult to regulate the motion of the top. It requires a considerable force to keep it in the angle of the strands, and it is always disposed to start forward. To prevent or check this, some straps of soft rope are brought round the staff of the top, and then wrapped several times round the rope behind the top, and kept firmly down by a lanyard or bandage. This both holds back the top, and greatly assists the laying of the rope, causing the strands to fall into their places, and keep close to each other, which is sometimes very difficult, especially in ropes composed of more than three strands. It will greatly improve the laying the rope, if the top has a sharp, smooth, tapering pin of hard wood, pointed at the end, projecting so far from the middle of the smaller end, that it gets in between the strands which are closing. This supports them, and makes their closing more gradual and regular. The top, its notches, the pin, and the warp, or strap, which is lapped round the rope, are all smeared with grease or soap, to assist the closing. The foreman judges of the progress of closing chiefly by his acquaintance with the walk, knowing that when the sledge is abreast of a certain stake, the top should be abreast of a certain other stake. When he finds the top too far down the walk, he slackens the motion at the tackle board, and makes the men turn briskly at the sledge. By this the top is forced up the walk, and the laying of the rope accelerates, while the sledge remains in the same place, because the strands are losing their twist, and are lengthening, while the closed rope is shortening. When, on the other hand, he thinks the top too far advanced, and fears that it will be at the head of the walk before the sledge has got to its proper place, he makes the men heave briskly on the strands, and the heavers at the sledge-crank work softly. This quickens the motion of the sledge by shortening the strands; and by thus compensating what has been over-done, the sledge and top come to their places at once, and the work appears to answer the intention. When the top approaches the tackle-board, the heaving at the sledge could not cause the strands immediately behind the top to close well, without having previously produced an extravagant degree of twist in the intermediate rope. The effort of the crank must therefore be assisted by men stationed along the rope, each furnished with a tool called a woolder. This is a stout oaken stick, about three feet long, having a strap of soft rope-yarn, or cordage, fastened on its middle or end. The strap is wrapped round the laid rope, and the workman works with the stick as a lever, twisting the rope round in the direction of the crank's motion. The woolders should keep their eye on the men at the crank, and make their motion correspond with theirs. Thus they send forward the twist produced by the crank, without either increasing or diminishing it, in that part of the rope which lies between them and the sledge. Such is the general and essential process of rope-making. The fibres of hemp are twisted into yarns, that they may make a line of any length, and stick among each other with a force equal to their own cohesion. The yarns are made into cords of permanent twist by laying them; and that we may have a rope of any degree of strength, many yarns are united in one strand, for the same reason that many fibres were united in one yarn; and in the course of this process it is in our power to give the rope a solidity and hardness, which make it less penetrable by water, which would rot it in a short while. Some of these purposes are inconsistent with others; and the skill of a rope-maker lies in making the best compensation, so that the rope may on the whole be the best in point of strength, pliancy, and duration, that the quantity of hemp in it can produce. The following rule for judging of the weight which a rope will bear is not far from the truth. It supposes them rather too strong; but it is so easily remembered, that it may be of use. Multiply the circumference in inches by itself, and take the fifth part of the product, it will express the tons which the rope will carry. Thus, if the rope has six inches circumference, 6 times 6 is 36, the fifth of which is $7\frac{1}{5}$ tons.

Rope *yarn*, among sailors, is the yarn of any rope untwisted, but commonly made up of junk; its use is to make sinnet, mats, &c.

RORIDULA, in botany, a genus of the Pentandria Monogynia class and order. Essential character: calyx five-leaved; corolla five-petalled; anthers scrotiform at the base: capsule three-valved. There is but one species, *viz.* R. dendata, a native of the Cape of Good Hope.

ROSA, in botany, the *rose*, a genus of the Icosandria Polygynia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Calyx pitcher-shaped, five-cleft, fleshy, contracted at the neck; petals five; seeds very many, hispid, fastened to the inner side of the calyx. There are forty species.

ROSACIC *acid*. During certain diseases, the urine, when it cools, deposits a peculiar substance, which has been denominated, from its colour, which resembles bricks, lateritious sediment. During fevers, this appearance of the urine takes place; and in gouty persons, at the termination of the paroxysms, it is very abundant. And when this suddenly disappears, and the urine at the same time continues to deposit this substance, a relapse may be dreaded. It appears in the form of red flakes, and adheres strongly to the sides of the vessel. If the urine be heated, this sediment is again dissolved. This substance was formerly considered by chemists as the uric acid. If into fresh urine, a little nitric acid is dropped, it becomes muddy, and a precipitate is formed. The nitric acid and the substance to which the name of rosacic acid has been given combine together, and are deposited. The uric acid being much less soluble than the rosacic acid, it is very easy to separate them. All that is necessary is, to pour boiling water on the sediments, and to wash them on the same filter, in which case the uric acid remains behind.

ROSMARINUS, in botany, a genus of the Diandria Monogynia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: corolla unequal, with the upper-lip two-parted; filaments long, curved, simple, with a tooth. There are two species, *viz.* R. officinalis, officinal rosemary; and R. chilensis, Chili rosemary.

ROTACEÆ, in botany, the name of the twentieth order in Linnæus's Fragments of a Natural Method, consiting of plants with one flat, wheel-shaped petal. Among the genera of this order is the gentiana, the root of which is a well-known stomachic, and makes a principal ingredient in bitters. The plant grows plentifully in the mountainous parts of Germany, from whence the roots are brought to England for medicinal purposes. The cistus, or rock-rose, and the hypincum, or St. John's wort, have been annexed also to this order. It may be observed, that gum labdanum is an odoriferous balsam, or resin, which is found on a species of the rock-rose, *viz.* the cistus ladanifera, that grows naturally in the Levant. This substance is collected by the natives by means of leathern thongs, rubbed gently over the surface of the shrub which produces it. From a species of the hypericum, an oil is extracted, that proves an excellent vulnerary.

ROTALA, in botany, a genus of the Triandria Monogynia class and order. Natural order of Caryophylleæ. Essential character: calyx three-toothed; corolla none; capsule three-celled, many-seeded. There is but one species, *viz.* R. verticillaris, a native of the East Indies.

ROTATION, in geometry, a term chiefly applied to the circumvolution of any surface round a fixed and immoveable line, which is called the axis of its rotation: and by such rotations it is, that solids are conceived to be generated. The late ingenious M. de Moivre shows how solids, thus generated, may be measured or cubed. His method is this: for the fluxion of such solids, take the product of the fluxion of the absciss, multiplied by the circular base; and suppose the ratio of a square to the circle inscribed in it to be $\frac{n}{1}$: then the equation expressing the nature of any circle, whose diameter is d, is $y\,y = d\,x - x\,x$. Therefore $\frac{4\,d\,x\,\dot{x} - x^2\,x}{n}$ is the fluxion of a portion of the sphere; and, consequently, the portion itself $4\frac{1}{2}\,d\,x\,x - x\,\frac{1}{3}\,x^3$, and the circumscribed cylinder is $\frac{4\,d\,x\,x - x^3}{n}$; and therefore the portion of the sphere is to the portion of the circumscribed cylinder, as $\frac{1}{2}d - \frac{1}{3}\,x$ to $d - x$.

ROTHIA, in botany, so named in honour of Albrecht Wilhelm Roth, physician at Bremen; a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Semiflosculosæ. Cichoraceæ, Jussieu. Essential character: calyx many-leaved, in a single row, equal, woolly; receptacle in the ray chaffy, in the disk villose; seeds in the ray bald, in the disk pappose. There is only one species, *viz.* R. andryaloides.

ROTTBOELLIA, in botany, so named in memory of Christian Früis Rottboel, Professor of Botany at Copenhagen; a genus of the Polygamia Monoecia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: rachis jointed, roundish, in most species filiform; calyx ovate, lanceolate, flat, one or two-valved; florets alternate on a flexuose rachis. There are seventeen species.

ROUND, in a military sense, signifies a walk which some officer, attended with a party of soldiers, takes in a fortified place around the ramparts, in the night-time, in order to see that the centries are watchful, and every thing in good order. The centries are to challenge the rounds at a distance, and rest their arms as they pass, to let none come near them; and when the round comes near the guard, the centry calls aloud, "Who comes there?" and being answered, "the rounds;" he says "stand;" and then calls the corporal of the guard, who draws his sword, and calls also, "Who comes there?" and when he is answered, "the rounds," he who has the word advances, and the corporal receives it with his sword pointed to the giver's breast. In strict garrison, the rounds go every quarter of an hour.

ROUSSEA, in botany, so named in memory of the celebrated Jean Jacques Rousseau; a genus of the Tetrandria Monogynia class and order. Essential character: calyx four-leaved; corolla one petalled, bell-shaped, four-cleft, inferior; berry quadrangular, many-seeded. There is but one species, *viz.* R. simplex, this is a small climbing shrub, found by Commerson in the island of St. Mauritius.

ROXBURGHIA, in botany, so named in honour of William Roxburgh, M. D; a genus of the Octandria Monogynia class and order. Essential character: calyx four-leaved; corolla four-petalled, inwardly keeled; nectary four, awl-shaped; leaflets on the apex of the keel of the petals, converging; anthers linear, sessile in the grooves of the keel; capsule one-celled, two-valved; seeds many, inserted in a spongy receptacle. There is but one species, *viz.* R. gloriofoides, a native of Coromandel, in moist valleys between the mountains, flowering in the cold season. It is the Canipoo Tiga of the Telingas.

ROYALTIES, are the rights of the King. See PREROGATIVE.

ROYAL *Exchange.* The term royal, applied to the Exchange of London, originated with Queen Elizabeth, a princess who, though tinctured with the arbitrary prejudices of her time, deserves the grateful remembrance of her countrymen for many wise and extremely beneficial acts, equally contributing to increase the political and commercial prosperity of England.

The word Exchange is certainly improperly applied to a building in which the act of exchanging or bartering takes place; but we are not the only people who thus misuse the appellation, as many towns on the Continent have their Places de Change. We know nothing more of the Bourse (synonimous with Exchange) frequented by the merchants of London before the reign of Elizabeth, except that it was situated in Lombard Street. It is, however, reasonable to suppose, that it was too inconsiderable in its extent, or had become ruinous by that period, as Sir Thomas Gresham then entertained thoughts of exerting his influence to render his fellow-citizens an essential service, and at the same time improve his own property.

It is singular, that a people celebrated for their commercial enterprize from the very foundation of their metropolis, should have proceeded through many centuries, contented with transacting their business at casual and uncertain meetings, when it seems so obvious to their posterity that a rallying point is absolutely necessary, where a trader may, at a fixed and certain hour, see and converse with those connected with him in commerce, and meet with purchasers for his commodities.

There cannot exist a doubt, that numbers of the citizens of London felt the necessity for an established and convenient Exchange, which may be supposed from the faint attempt made in Lombard Street, and which might have suggested the plan afterwards executed by Gresham, whose very extensive concerns made him more particularly sensible of the deficiencies of London in this instance. The circumstances attending the founding of the original Exchange on the present scite, has contributed to convey all the honour of the undertaking to Sir Thomas, when, in truth, he was only an active partner in that honour; as it is an indisputable fact, that the Corporation of London purchased, at the expense of the city, not less than eighty houses, and the ground on which they stood, for the sum of four thousand pounds: these they ordered to be taken down, and the earth prepared for building a magnificent structure.

It will be perceived from this statement, that the collective body of the citizens was by no means deficient in their wishes to second the views of Gresham, who engaged to erect the Exchange at his own expense, and the parties were mutually to enter into conveyances of the ground and building to each other, that their descendants and successors might for ever possess a joint and equal property in the subsequent profits of the concern. This covenant was faithfully complied with by the Corporation, but Sir Thomas neglected to execute his part of it. Hence, it must be admitted, that the latter has no claim to the exclusive gratitude of the natives of London; on the contrary, it is very evident, the patriotism of the act should be divided between the then Lord Mayor, Alderman, and Council, and Gresham; with this admission in his favour, that it is more than probable the Corporation would never of themselves have conferred an Exchange on the city they governed.

Sir Thomas laid the first stone of the edifice on the seventh day of June, 1566, which was completed with brick, and so contrived as to render the reimbursement of his expenses as certain as human foresight would permit. This he supposed might be accomplished by the fines and rents accruing from a very considerable number of vaults and shops which inclosed the area intended for the ostensible purposes of the building. The novelty of this arrangement operated greatly in his favour, and the shops let rapidly; but the vaults, as our ancient writers term them, being partly under ground, and consequently equally dark and damp, were but partially occupied. Sensible of his mistake, and determined to retrieve it if possible, he resolved that his future tenants should take the vaults with the shops at eight marks per annum; and they proceeded thus for some time, till at length it was fully ascertained the public would not be compelled to descend to purchase commodities in the dark. The tenants, therefore, unanimously resolved to offer him four pounds per annum for the shop only, resigning all claims to the vaults. This the knight immediately accepted, and let them to merchants for the reception of packages, and large quantities of pepper, which article is still deposited in those of the present building.

While the projector of the Exchange employed every engine to increase his profits on its erection, neither himself nor his colleagues were inattentive to its original purpose; and they considered, that though it was impossible the merchants and traders of the city, and the foreigners who visited it, should not perceive the advantages it offered them, in the expediting their business, yet, that they might be more firmly impressed on their minds, he had recourse to a stratagem which it was amply in his power to apply.

During the reigns of Edward VI. and Queen Mary, this enterprizing merchant had been employed as their agent in procuring loans on the Continent, and had conducted himself with so much prudence and success, that Queen Elizabeth entrusted him with similar commissions, particularly at Antwerp, where he procured her large sums. This method of proceeding did not, however, accord with the patriotic views of our great trader, who contrived to prevail upon the sovereign to apply to her own subjects for assistance, which he more than once afforded her himself, with much profitable advice on financial matters. The stratagem alluded to was the prevailing on the Queen to go in solemn procession to the new Exchange, and there proclaim it such, under the additional sanction of her royal protection and recommendation. Had this monarch been less attached to splendid exhibitions of regal state, the claims of Sir Thomas on her gratitude were sufficiently powerful to demand a still greater favour. It is not, therefore, to be wondered, that she readily consented to perform her part, particularly as it was intimately connected with the future welfare of her good city of London. Accordingly, after due preparation, her Majesty departed from Somerset House, in the Strand, on the twenty-third of January, 1570, attended by the officers of her court and a train of nobility, to the magnificent residence of Sir Thomas, who, at a very great expense, provided a most superb entertainment for his royal guest, her attendants, and the principal citizens; after which the whole party went to the new edifice, where every possible display of rich goods was made in the shops, the occupiers of which, delighted with the condescension of their Queen, endeavoured to exceed each other in gratifying her curiosity, and expressing their loyalty and gratitude. The moment, at length, arrived for the accomplishment of this well-concerted plan; and Sir Thomas and the citizens had the satisfaction of hearing a herald proclaim the place a Royal Exchange by the sound of trumpet, at the express command of her majesty.

It appeared sufficiently plain, after the decease of Sir Thomas Gresham, that he had not erred in his calculations on the probable profits of the Exchange, as it was known that his lady received 751*l.* 5*s.* per annum in rents from it. And this result is precisely what a generous citizen would wish, that public advantage should be attended with private benefit to the successors of a public benefactor. The difficulty attending procuring the perusal of the archives of the different institutions of London has hitherto prevented the historian from giving a sketch of the existing connection between the estate of Sir Thomas Gresham, held by the Company of Mercers and the City of London; but it is certain that, after the year 1596, all the affairs of Sir Thomas Gresham's trust were managed by a committee of four aldermen and eight commoners on the part of the Corporation; and by the master, wardens, and eight of the court of assistants of the Mercer's Company.

The dreadful calamity of 1666 destroyed the old Royal Exchange, when only 234*l.* 8*s.* 2*d.* belonging to the Gresham trust remained in the coffers of the Company; and yet the persons composing it contrived to employ labourers to remove the ruins within six months after the conflagration occurred, in order to prepare the ground for the present structure; and on the twenty-fifth of February the King was petitioned for a supply of Portland stone. In September, 1667, the committee appointed to superintend the rebuilding of the Exchange submitted their plans and elevations to the inspection of Charles II. at the same time requesting permission to project the south portico into Cornhill. They had soon the satisfaction of hearing that the first were highly approved of, and that their request was granted. On the twenty-third of October in the above year, the monarch went to the scite, and placed the base of the pillar on the west side of the north entrance, after which he accepted of a handsome entertainment, provided at the joint expense of the City and Company of Mercers, and served under a temporary building erected on the Scotch walk. In return for this hospitality, the King knighted the Sheriffs Ganden and Davis, and gave 20*l.* in gold to the workmen. James, Duke of York, laid the first stone of the eastern pillar, on the thirty-first of October; and on the eighteenth of the following month Prince Rupert placed that on the east side of the south entrance, each being entertained in a sumptuous manner.

The Committee, inspecting the plan

made by Mr. Jerman for rebuilding the Exchange, on the 9th of December, 1667, resolved "that porticos should be built on the north and south sides, according as his Majesty desires, and as are described in the aforesaid draft; and that houses shall be built on the heads of the said porticos, and shops underneath." Mr. Malcolm has collected many particulars relating to this noble edifice, in his "Londinium Redivivum," and amongst others, the following extract from a book produced to a Committee of the House of Commons, 1747. "The said book begins the 27th of October, 1666, and ends July 12, 1676; and it thereby appears that the total expense of rebuilding the Royal Exchange amounted unto 58,962*l.*; the Company's moiety whereof was the sum of 29,481*l.* To defray which expense, it appeared the Company were obliged to borrow money upon their seal, insomuch that, in the year 1682, they had taken up money on their bonds, on account of the trust of Sir Thomas Gresham, to the amount of 45,795*l.*" It appeared, on this occasion, from the evidence of a Mr. Crumpe, "that the company had hitherto contributed equally with the city in the repairing of the Royal Exchange, and paying Sir Thomas Gresham's lectures and charities; and that, in or about the year 1729, one of the lecturers of Sir Thomas Gresham filed a bill, in Chancery, against the City of London, and the Mercer's Company: to answer which, it became necessary to draw out and state an account between the Mercer's Company, and Sir Thomas Gresham's trust estates, as also between the City and Company and the said estate; and, accordingly, such accounts were drawn up: and thereby it appears, that there was due to the Mercer's Company, for their moiety of the expense of building the Royal Exchange, and other payments up to that time, the sum of 100,659*l.* 18*s.* 10*d.*" Mr. Cawne, the then Clerk of the Company of Mercers, produced a continuation of this account to the Committee above mentioned, down to 1745, when the principal and interest amounted to the enormous sum of 142,885*l.* 7*s.* 1*d.*

In the year 1767, it was represented to the Legislature that essential repairs were required in different parts of the Royal Exchange, which procured a grant of 10,000*l.* and these were completed under the direction of Mr. Robinson, surveyor, who thought proper to rebuild the west side.

During the time occupied in rebuilding the present structure, the merchants of London transacted their business at Gresham College; and the new building was opened for that purpose, September 28, 1669: in 1703, the following notice appeared in the public papers: "An act of the Lord Mayor and Court of Aldermen is affixed at the Exchange, and other places in this City, by which all persons are prohibited coming upon the Royal Exchange to do business before the hours of twelve o'clock, and after the hour of two, till evening change. Wherein it is further enacted, that for a quarter of an hour before twelve the Exchange bell shall ring, as a signal of change time; and shall also begin to ring a quarter of an hour before two, at which time the change shall end: and all persons shall quit it, upon pain of being prosecuted to the utmost, according to law. That the gates shall then be shut up, and continue so till evening change time; which shall be from the hours of six to eight from Lady-day till Michaelmas, and from Michaelmas to Lady-day from the hours of four to six; before and after which hours the bell shall ring as above said. And it is further enacted, that no persons shall assemble in companies, as stock-jobbers, &c. either in Exchange Alley, or places adjacent, to stop up and hinder the passage from and to the respective houses thereabouts, under pain of being immediately carried before the Lord Mayor, or other Justice of the Peace, and prosecuted."

There are at present numerous shops encircling the Royal Exchange, but they are confined to the ground floor, under the arches or piazza; many years past the upper rooms were used for this purpose, and it has been said to the amount of two hundred. Lloyd's Coffee House now occupies the greater part of the upper story.

Before the present unhappy war, the Royal Exchange of London presented an epitome of the world, where specimens of all the varieties of man might be seen and studied; in which point of view it was equally valuable to the philosopher, as to the merchant for his extended pursuits, nor was it less useful to the observer of the manners of different nations; now, unfortunately, neither the philosopher, the observer of manners, nor the merchant, finds it a place of its original attraction. The frantic decrees against the commerce of England, on the continent, and the necessary reprisals of our own government, are the causes which have rendered the area of the

Royal Exchange a splendid desert, compared to what it has been; but the enterprising spirit of our traders, which outstrips all the cold calculations of politicians, may serve to convince the world, that though this spirit may be checked for a short time, it can never be extinguished, nor will all the powers of the earth combined produce the growth of grass between the stones of its pavement.

The architectural decorations render the exterior and interior fronts of the Royal Exchange an ornament to the vast metropolis of England. The form is square, and the area the same; there are four gates which face the cardinal points, but the principal is in Cornhill. Mr. Malcolm informs us that the statues of George I. and George II. are by Rysbrack; his present Majesty's by Wilton, which was erected in March, 1764; and that most of the Kings previously to Charles II. were sculptured by Cibber; that of the latter King, which originally stood in the area, is the work of Grinlin Gibbons, the unrivalled carver in wood; those of Charles I. and II., on the principal front, are by Bushnell. The statue of Charles II., in the area, was a few years since replaced by another in a Roman habit, the performance of Mr. Spiller. We shall conclude this slight sketch of the history of the Royal Exchange with a brief description by the author just mentioned. The grand gateway is in the centre intercolumniation of four Corinthian pillars, which are the whole height of the front, and have a complete entablature, the great arch reaching to the architrave. In the attic, directly over the gate, are the royal arms, and this forms the base of the steeple, on which there are three gradations, or stories, each bounded by pilasters and pillars, with entablatures and balustrades, and busts in place of vases, the usual ornaments of this sort of magnificent edifices; except the third, which has pediments on each side, with a cupola arising from the centre. On this is a globe and gilt grasshopper.

Over each side intercolumniation of the front are circular pediments; above them are attics and balustrades, with the Mercers' crest and the City supporters. The lesser entrances have divided pediments, and over them Corinthian niches, and pediments containing statues of Kings Charles the First and Second. The wings of the front are five arches in length, on each side of the gates, three of these form a piazza; the two remaining retire into the main building. The basement in which they are turned is rustic, and the story above them Corinthian, with four pillars, an entablature, and balustrade. The three windows of the projection, and those of the building, are exactly attic in their borders, though placed in Corinthian intercolumniations. The four sides of the quadrangle are magnificent, and richly decorated with the basement arches of the walks, the cornices over them, the niches, statues, pillars, circular windows, entablatures, and balustrade, all in correct proportion and arrangement.

ROYENA, in botany, *African bladder-nut*, so named in honour of Adrian Van Royen, a genus of the Decandria Digynia class and order. Natural order of Bicornes. Guaiacanæ, Jussieu. Essential character: calyx pitcher-shaped; corolla one-petalled, with the border revolute; capsule one-celled, four-valved. There are seven species.

RUBIA, in botany, *madder*, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla one-petalled, bell-shaped; berries two, one-seeded. There are seven species. See MADDER.

RUBRIC, in the canon-law, signifies a title or article in certain ancient law-books; thus called because written, as the titles of the chapters in our ancient Bibles are, in red letters. Rubrics also denote the rules and directions given at the beginning, and in the course of, the liturgy, for the order and manner in which the several parts of the office are to be performed. There are general rubrics and special rubrics, a rubric for the communion, &c. In the Romish missal and breviary are rubrics for matins, for lauds, for translations, beatifications, commemorations, &c.

RUBUS, in botany, the *raspberry*, a genus of the Icosandria Polygynia class and order. Natural order of Senticosæ. Rosaceæ, Jussieu. Essential character: calyx five-cleft; petals five; berry composed of one-seeded acini. There are thirty-two species; among which is the R. idæus, or common garden raspberry, too well known to need a particular description: it is found wild in many parts of Europe, particularly in rocky mountains, moist situations, woods, and hedges. The varieties of the raspberry are, the red-fruited, the white-fruited, and the twice-bearing.

RUBY. See Corundum.

Ruby, in heraldry, denotes the red colour wherewith the arms of noblemen are blazoned; being the same which, in the arms of others, not noble, is called gules.

RUDBECKIA, in botany, so named from Olaus Rudbeck, father and son, professors of botany at Upsal, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx with a double row of scales; crown of the seed a four-toothed rim; receptacle chaffy, conical. There are seven species.

RUDDER, in navigation, a piece of timber turning on hinges in the stern of the ship, and which, opposing sometimes one side to the water, and sometimes another, turns or directs the vessel this way or that. The rudder of a ship is a piece of timber hung on the stern posts by four or five iron-hooks, called pintles, serving as it were for the bridle of a ship, to turn her about at the pleasure of the steersman. The rudder being perpendicular, and without-side the ship, another piece of timber is fitted to it at right angles, which comes into the ship, by which the rudder is managed and directed. This latter properly is called the helm or tiller; and sometimes, though improperly, the rudder itself. The power of the rudder is reducible to that of the lever. As to the angle the rudder should make with the keel, it is shown, that in the working of ships, in order to stay or bear up the soonest possible, the tiller of the rudder ought to make an angle of 55° with the keel. A narrow rudder is best for a ship's sailing, provided she can feel it; that is, be guided and turned by it: for a broad rudder will hold much water when the helm is put over to any side; but if a ship have a fat quarter, so that the water cannot come quick and strong to her rudder, she will require a broad rudder. The aft-most part of the rudder is called the rake of the rudder.

RUDOLPHINE *Tables*, a set of astronomical tables that were published by the celebrated Kepler, and so called from the Emperor Rudolph, or Rudolphus.

RUELLIA, in botany, so named in honour of Joannes Ruellius, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Acanthi, Jussieu. Essential character: calyx five-parted; corolla subcampanulate; stamens approximating by pairs; capsule opening by elastic teeth. There are forty-three species. Swartz observes, that the Ruelliæ are very nearly allied to the Justiciæ in their natural order, flowers, fruit, and habit.

RUIZIA, in botany, so named in honour of Don Hipolito Ruiz, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx double, exterior three-leaved; styles ten; capsule ten, one-celled, two-seeded, closely cohering. There are three species, all natives of the Isle of Bourbon.

RULE, in arithmetic, denotes an operation performed with figures, in order to discover sums or numbers unknown. The fundamental rules are addition, subtraction, multiplication, and division. But, besides these, there are other rules, denominated from their use; as the rule of Alligation, Fellowship, Interest, Practice, Reduction, &c. which see in the alphabetical order.

Rule *of Three*, Golden *Rule*, or Rule *of Proportion*, is one of the most essential rules of arithmetic; for the foundation of which see the article Proportion. It is called the Rule of Three from having three numbers given to find a fourth; but, more properly, the Rule of Proportion, because by it we find a fourth number proportional to three given numbers: and because of the necessary and extensive use of it, it is called the Golden Rule. But to give a definition of it, with regard to numbers of particular and determinate things, it is the rule by which we find a number of any kind of things, as money, weight, &c. so proportional to a given number of the same things, as another number of the same or different things is to a third number of the last kind of thing. For the four numbers that are proportional must either be all applied to one kind of things; or two of them must be of one kind, and the remaining two of another: because there can be no proportion, and consequently no comparison of quantities of different species: as, for example, of three shillings and four days; or of six men and four yards. All questions that fall under this rule may be distinguished into two kinds: the first contains those wherein it is simply and directly proposed to find a fourth proportional to three given numbers, taken in a certain order: as if it were proposed to find a sum of money so proportioned to one hundred pounds, as sixty-four pounds ten shillings is to eighteen pounds six shillings and eight-pence, or as forty pounds eight shillings is to six hundred weight. The second kind contains all such questions wherein we are left to discover, from the nature and circumstances of the question, that a fourth proportional is sought; and consequently, how the state of the proportion, or comparison of the term, is to be made; which depends upon a clear understanding of the nature of the question and proportion. After the given terms are duly ordered, what remains to be done is to find a fourth proportional. But to remove all difficulties as much as possible, the whole solution is reduced to the following general rule, which contains what is necessary for solving such questions, wherein the state of the proportion is given; in order to which it is necessary to premise these observations.

1 In all questions that fall under the following rule there is a supposition and a demand: two of the given numbers contain a supposition, upon the conditions whereof a demand is made, to which the other given term belongs; and it is therefore said to raise the question; because the number sought has such a connection with it as one of these in the supposition has to the other. For example: if three yards of cloth cost 4*l.* 10*s.* (here is the supposition) what are 7 yards 3 quarters worth? here is the demand or question raised upon 7 yards 3 quarters, and the former supposition.

2. In the question there will sometimes be a superfluous term; that is, a term which, though it makes a circumstance in the question, yet it is not concerned in the proportion, because it is equally so in both the supposition and demand. This superfluous term is always known by being twice mentioned, either directly, or by some word that refers to it. Example, if three men spend 20*l.* in 10 days, how much, at that rate, will they spend in 25 days? Here the three men is a superfluous term, the proportion being among the other three given terms, with the number sought; so that any number of men may be as well supposed as 3.

Rule 1. The superfluous term (if there is one) being cast out, state the other three terms thus: of the two terms in the supposition, one is like the thing sought (that is, of the same kind of thing the same way applied); set that one in the second or middle place; the other term of the supposition set in the first place, or on the left hand of the middle; and the term that raises the question, or with which the answer is connected, set in the third place, or on the right hand; and thus the extremes are like one another, and the middle term like the thing sought: also the first and second terms contain the supposition, and the third raises the question; so that the third and fourth have the same dependence or connection as the first and second. 2. Make all the three terms simple numbers of the lowest denominations expressed, so that the extremes be of one name. Then, 3. Repeat the questions from the numbers thus stated and reduced (arguing from the supposition to the demand), and observe whether the number sought ought to be greater or lesser than the middle term, which the nature of the question, rightly conceived, will determine; and, accordingly, multiply the middle term by the greater or lesser extreme, and divide the product by the other, the quote is like the middle term, and is the complete answer, if there is no remainder; but if there is, then, 4. Reduce the remainder to the denomination next below that of the middle term, and divide by the same divisor, the quotient is another part of the answer in this new denomination. And if there is here also a remainder, reduce it to the next denomination, and then divide. Go on thus to the lowest denomination, where, if there is a remainder, it must be applied fraction-wise to the divisor; and thus you will have the complete answer in a simple or mixed number.

Note. If any of the dividends is less than the divisor, reduce it to the next denomination, and to the next again, till it be greater than, or equal to, the divisor.

EXAMPLES.

Quest. 1. If 3 yards of cloth cost 8*s.* what is the price of 15 yards? Answ. 40*s.* or 2*l.*

Work.

yds. s. yds.
3—8—15
15

3)120(40*s.*

Explanation. 3 yards and 8*s.* contain the supposition, and 8*s.* is like the thing sought; therefore 8*s.* is the middle term, and yards on the left: then the demand arises upon 15 yards, and therefore it is on the right. Again, from the nature of the question, it is plain that 15 yards require more than 3 yards, *i. e.* the answer must be greater than the middle term; wherefore 8*s.* is to be multiplied by 15 yards; the product is 120*s.* which, divided by 3 yards, quotes 40*s.* without a remainder; so 40*s.* or 2*l.* is the number sought.

Quest. 2. If 4*lb.* of sugar cost 2*s.* 9*d.* what is the value of 18*lb.*? Answer 12*s.* 4½*d.*

Work.

```
lb. s. d. lb.
4—2 : 9—18
     12
    ——
     33 d.
     18
     —
    264
    33
    ——
 4)594(148 d.
      2
      4
      —
   4)8(2 farthings.
```

Explanation. The supposition is in 4*lb.* and 2*s.* 9*d.* this last term being like the thing sought, which is connected with 18*lb.* wherefore the terms are stated according to the rule: then the middle term being mixed, it is to be reduced to pence; and then argue thus; if 4 *lb.* cost 33*d.*, 18 *lb* must cost more; therefore multiply 33*d.* by 18*lb.* and divide their product by 4; the quotient is 148*d.* and 2 remains, which is to be reduced to farthings, and the product, divided by the former quotient, gives 2; so the answer is 148*d.* 2 farthings, or 12*s.* 4½*d.* because 148*d.* is, by reduction, 12*s.* 4*d.*

Quest. 3. What time will 7 men be boarded for 25*l.* when 3 men paid 25*l.* for 6 months? Answ. 2 months, 16 days, reckoning 28 days to 1 month.

Work.

```
men. months. men.
3——6——7
       3
       —
    7)18(2
      14
      ——
   Rem. 4
       28
      ——
   7)112(16 days.
```

Explanation. The 25*l.* is a superfluous number; then the supposition is in the 3 men and 6 months, and the demand regards the 7 men: the terms being all simple, you are to argue thus; if 3 men are boarded 6 months for 25*l.* (or any sum), 7 men will be boarded for the same a shorter time: therefore multiply 6 months by 3, and divide the product 18 by 7, whereby the answer is found to be 2 months and 16 days.

Note. The first two questions are what is called the rule of three direct, that is, where the third term, being greater or less than the first, requires that the answer also be greater or lesser than the second term. The last, of the rule of three indirect, or reverse; where the third term, being greater or lesser than the first, requires the fourth contrarily lesser or greater than the second. But we have comprehended both in one general rule. And from this observation may be learned what questions are of either kind.

Rule, or Ruler, an instrument of wood or metal, with several lines delineated on it, of great use in practical mensuration. When a ruler has the lines of chords, tangents, sines, &c. it is called a plane scale.

The carpenter's joint rule is an instrument usually of box, &c. twenty-four inches long, and one and a half broad; each inch being subdivided into eight parts. On the same side with these divisions is usually added Gunter's line of numbers. On the other side are the lines of timber and board measure; the first beginning at 82, and continued to 36, near the other end; the latter is numbered from 7 to 36, 4 inches from the other end. We shall point out some of the uses of this rule.

The application of the inches, in measuring lengths, breadths, &c. is obvious. That of the Gunter's line, see under the article Gunter's Line.

The use of the other side is that with which we are now concerned. 1. The breadth of any surface, as board, glass, &c. being given, to find how much in length makes a square foot. Find the number of inches the surface is broad, in the line of board measure, and right against it is the number of inches required. Thus, if the surface were eight inches broad, eighteen inches will be found to make a superficial foot. Or more readily thus: apply the rule to the breadth of the board, or glass, that end, marked 36, being equal with the edge, the other edge of the surface will show the inches, and quarters of inches, which go to a square foot. 2. Use of the table at the end of the board-measure. If a surface be one inch broad, how many inches long will make a superficial foot? look in the upper row of figures for one inch, and under it in the second row is twelve inches, the answer to the question. 3.

Use of the line of timber-measure. This resembles the former; for having learned how much the piece is square, look for that number on the line of the timber-measure; the space thence to the end of the rule is the length, which, at that breadth, makes a foot of timber. Thus, if the piece be nine inches square, the length necessary to make a solid foot of timber is 21$\frac{1}{3}$ inches. If the timber be small, and under nine inches square, seek the square in the upper rank of the table, and immediately under it is the feet and inches that make a solid foot. If the piece be not exactly square, but broader at one end than the other, the method is to add the two together, and take half the sum for the side of the square. For round timber the method is to girt it round with a string, and to allow the fourth part for the side of the square; but this method is erroneous, for hereby you lose nearly one fifth of the true solidity; though this is the method at present practised in buying and selling timber.

RULE, *Coggeshall's sliding*, is chiefly used for measuring the superficies and solidity of timber, &c. It consists of two rulers, each a foot long, one of which slides in a groove made along the middle of the other.

On the sliding side of the rule are four lines of numbers, three whereof are double; that is, are lines to two radiuses; and one, a single broken line of numbers: the three first, marked A, B, C, are figured 1, 2, 3, &c. to 9; then 1, 2, 3, &c. to 10. The single line, called the girt-line, and marked D, whose radius is equal to the two radiuses of any of the other lines, is broke for the easier measurement of timber, and figured 4, 5, 6, 7, 8, 9, 10, 20, 30, &c. From 4 to 5 it is divided into ten parts, and each tenth subdivided into 2, and so on, from 5 to 6, &c. On the back side of the rule are, 1. A line of inch-measure, from 1 to 12; each inch being divided and subdivided. 2. A line of foot measure, consisting of one foot, divided into 100 equal parts, and figured 10, 20, 30, &c. The back part of the sliding piece is divided into inches, halves, &c. and figured from 12 to 24; so that when drawn wholly out, there may be a measure of two feet.

"Use of Coggeshall's Rule for measuring plane superficies." 1. To measure a square: suppose, for instance, each of the sides 5 feet; set 1 on the line B, to 5 on the line A; then against 5 on the line B is 25 feet, the content of the square on the line A. 2. To measure a long square. Suppose the longest side 18 feet, and the shortest 10; set 1 on the line B, to 10 on the line A; then against 18 feet, on the line B, is 180 feet, the contents on the line A. 3. To measure a rhombus. Suppose the side 12 feet, and the length of a perpendicular let fall from one of the obtuse angles to the opposite side, 9 feet; set 1 on the line B, 12, the length of the side on the line A: then against 9, the length of the perpendicular on the line B, is 108 feet, the content. 4. To measure a triangle. Suppose the base 7 feet, and the length of the perpendicular let fall from the opposite angle to the base 4 feet; set 1 on the line B, to 7 on the line A; then against half the perpendicular, which is 2 on the line B, is 14 on the line A, for the content of the triangle. 5. To find the content of a circle, its diameter being given. Suppose the diameter 3.5 feet; set 11 on the girt line D, to 95 on the line C; then against 3.5 feet on D, is 9.6 on C, which is the content of the circle in feet 6. To find the content of an oval or ellipsis. Suppose the longest diameter 9 feet, and the shortest 4. Find a mean proportional between the two, by setting the greater 9 on the girt line, to 9 on the line C; then against the less number 4 on the line is C 6, the mean proportional sought. This done, find the content of a circle, whose diameter is 6 feet; this, when found, by the last article, will be equal to the content of the ellipsis sought.

"Use of Coggeshall's Rule in measuring timber." 1°. To measure timber the usual way. Take the length in feet, half feet, and, if required, quarters; then measure half way back again; then girt the tree with a small cord or line; double this line twice very evenly, and measure this fourth part of the girt or perimeter in inches, halves, and quarters. The dimensions thus taken, the timber is to be measured as if square, and the fourth of the girt taken for the side of the square, thus; set 12 on the girt line D, to the length in feet on the line C; then against the side of the square, on the girt line D, taken in inches, you have, on the line C, the content of the tree in feet. For an instance: suppose the girt of a tree, in the middle, be 60 inches, and the length 30 feet, to find the content, set 12 on the girt-line D, and 30 feet on the line C; then against 15, one fourth of 60, on the girt-line D, is 46.8 feet, the content on the line C. If the length should be 9 inches, and the quarter of the girt 35 inches; here, as the length is beneath a foot, measure it on the line of foot-measure, and see what decimal part of a foot it makes, which you will find .75. Set 12, therefore, on the girt line, to 75 on the first radius of the line C, and against 35 on the girt-line is 64 feet on C, for the content. 2°. To measure round timber the true way. The former method, though that generally in use, is not quite just. To measure timber accurately, instead of the point 12 on the girt-line, use another, *viz.* 10.635; at which there should be placed a centre-pin. This 10.635 is the side of a square equal to a circle, whose diameter is 12 inches. For an instance: suppose the length 15 feet, and ¼ of the girt 42 inches, set the point 10.635 to 15, the length; then against 42 on the girt-line is 233 feet for the content sought; whereas by the common way, there arises only 184 feet. In effect, the common measure is only to the true measure, as 11 to 14. 3°. To measure a cube. Suppose the sides to be 6 feet each; set 12 on the girt-line D, to 6 on C; then against 72 inches (the inches 6 feet) on the girt-line, is 216 feet on C, which is the content required. 4°. To measure unequally squared timber; that is, where the breadth and depth are not equal. Measure the length of the piece, and the depth (at the end) in inches: then find a mean proportional between the breadth and depth of the piece. This mean proportional is the side of a square, equal to the end of the piece; which found, the piece may be measured as square timber. For an instance: let the length of the piece of timber be 13 feet, the breadth 23 inches, and the depth 13 inches; set 23 on the girt-line D, to 23 on C; then against 13 on C is 17.35 on the girt-line D, for the mean proportional. Again, setting 12 on the girt-line D, to 13 feet, the length of the line C; against 17.35 on the girt-line is 27 feet, the content. 5°. To measure taper timber. The length being measured in feet, note one-third of it; which is found thus: set 3 on the line A, to the length on the line B; then against 1 on A is the third part on B: then, if the solid be round, measure the diameter at each end in inches, and subtract the less diameter from the greater; add half the difference to the less diameter; the sum is the diameter in the middle of the piece. Then set 13.54 on the girt to the length of the line C, and against the diameter in the middle on the girt-line is a fourth number on the line C. Again, set 13.54 on the girt-line to the third part of the length on the line C; then against half the difference on the girt-line is another fourth number on the line C; these two fourth numbers, added together, give the content. For an instance: let the length be 27 feet (one third whereof is 9) the greater diameter 22 inches, and the lesser 18; the sum of the two will be 40, their difference 4, and half the difference 2, which, added to the less diameter, gives 20 inches for the diameter in the middle of the piece. Now set 13.54 on the girt-line to 27 on the line C, and against 20 on D is 58.9 feet. Again, set 13.44 of the girt-line to 9 on the line C; and against 2 on the girt-line (represented by 20) is .196 parts; therefore, by adding 58.9 feet to .196 feet, the sum is 59.096 feet, the content.

If the timber be square, and have the same dimensions: that is, the length 27 feet, the side of the greater end 22 inches, and that of the lesser 18 inches; to find the content, set 12 on the girt-line to 27, the length on the line C, and against 20 inches, the side of the mean square on the girt line is 75.4 feet. Again, set 12 on the girt-line to 9 feet, one third of the length, on the line C, and against 2 inches, half the difference of the sides of the squares of the ends on the girt-line is .25 parts of a foot; both together make 75.65 feet, the content of the solid.

The girt or circumference of a tree, or round piece of timber, given; to find the side of the square within, or the number of inches of a side, when the round timber is squared. Set 10 on A to 9 on B, then against the girt on A are the inches for the side of a square on the line B.

RUM, a species of vinous spirit, distilled from sugar canes.

RUMEN, in comparative anatomy, the paunch, or first stomach, of such animals as chew the cud, thence called ruminant animals. The rumen is by far the largest of all the stomachs, and in it the whole mass of crude aliments, both solid and liquid, lies and macerates, to be thence transmitted to the mouth, to be again chewed, comminuted, and fitted for further digestion in the other ventricles.

The ruminant animals, Mr. Ray observes, are all hairy quadrupeds, viviparous, and have four stomachs; they also want the dentes primores, or broad teeth in the fore-part of the upper jaw, and are furnished with that kind of fat called suet, sebum.

RUMEX, in botany, *dock*, a genus of the Hexandria Trigynia class and order. Natural order of Holoraceæ. Polygoneæ, Jussieu. Essential character: calyx three-leaved; petals three, converging; seed one, three-sided. There are thirty-six species.

RUMMAGE, in the sea-language, signifies to clear a ship's hold, or to remove goods from one place of it to another.

RUMOURS, spreading such as are false, is criminal and punishable by common law.

RUMPHIA, in botany, so named in honour of George Everhard Rumphius, M. D. a genus of the Triandria Monogynia class and order. Natural order of Terebintaceæ, Jussieu. Essential character: calyx three-cleft; petals three; drupe three-celled. There is only one species, *viz.* R. amboinensis, a native of the East Indies.

RUNDLET, or RUNLET, a small vessel, containing an uncertain quantity of any liquor; from three to twenty gallons.

RUNGS, in a ship, the same with the floor or ground timbers, being the timbers which constitute her floor, and are bolted to the keel, whose ends are rung-heads.

RUNG *heads*, in a ship, are made a little bending, to direct the sweep or mould of the futtocks and navel timbers; for here the lines, which make the compass and bearing of a ship, do begin.

RUNIC, a term applied to the language and letters of the ancient Goths, Danes, and other northern nations.

RUNNER, in the sea language, a rope belonging to the garnet, and to the two bolt-tackles. It is reeved in a single block, joined to the end of a pennant, and has at one end a hook to hitch into any thing, and at the other end a double block, into which is reeved the fall of the tackle, or the garnet, by which means it purchases more than the tackle would without it.

RUNNET, or RENNET, the acid juice found in the stomachs of calves that have fed on nothing but milk, and are killed before the digestion is perfect.

RUPALA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Contortæ. Protæ, Jussieu. Essential character: calyx none; petals four, cohering at the base; stamina inserted into the middle of the petals; pericarpium one-celled, one-seeded.—There are two species, *viz.* R. montana and R. sessilifolia, both natives of Cayenne.

RUPERT'S *drops*, a sort of glass-drops, with long and slender tails, which burst to pieces on the breaking off those tails in any part, said to have been invented by Prince Rupert, and therefore called after his name. This surprising phenomenon is supposed to rise from hence, that while the glass is in fusion, or in a melted state, the particles of it are in a state of repulsion; but being dropped into cold water, it so condenses the particles in the external parts of their superficies, that they are easily reduced within the power of each other's attraction, and by that means they form a sort of hard case, which keeps confined the before-mentioned particles in their repulsive state; but when this outer-case is broken, by breaking off the tail of the drop, the said confined particles have then a liberty to exert their force, which they do by bursting the body of the drop, and reducing it to a very peculiar form of powder.

RUPPIA, in botany, so named in memory of Henry Bernhard Ruppius, a genus of the Tetrandria Tetragynia class and order. Natural order of Inundatæ. Naiades, Jussieu. Essential character: calyx none; corolla none; seeds four, pedicelled. There is but one species, *viz.* R. maritima, sea ruppia, or tassel pond-weed.

RUSCUS, in botany, *butcher's broom*, a genus of the Dioecia Syngenesia class and order. Natural order of Sarmentaceæ. Asparagi, Jussieu. Essential character: calyx six-leaved; corolla none; nectary central, ovate, perforated at the top. There are five species.

RUSSELIA, in botany, so named in honour of Alexander Russel, M. D. a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: calyx five-leaved, setaceous at the end; corolla tube very long, hairy at the throat; border two-lipped, lower lip trifid; capsule acuminate, one-celled, two-valved, many-seeded. There is only one species, *viz.* R. sarmentosa, found by Jacquin about Havana, in close woods and coppices.

RUST *of a metal*, a word that has now given way to the modern term OXIDE, which see.

RUTA, in botany, *rue*, a genus of the Decandria Monogynia class and order. Natural order of Multisiliquæ. Rutaceæ, Jussieu. Essential character: calyx five-parted; petals concave; receptacle surrounded by ten honey dots; capsule lobed. There are seven species.

RUTILE, in mineralogy, a species of the Menachine genus, of a dark blood red colour, of various degrees of intensity, passing to a brownish red. It occurs crystallized, and the crystals are longitudinally streaked; externally it is shining and glistening; internally its principal fracture is splendent. It is slightly translucent, brittle; it yields a pale yellow or orange yellow coloured streak. It is easily frangible; specific gravity about 4.2. Without addition it is infusible before the blow-pipe; with borax or alkali it affords a hyacinth transparent glass. It is found to be a pure oxide of menachine, with a slight portion of silica.

RUTULITE, a mineral found in Norway, of a yellowish colour; it occurs massive, disseminated, and crystallized. The crystals are small, singly imbedded, and seldom aggregated. It is translucent on the edges, or opaque, yields a grey streak; it is hard, brittle, and easily frangible. Specific gravity 3.5. It experiences little change before the blow-pipe, without addition, but with borax it forms a yellowish-green transparent bead; the constituent parts are different, according to the place from which the specimens are found; one from Norway was found to consist of

Silica	22
Oxide of menachine	58
Calcareous earth	20
	100

It is found at Passau, in the district of the Inn, and in several Norwegian mines.

RUYSCHIA, in botany, so named in memory of Frederic Ruysch, professor of botany at Amsterdam, a genus of the Pentandria Monogynia class and order. Essential character: calyx five-leaved; corolla five-petalled, reflexed; style none; berry many-seeded. There are two species, *viz.* R. clusiæfolia, and R. surubea.

RYANIA, in botany, so named in honour of John Ryan, M. D. a genus of the Polyandria Monogynia class and order. Essential character: calyx five-leaved, permanent, coloured; corolla none; stigmas four; berry suberous, one-celled, many-seeded. There is only one species, *viz.* R. speciosa, a native of the Isle of Trinidad.

RYE. See SECALE.

RYNCHOPS, the *skimmer*, in natural history, a genus of birds of the order Grallæ. Generic character: the bill greatly compressed; lower mandible considerably longer than the upper; nostrils linear and pervious; back toe very small; tail very forked. R. nigra, or the black skimmer, the only species, is twenty inches long and three feet and a half in width. It inhabits America and the East Indies, and is almost incessantly on the wing, skimming over the surface of the water, into which it plunges its bill with extreme frequency, to seize small fishes, which constitute its chief food. It is a vulgar error, that the structure of its bill enables it to open oysters and other shell fish with extreme ease, and that in stormy weather it is seen on the shores opening and devouring them. See AVES, Plate XIII. fig. 3.

END OF VOL. V.

AVES. *Plate XII.*

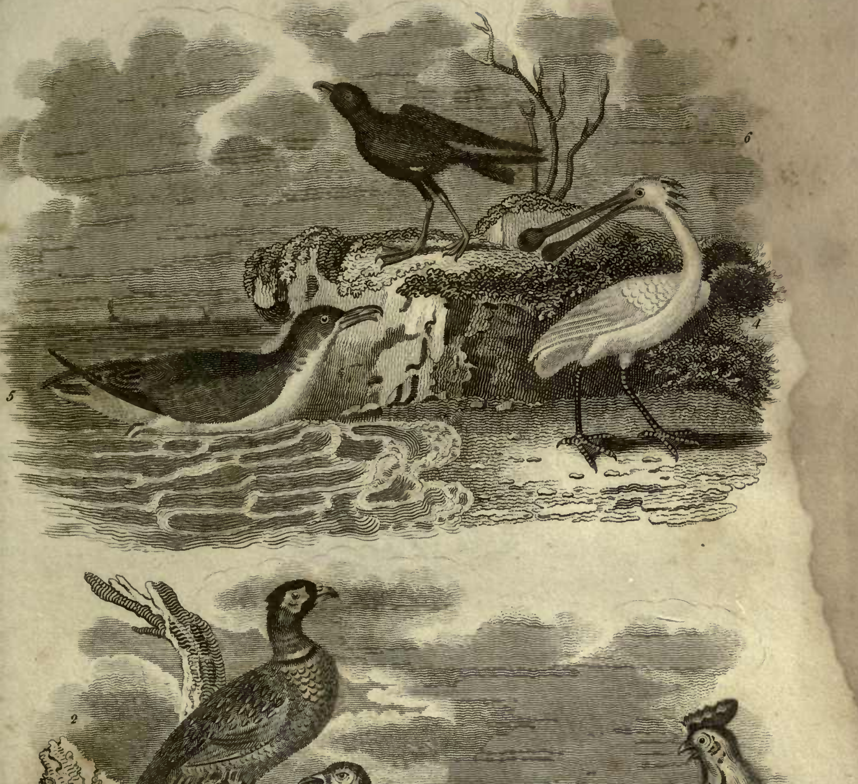


Fig. 1. Phasianus *Gallus: Domestic Cock – Fig. 2.* P. *Colchicus: Common Pheasant – Fig. 3.* Picus *Major: Greater spotted Wood-pecker – Fig. 4.* Platalea *Leucorodia: White Spoon bill – Fig. 5.* Procellaria *Puffinus Shearwater – Fig. 6.* P. *Pelagica: Stormy Petrel – Fig. 7.* Rallus *Crex: Corn-Crake.*

Fig. 1. Sciurus *vulgaris: Common squirrel – Fig.* 2. S. *getula: Barbary squirrel – Fig.* 3. S. *niger: Black squirrel – Fig.* 4. S. *volucella: Flying squirrel – Fig.* 5. Rhinoceros *unicornis one horned Rhinoceros.*

OBSERVATORY.

Mr. GRAHAM'S. Equatorial Sector

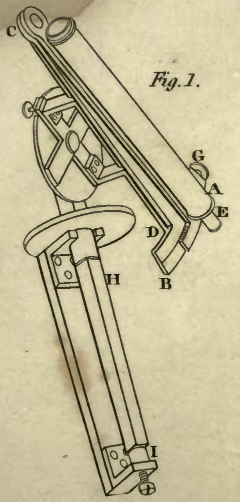
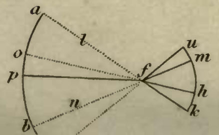


Fig. 1.



Transit Instrument

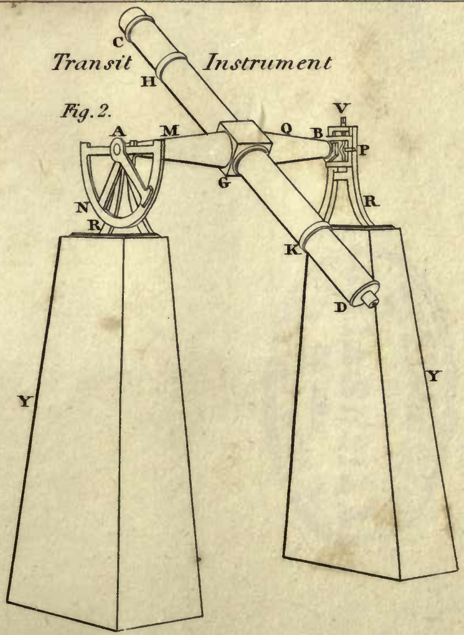


Fig. 2.

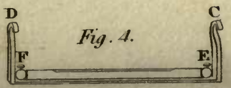


Fig. 4.

Mr. RAMSDEN'S. Universal Equatorial

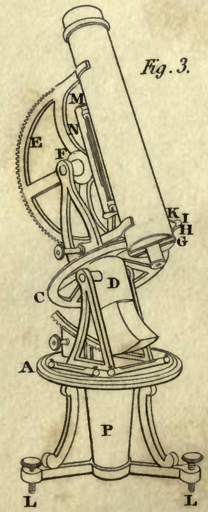


Fig. 3.

BARREL ORGAN MADE BY LINCOLN.

Plate 1.

Fig. 1.

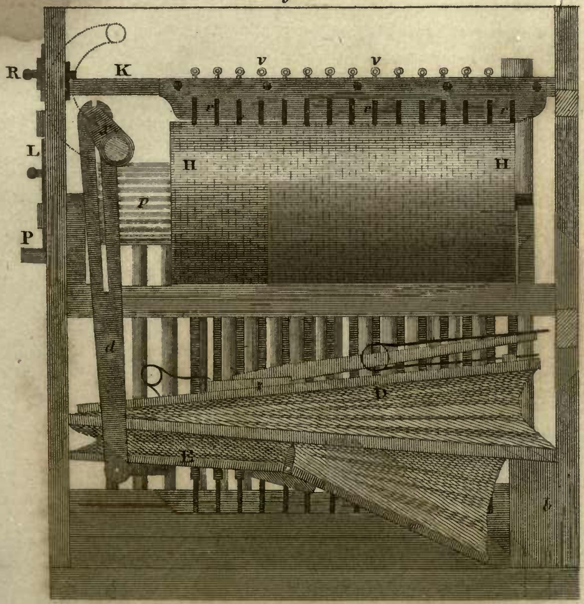
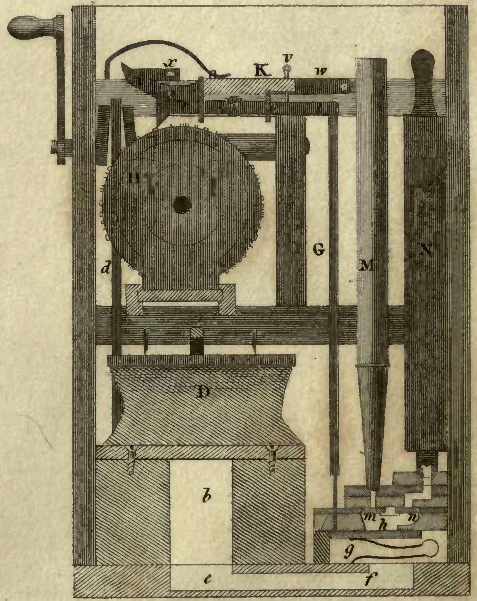


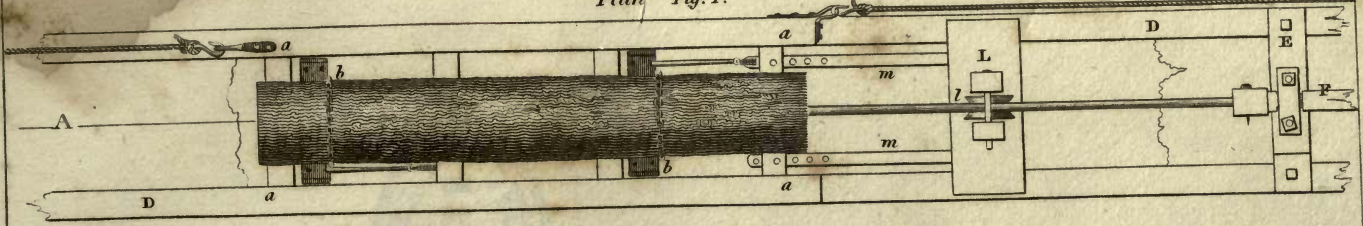
Fig. 2.



Kneass, Young & Co. sc.

Machine for Boring Wooden Pipes.

Plan Fig. 1.



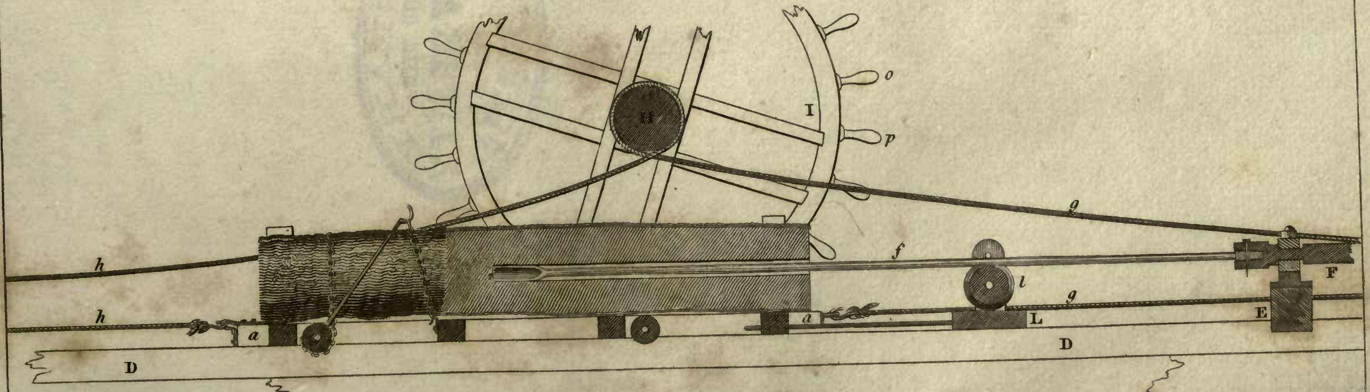


Fig. 2. Elevation through the line AB.

PRESSES.

Fig. 1.

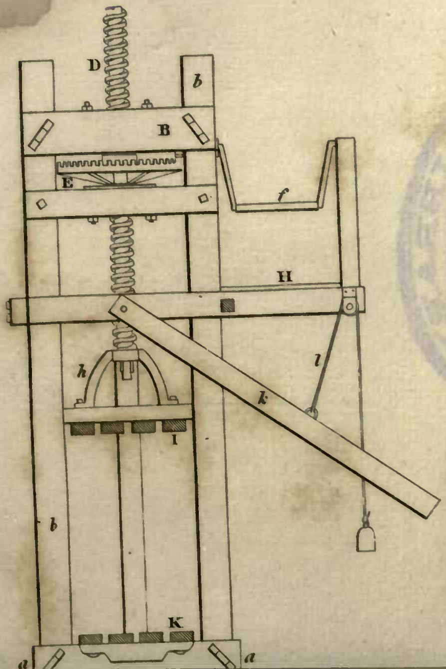


Fig. 2.

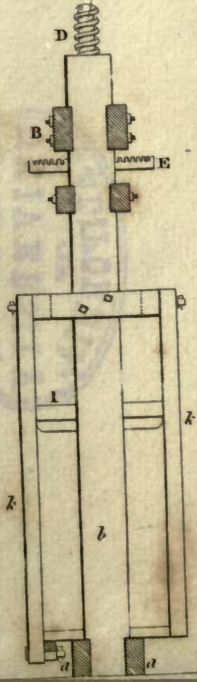
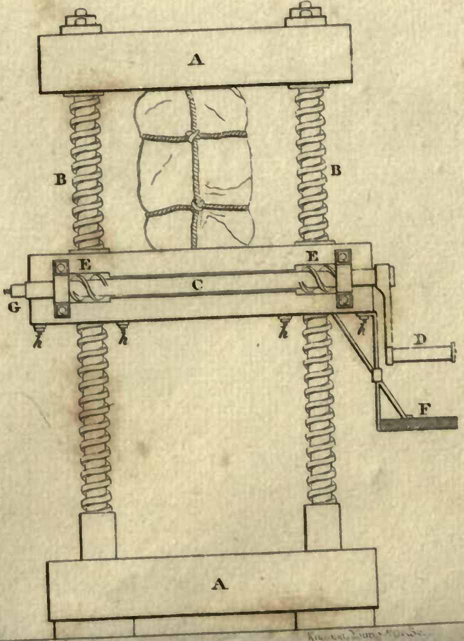


Fig. 3.



PLANETARIUM

Elevation Fig. 1.

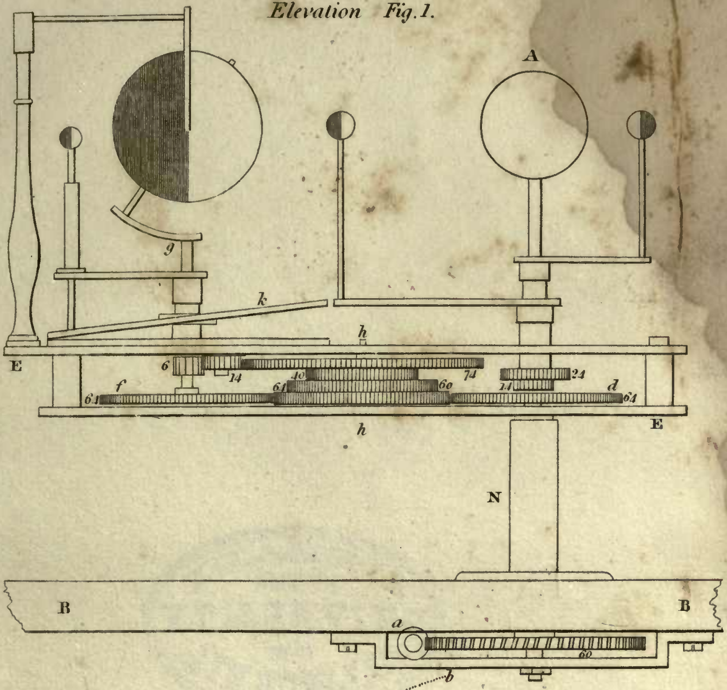
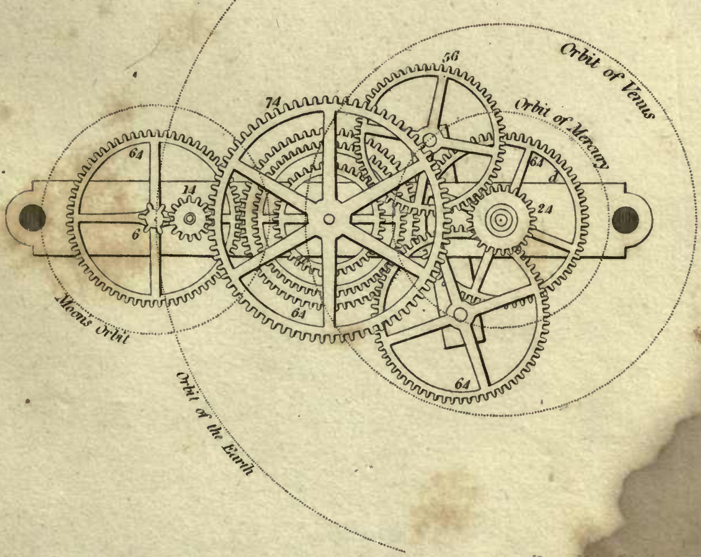
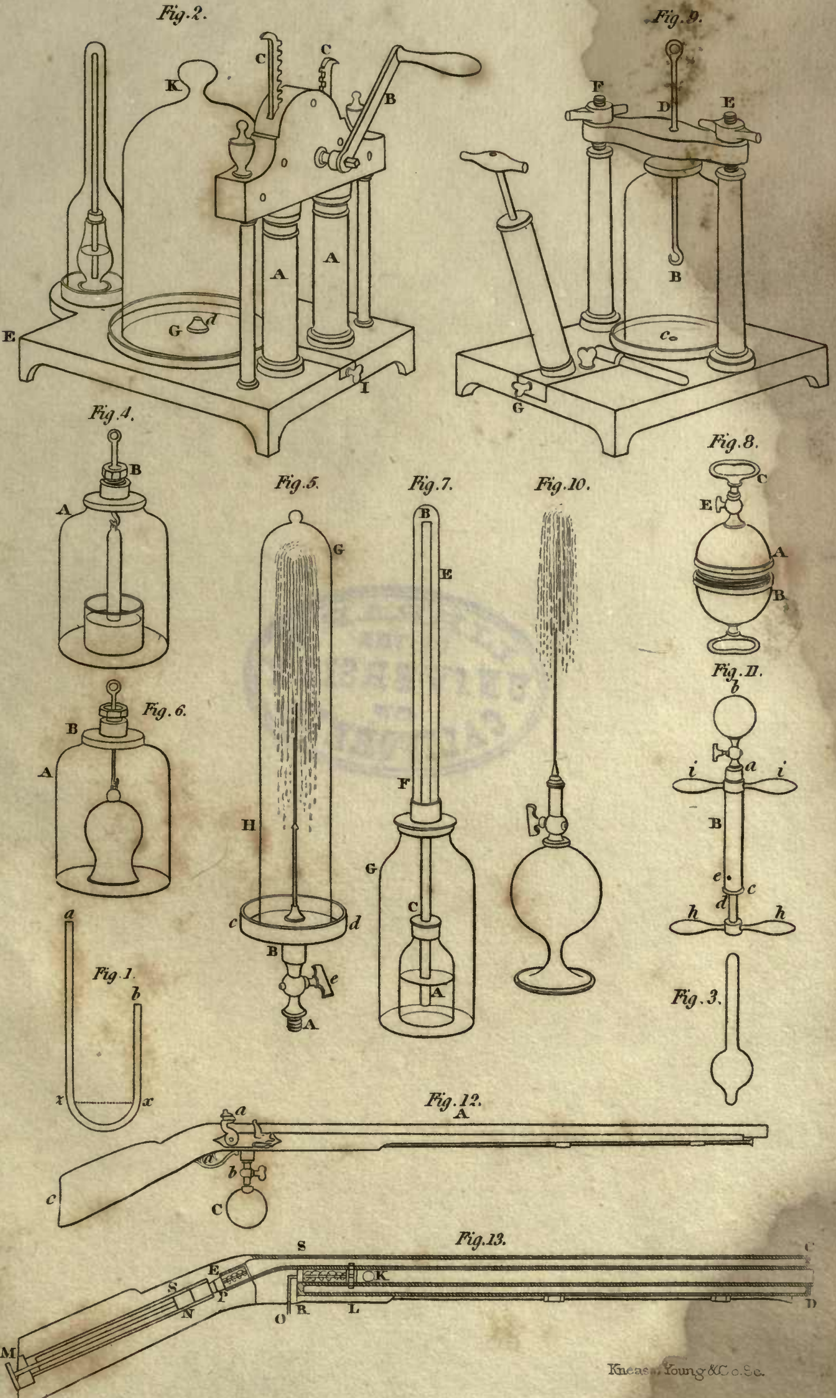


Fig. 2. *Plan*

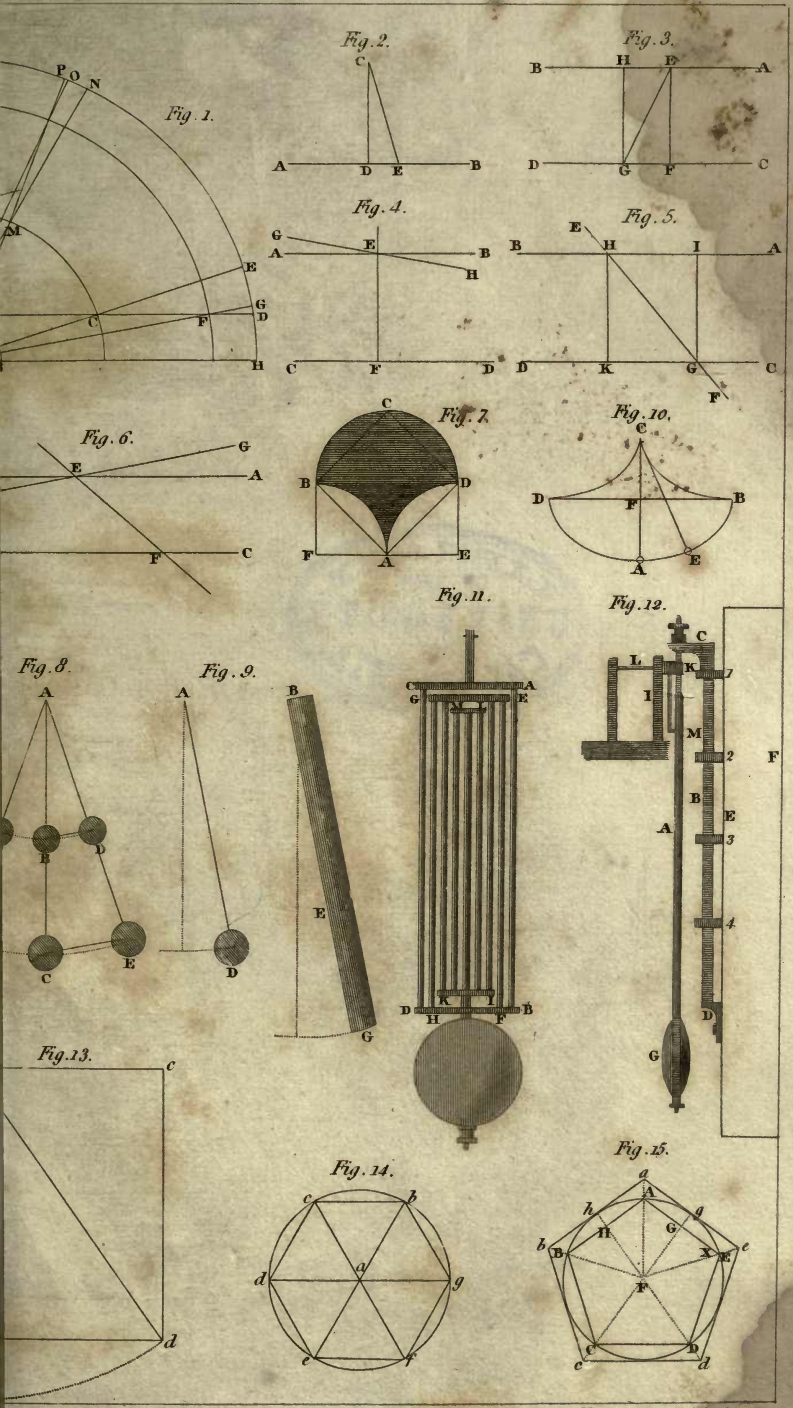


10

PNEUMATICS.



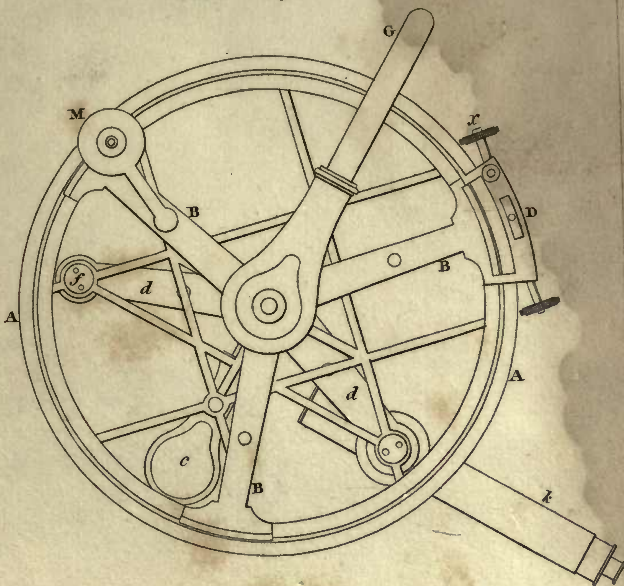
Kneass, Young & Co. Sc.



Kneass, Young & Co. Sc.

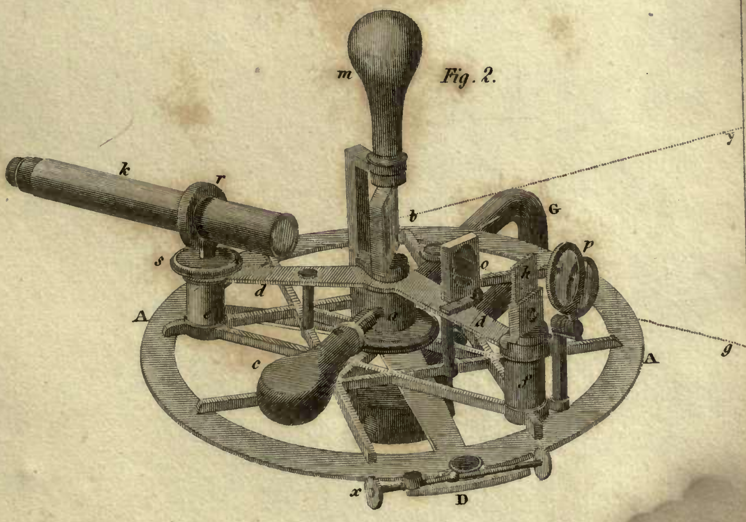
REFLECTING CIRCLE made by Mr. TROUGHTON.

Plan Fig. 1.



View of the upper side of the instrument.

Fig. 2.



Kneass, Young & Co. Sc.

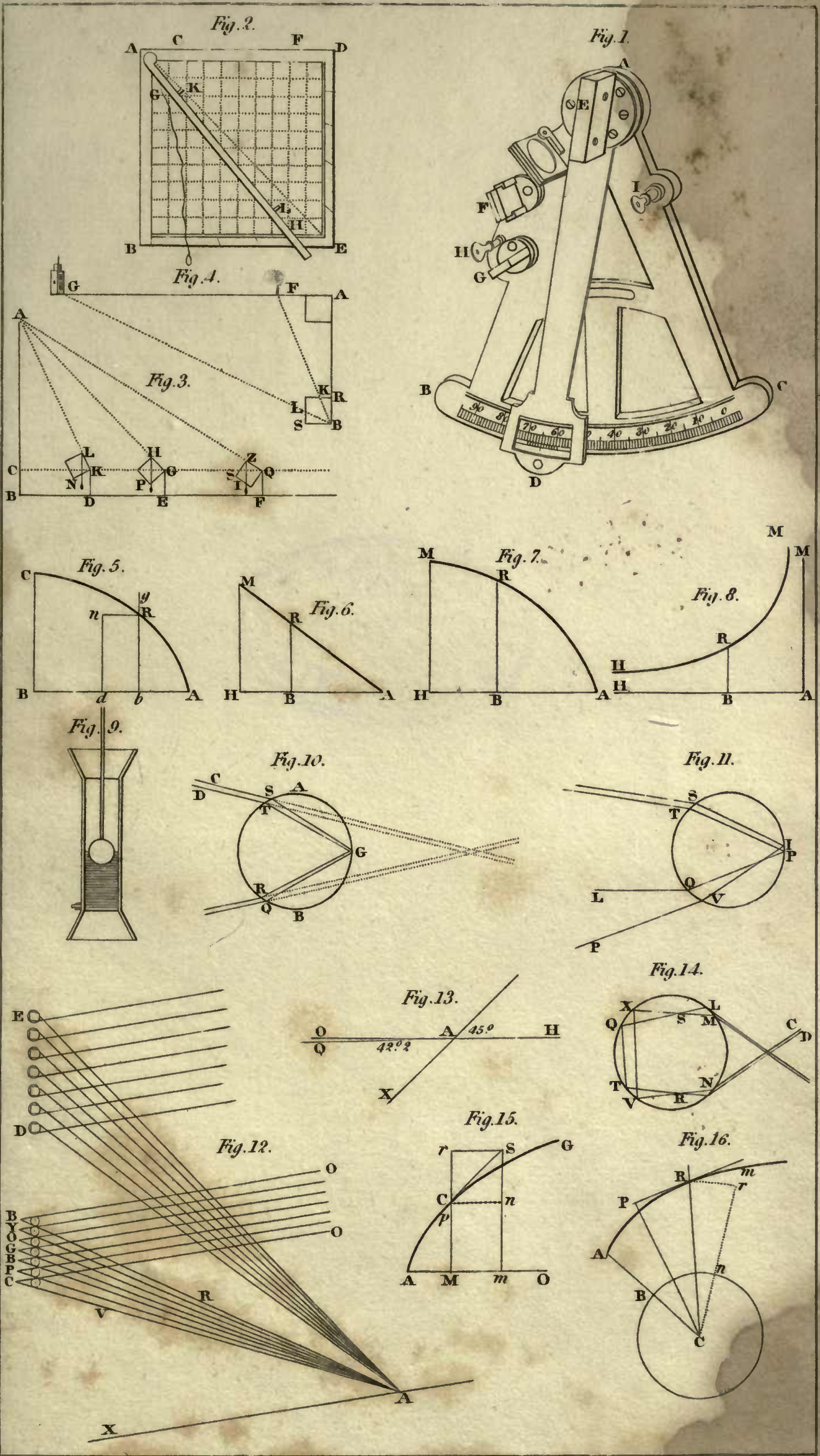


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.
Fig. 11.
Fig. 12.
Fig. 13.
Fig. 14.
Fig. 15.
Fig. 16.

ROLLING MILL.

Fig. 1.

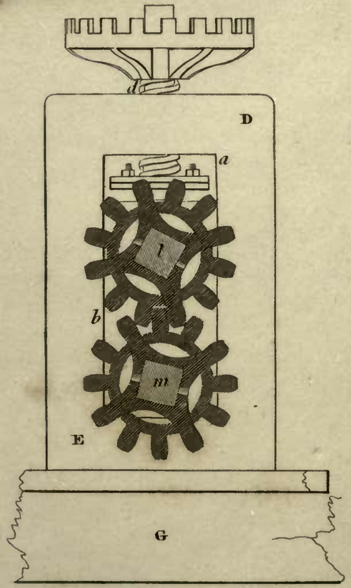


Fig. 2.

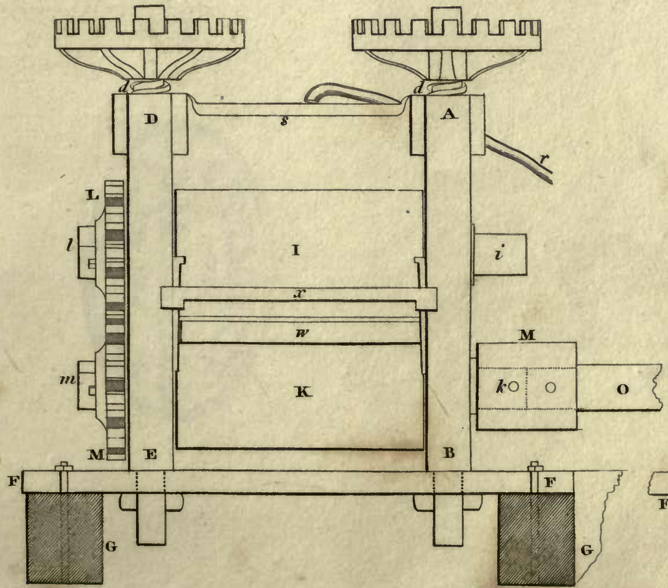
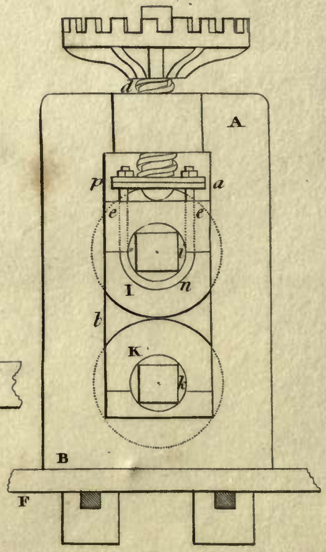


Fig. 3.



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[illegible]