Serfojee Rajah 1827

THE CHEMICAL POCKET-BOOK;

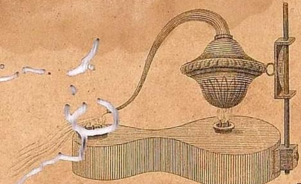
OR

MEMORANDA CHEMICA;

ARRANGED IN A

COMPENDIUM OF CHEMISTRY.

By JAMES PARKINSON, Hoxton.



189

THIRD EDITION.

With appropriate tables & accounts of the lateſt diſcoveries.

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DESCRIPTION

OF THE

FRONTISPIECE.

IN the upper part of the plate is represented THE ECONOMICAL LABORATORY OF GUYTON, which may be seen to consist of an Argand's lamp, and a frame-work with a ring, in which a *retort* is suspended over the lamp. The retort is connected with its *receiver*, in which is received whatever on passing over will condense into a *fluid* state. From the receiver proceeds a *tube*, through which the several *gaseous* matters which are extricated pass into their proper *recipient*. To prevent the escape of the gas, this tube passing through *water*, or (if the gas is susceptible of absorption by water) through QUICKSILVER, which is contained in the PNEUMATIC *trough*, opens underneath the receiver, which is a glass vessel inserted in the fluid contained in the trough. To prevent any accident arising from the difference between the elasticity of the contents of the vessels and that of the external air, the *reversed syphon* or *tube of safety of* WELTER is employed, which acts in this manner. Into the upper bell-shaped vessel, which is nearly of the same magnitude as the bulb at the lower end of the tube, a quantity of suitable fluid, somewhat less than the contents of that vessel, is put. Then, if the elasticity of the contents of the vessels be less than that of the external air, the fluid will descend into the bulb, and atmospheric air will follow, and pass through the fluid into the vessels; but, on the contrary, if the elasticity of the contents be greater, the fluid will be either sustained in the tube, or driven into the bell-shaped vessel; and if the force be strong enough, the gaseous matter will pass through the fluid, and in part escape. Thus is formed the PNEUMATO-CHEMICAL APPARATUS. By reversing the frame-work, removing that piece to which the neck of the retort was suspended, and shortening the glass chimney of the lamp, the apparatus is rendered fit to perform *evaporation* or *saline fusion*, a CAPSULE of glass, platina, &c. being placed on the ring instead of the retort: or, a triangle of iron being placed on the ring, a small CRUCIBLE may be substituted.

The tablet in the lower compartment of the plate exhibits the characters employed by *Hassenfratz and Adet*, for the symbolical expression of the subjects of chemistry, and of their affinities and composition.

The first character, in the first column, denotes LIGHT; the one beneath it CALORIC, to which succeed OXYGEN and NITROGEN. These four are *simple substances, which may exist in a gaseous state at the ordinary state of the atmo-*

sphere. The next denotes FIXED ALKALI, which, by the central insertion of the initial letter, serves to denote *pot-ash, soda*, &c. The last character in this column is that of SIMPLE EARTHS, which by the initial letter is made to denote *lime, silica*, or any other *simple earth*.

The four first characters in the second column denote *simple combustible substances*, commonly called *inflammable*, in this order, CARBON, HYDROGEN, SULPHUR, PHOSPHORUS. The next character is a circle denoting METALS, a point in the centre denoting GOLD, and the initial letter placed in the same manner distinguishing all the others. The next character, a square, denotes *radical acidifiable compounds, whose bases are but little known*, such as the MURIATIC, BORACIC, &c. the particular radical being marked by descriptive letters in the centre.

The first character of the third column, a lozenge, denotes certain *compound substances not having acidifiable bases*, nor having been yet compounded by synthesis; these are ETHER, ALCOHOL, FIXED OIL, VOLATILE OIL, BITUMEN, MUCUS, and are also denoted by their initial letters.

The quantity of caloric rendering a substance fluid is marked, by placing the sign of caloric at the upper part of the sign of the substance thus affected by it; and the quantity which renders it gaseous is implied, by placing the sign for caloric at the bottom. The rule for this purpose being, that the greater quantities should always be placed in the lower position, and the smaller quantity in the higher.

The PRESENCE OF OXYGEN is denoted by the addition of the *horizontal line,* which is the character denoting it; if this be separated by a *small break,* and placed *lower than the other character,* a SUPER-OXYGENATION is implied; and the *higher* it is placed, the *less the degree of supposed acidity.* To illustrate this the second character is that of water in its simplest state (ice) being made by joining the characters of oxygen and hydrogen; it is followed by that of *fluid* water, and of water in state of *gas,* by the proper disposition of the symbol representing caloric. The fifth in this column is the character marking OXYGENIZED MURIATIC ACID, and is followed by NITRIC ACID.

The first in the fourth column is that of NITROUS ACID, followed by NITROUS ACID GAS, NITROUS OXIDE GAS, and OXIDULE or OXIDE OF NITROGEN GAS. In this manner is designated all the other compounds of oxygen and caloric with different bodies. Thus, for farther illustration of this point, the fifth character denotes *concrete arsenic* ACID, and the sixth, OXIDE *of arsenic.*

The first character of the fifth column is that of AMMONIA, formed by *Hydrogen* and *Nitrogen*; the second is that of SULPHURETS; the third, of PHOSPHURETS; the fourth, of CARBURETS; the fifth, of AMALGAMS; and the sixth, of ALLOYS.

The first character of the sixth column is that of ACETATES, this character being formed by the union of that of ACETIC ACID and EARTH, denotes an *acetate with an earthy base:* this is followed by ACETITES, BOMBIATES, CARBONATES, BENZOATES, and BORATES.

The seventh column contains CAMPHORATES, CITRATES, FLUATES, FORMIATES, LACTATES, and GALLATES, in the order here mentioned.

The eighth column contains MALATES, MURIATES, OXY-MURIATES, NITRATES, NITRITES, and OXALATES.

The ninth contains ACIDULOUS OXALATES, PHOSPHATES, PHOSPHITES, PRUSSIATES, SULPHATES and SULPHITES.

The tenth contains ACIDULOUS SULPHATES, SULPHATES WITH EXCESS OF BASE, SUCCINATES, ARSENIATES, ACIDULOUS ARSENIATES, ARSENIATES WITH EXCESS OF BASE.

The characters for the remaining compounds of *alkaline, earthy, or metallic bases,* with the TARTARIC, MOLYBDIC, TUNGSTIC, CHROMIC, SUBERIC, ZOONIC ACIDS, &c. may be easily inferred from an attentive consideration of the formation of the characters already described.

ERRATA.

Page 23, line 22, after phosphorus, read, *carbon* requiring a small portion of oxygen to promote its union with it.

Page 36. The article NITRATE OF BARYT should precede NITRATE OF POT-ASH, at page 33.

Page 44, line 10, for *sulphate of glucine*, read, SULPHATE OF GLUCINE.

——— line 15, for *alid*, read, *acid*.

Page 50, and *passim*, for phosphorised, read, phosphuretted.

Page 95, line 6, for $+ 70^{\circ}$, read, $+ 7^{\circ}$.

PREFACE.

THE following assemblage of Chemical Facts was formed, with the hope of rendering it an agreeable Pocket Companion for the Lovers of Chemistry in general; and more particularly so for those who may be just engaging in the study of this most useful and interesting science. To the latter it was hoped it might furnish, like a bird's eye view to a traveller, a general knowledge of the relation and connection of the several parts of that region, which is intended to become the object of a nearer and closer investigation.

The obligations of the Editor to the best Chemical Writers of the age are obvious: it is, however, necessary to particularise that these memoranda have been enriched by a careful collation with the Course of Lectures *on Chemistry, delivered at the Royal Institution of Great Britain, by Mr. Davy, and with the Systeme des connoissances Chymiques of Fourcroy. Whilst thus pointing out those to whom his acknowledgement of obligations are due, gratitude and honest pride impel him, respectfully, to mention the names of Wollaston, Chevenix, Hatchett, Babington, Crichton, Pearson, and Powell.*

In this edition are introduced those alterations in the names of substances which have been proposed by Mr. Chevenix. For the uncouthness of some of these, an apology may seem necessary. But this is really not the case, since these names are formed exactly in agreement with the established principles, which directed the formation of the generally accepted modern nomenclature; and, of which, the continuance of the names now rejected would be an undoubted violation. If the Editor has erred*

* Remarks upon Chemical Nomenclature, by *Richard Chevenix*, Esq. F. R. S. M. R. I. A. &c.

in being the first to adopt these alterations, he must plead, in his excuse, that the arguments adduced in their favour, by their learned Author, appeared, to him, to be incontrovertible.

Like the bee, he has roved freely, in search of materials; and shall be highly gratified if it appear, that he has even faintly imitated its skill in selection and arrangement.

May this little Compendium lead fresh admirers into the delightful walks which are to be found in this department of science, where wide scenes of interest and amusement are constantly opening upon the mind. May it point out the indispensable connection between Chemistry and many of the other sciences; and the vast advantages a knowledge of its principles may yield to those who are engaged in the useful and profitable arts; and thereby induce those who are not of the medical profession, to seize the opportunity of obtaining fuller information, by the pleasing and expeditious mode of Public Lectures.

CONTENTS.

CHEMISTRY.

CHEMISTRY is the Science which discovers the constituent principles of bodies, the results of their various combinations, and the laws by which those combinations are effected.

Chemical inquiries are prosecuted by certain operations or processes; which are performed either by ANALYSIS, or *Decomposition*, or by SYNTHESIS, or *Composition*. These operations depend on the affinities, or powers of attraction, which act on bodies, and on the elementary parts of bodies.

THE ATTRACTION OF AGGREGATION is that by which the homogeneous particles of bodies are united.

THE ATTRACTION OF COMPOSITION, called also CHEMICAL ATTRACTION, is that by which the heterogeneous particles of bodies are united. Its action is inversely as that of the attraction of aggregation, since its operation must necessarily be impeded by that force of aggregation which allows but few of the ultimate molecules to be exposed to its influence. The general principles, or laws by which this power acts, are, according to *Fourcroy*, the following:

1. *It unites bodies of different natures.* Thus acids combine with alkalies, alkalies with sulphur, metals with acids, &c.

2. *It only takes place between the ultimate molecules of bodies.* Agreeable to this law, a state of extreme division is necessary in bodies thus acted upon.

3. *The Attraction of Composition may take place between two or more bodies.* The possible number of combinations thus resulting from the various intermixture of fifty-seven indecomposable bodies, considered as being combined two and two, three and three, four and four, five and five, will yield 4,612,972 compounds.

4. *To allow the Attraction of Composition to take place between two bodies, it is, in general, necessary, that one of the two, at least,*

be in a fluid state. The subsequent solution in this case depends not on any superior power possessed by that body, which is termed the *solvent*, but results from the reciprocal action of the molecules of the two bodies on each other.

5. *When two or more bodies unite or combine together, their temperature changes at the moment the attraction of composition acts between them.* The compounds, which thus manifest an increase of temperature, part with their heat, and therefore contain less than was possessed by their components: whilst those which have their temperature diminished, absorb and retain a greater portion than their components.

6. *The compounds formed by chemical attraction acquire new properties, different from those of the bodies of which they are composed.* This difference may exist not only in the taste, but in the consistence, smell, form, colour, fusibility, &c. The properties of the compound never exist in a medium state, with respect to the bodies of which it is composed.

7. *The Attraction of Composition is measured by the force required for the separation of the component parts.* This force is not to be estimated by the quantity of time required for the combination; but rather by circumstances noticed in the consideration of the next law.

By obtaining a knowledge of the powers of these respective affinities, the result of different combinations may be previously ascertained. This knowledge is obtained by measuring the difficulty with which combinations are destroyed, on the application of other substances. Thus an acid may be preserved in union with a metal, by a certain degree of elective attraction; but on an alkali being presented to this compound, a decomposition takes place, the alkali immediately unites with the acid, forming a new combination, and manifesting a *superior degree of attraction;* the metal being at the same time separated in a precipitate. This is termed a case of *decomposition* by SINGLE ELECTIVE ATTRACTION, or *simple Affinity*, in which one of two principles is displaced by a third.

But when two bodies, each consisting of two principles, suffer decomposition, by a reciprocal exchange and union of their elements, by which two new compound bodies are produced, this change is said to be effected by DOUBLE ELECTIVE ATTRACTION, or *double Affinity.* Mr. Kirwan employs the term, *Quiescent Affinity*, to mark that, by virtue of which, the principles of each compound adhere to each other; and *Divellent Affinity*, to distinguish that by which the principles of one body unite, and change order with those of the other.

8. *Different degrees of attraction act between different bodies, and may be marked by observation.* By a careful examination of the circumstances referable to this law much light is thrown on the various phænomena of chemistry. A body being presented to two bodies already united by the attraction of composition, 1. it occasions no change—or 2. it becomes united, and forms a ternary compound. In the first of these cases, the newly added substance manifests a weaker degree of attraction for either of the two component substances, than that which unites them together. In the second case, an equal degree of attraction only is marked.—or 3. it unites with one of the two principles, and forms a new compound, which separates from the other principle—or 4. it unites to only a part of one of the principles of the compound, of which it only alters the proportion, and at the same time forms a new compound with that portion of the principle it has seized. In the two last cases, the attraction is evidently stronger between the newly added body and one of the two bodies forming the compound, and the decomposition appears to be the effect of a preference of the newly added body for one of the two principles of the existing compound.

In both the third and fourth cases just mentioned, if the substances are in a state of solution, the separated body falls to the bottom of the fluid in which its principles had been before suspended; this is termed *precipitation.* The sediment is termed *the precipitate*, and the substance added, *the precipitant.*

But it should be remembered, that the precipitate is not always formed of one of the principles of the former compound, separated in a *pure* state; but it may be formed by a new compound, indissoluble in that portion of fluid. But a decomposition may take place, whilst all the substances being soluble, no precipitate is formed; and in other cases the separated principles may even, instead of being precipitated, be raised in the form of vapour.

What has been here said refers only to the operations in the *humid way*, where substances are employed in a fluid state, since in the *dry way* the effects come not so evidently under our observation and judgment.

9. *The Attraction of Composition is in an inverse proportion to the saturation of one body by another.* That is, the first portion of that body which is united to another body adheres with more force than the second, the second than the third, &c. attraction becoming so much more feeble as the approach is made nearer to saturation. Hence, in every decomposition, the last portions added are most easily separated, whilst those which were first attracted are strongly retained. Agreeable to this law is the fact, that, the greater the degree of attraction is of one body for another, the less quantity of that body is required for its saturation.

10. *The decomposition may take place between two compounds, which are not decomposed reciprocally by a double elective attraction, if the attraction of two of the principles for a third principle exceeds that which unites that third principle to one of the two other principles, although even at the moment of action the union of these two has not existed.* An attraction is here supposed between a binary compound, not yet formed, and another body united to a fourth principle. Thus in the compounds N O and P Q, the attraction which unites N to O, and P to Q, exceeds the divellent attractions of O to P, and N to Q; but if the force tending to unite O and P together added to that which tends to unite the compound O P to Q is more considerable than that which originally united N O and P Q, there will be a decomposition: the ternary compound O P Q will be formed, and one of the components, N, must be separated.—*Fourcroy*, 1802.

Berthollet has discovered, that the affinities of bodies are affected by the proportion in which the bodies are employed: thus a body, in a quantity proportionably large may effect the decomposition of a compound, which it would not do in a less quantity; the quantity of the mass compensating for want of affinity.

He has also ascertained, that the opposing substances divide that body which is the subject of combination—Insolubility, cohesion, and crystallization, modify the conditions of chemical action, by limiting the quantity of a substance to be brought into action in a liquid—Elasticity, by separating a part in an elastic state, which no longer affords any resistance, modifies the effects of affinity, in an opposite direction to the former—Solvents, water for instance, dissolve, according to their quantity, as well as affinity—The action of heat concurs with those of solvents in opposing the force of cohesion and, lastly, that—the quantity of a precipitate may depend on the proportion which the action of the fluid bears to the force of cohesion in the precipitate.

Tables of affinities having been constructed, without an attention to the proportions and the other conditions which contribute to the results; these tables give a false idea of the degrees of chemical action.—*Annales de Chimie*, 1801.

EARTHS.

The Earths are white, inodorous, tasteless, and uninflammable substances; nonconductors of electricity, insoluble in water, but soluble in one or more of the acids. Sp. gr. compared to that of water, not exceeding 5 to 1. These appear to be six in number.

1. Silica, which is the earth which chiefly forms flint, rock crystal, and many of the gems. It is of a rough and harsh feel. The *phosphoric* and *boracic* acids unite with it by fusion; but it is acted on by no other acid but the *fluoric*: and yet an alkaline solution of this earth admits of supersaturation with an acid, particularly the *muriatic*, without any precipitation. Alone it is infusible; but fuses readily with *fixed alkalies*, which act on it even in the moist way. It also may be fused by being joined with *lime* and *alumine*. To obtain this earth pure, it should be precipitated from its alkaline solution by muriatic acid.

2. Alumine, or *Earth of Alum*, is the true *argillaceous* part of common clay. When pure it is smooth, and has an unctuous feel. It is adherent to the tongue; diffusible, but not soluble in water. Sp. gr. 2,00. When heated it diminishes in bulk, and, it is said, may be so hardened by fire as to give sparks with steel.

It combines with most *acids*, though with difficulty, uniting best during precipitation. With the *sulphuric* it forms alum, but with the *nitric* and *muriatic* it crystallizes difficultly.

It becomes softened by very intense heat, and with *phosphate* or *borate of soda*, it may be fused, with nearly the same degree of facility, as lime and magnesia.

3. ZIRCON is found in the stone called *Jargon*, from Ceylon, and in the HYACINTH. It possesses roughness and hardness resembling silica, but in many respects resembles alumine. Sp. gr. 4,3.

It unites with the *carbonic*, *nitric*, and *sulphuric acids*, but is precipitated from the last by the alkalies, and the other earths. When precipitated by the caustic alkalies it retains a quantity of water, which imparts to it the semitransparency of horn: this, with its colour and fracture, gives it the appearance of gum arabic.

It is infusible alone, but melts with *borate of soda*. Neither the *alkalies* nor the *alkaline phosphates* aid its fusion.

4. GLUCINE was discovered by Vauquelin in the BERYL, or AQUA MARINA, and in the EMERALD. It is soluble in the *sulphuric acid* in excess, and in the *carbonate of ammonia*. It forms a very soluble salt with the *oxalic acid*. It decomposes aluminates, and is completely precipitated from its solutions by ammonia. Its affinities for *acids* appear to be intermediate, between those of magnesia and alumine. Its salts are of a sweetish taste, from which circumstance it derives its name.

5. AGUSTINE is an earth which, as its name imports, forms, with acids, salts which are tasteless. Its existence is believed on the authority of Trommsdorff, who informs us he found it in a mineral resembling the beryl. This earth, he says, resembles alumine, in not being acted on either by the *fixed alkalies or ammonia*. It is not soluble in water; and by fire it acquires hardness, but no taste; and suffers no change in its solubility in acids. Supersaturated with *phosphoric acid* it yields a salt of easy solubility; but its sulphate and acetite are very difficultly soluble.

6. YTTRIA, discovered in 1794 by M. *Gadolin*, in a stone termed *Ytterby*, and now GADOLINITE, is a fine white earth, possessing neither taste nor smell. It is infusible alone; but forms, with *borax*, a white glass. Unlike alumine and glucine, it is not soluble in the *fixed alkalies*. It is soluble, like glucine, in *carbonate of ammonia*, but requires five or six times more of the salt. *Ammonia* precipitates Yttria from the sulphuric, nitric, and muriatic acids.

The *oxalic acid* also separates it in a dull, thick precipitate, like the muriate of silver: and its precipitation is also produced by the prussiate of pot-ash. These last circumstances also distinguish it from glucine.

Guyton has obtained unequivocal proofs, not only that there exists among THE EARTHS a tendency to unite both in the dry and humid way; but also that with regard to some of the earths, the union is such as to be capable of resisting an addition of acid in excess.

Ingenhouz, *Humboldt*, and *Van Mons*, observed that the earths, being moistened, possessed the property of absorbing oxygen from the atmosphere at the ordinary temperature.

M. Girtanner discovered, that by the application of heat this effect was considerably increased; and that with a temperature much exceeding that of the atmosphere they would separate oxygen from water. *Alumine* attracts it with the greatest avidity, at a temperature much below that of boiling water. *Lime* requires a higher temperature, and then does not absorb so much oxygen. *Silica* requires a red heat, and then it seizes it rapidly.

The avidity with which oxygen is absorbed by lime, accounts for the unhealthiness of rooms, the walls of which have been lately white washed.—*Annales de Chimie*, xxxiii.

Guyton has also shewn, that concentrated alkaline solutions of silica and alumine mixed in equal proportions produce a firm, gelatinous mass, perfectly insoluble in water, but soluble in concentrated or diluted acids, and even in distilled vinegar; so altered is the silica.

ALKALIES.

ALKALIES, whose general characteristics are, 1. an acrid, urinous taste; 2. changing the vegetable blues green; 3. combining with acids, and forming neutral salts; are divided into *volatile* and *fixed*.

The VOLATILE ALKALI or AMMONIA will be fully treated of, when examining the principles of which it is composed.

Fixed Alkalies have for their peculiar characteristics, 1st, Their not being volatilized but by the most intense heat. 2dly, The rendering oils miscible with water. 3dly, The forming glass when fused with flinty substances.

1. Pot-Ash, or the *Vegetable fixed Alkali*, is obtained by washing the ashes of burnt vegetables, or of the lees, or of the tartar of wine. When obtained from the two latter substances it has been called the *Salt of Tartar*, and when it has become fluid by imbibing moisture, it has improperly been termed *Oil of Tartar, per deliquium.*

It is conjectured by *Fourcroy*, that pot-ash is the result of the combination of *nitrogen* with *lime*. This conjecture he formed on perceiving that atmospheric air being exposed to the action of hydro-sulphuret of lime for some hours, the air held less nitrogen, and the sulphuret manifested some marks of the presence of pot-ash.

To obtain pot-ash pure it must be dissolved in spirits of wine, and the solution evaporated to dryness in a silver vessel. It is then most powerfully caustic.

No action appears to take place between pot-ash and *oxygen, nitrogen*, or *hydrogen*; nor does it combine with *carbon* unless by the intervention of *hydrogen*. It acts but feebly on *phosphorus*, but promotes the decomposition of water when mixed with this substance. The action between it and *sulphur* is much more powerful. It combines with many of the *metallic oxides*, and with all the *acids*; and is rapidly dissolved in *water*. It dissolves *silex* in the dry, and *alumine*, even in the moist way; but it has no action on *zircon, glucine, lime*, or *magnesia*. Triturated with substances containing *nitrogen* combined with *hydrogen*, it promotes their union, and the formation of ammonia; it uniting with the other principles, which become more or less oily.

2. Soda is sometimes found in a formed state, but in general it is obtained by the combustion of maritime plants, particularly of the *salsula soda*. It differs from pot-ash in not being deliquescent, and in efflorescing in the air, from which it absorbs carbonic acid. But the chief differences between them are observable in their combinations. It is obtained in a state of purity by the same method as pot-ash.

These two substances, pot-ash and soda, were supposed, until lately, to be the only fixed alkalies; but chemists are now in general agreed that the following substances, which used to be considered as earths, possess the characteristic properties, and therefore deserve to be ranked among the fixed alkalies.

3. Lime, when perfectly pure, is termed *QUICK LIME*, or *pure calcareous earth*. To obtain it in that state, it must be long exposed to a strong heat. It is then white, moderately hard and brittle, and its specific gravity 2,3. It yields a hot burning taste, changes violets green, and corrodes animal and vegetable substances. It heats and bursts by the application of water, 100 grains absorbing and solidifying 28,7 of water, and thereby becoming *SLAKED LIME*; during this change a degree of phosphorescence may be discovered in the dark.

It is less soluble in water, and has a weaker affinity with acids than strontian and baryt.

It requires nearly 700 times its weight of water to hold it in solution; this solution, which is called *LIME WATER*, has rather an acrid taste; on exposure to the air the lime separates from it.

Lime combines with all *acids*, particularly with the *nitric* and *muriatic*: these solutions crystallize difficultly, and yield the lime to the *sulphuric*.

It has no attraction for *oxygen*, *nitrogen*, or *hydrogen*. It absorbs the *carbonic acid* of the atmosphere, slowly passing to the state of carbonate. It combines with *sulphur*, *phosphorus*, and the *metallic oxides*.

Lime, alone, is infusible, it may however be fused when joined with *silica* and *clay*. Mixed with *borate* or *phosphate of soda*, it is fused without effervescence. It has been supposed to be entirely of animal origin; but this is doubtful where it exists as primitive lime-stone, or in granite.

4. Magnesia has not been met with native, in an uncombined state. When pure it is very light and white, and requires 2000 times its weight of water to hold it in solution. Sp. gr. about 2,3. It combines with all the *acids*, the *sulphuric* taking it from the *nitric* or *muriatic*, without forming a precipitate: but it has the least affinity with the acids of all the alkaline substances. It produces, however, the most intense heat in its mixture with the concentrated acids, giving out a vivid red light.

It is as infusible as lime, but, like it, is fused when mixed with the *phosphate*, or *borate of soda*, and without effervescence.

It is acted on very strongly by pot-ash, both in the dry and wet way.

5. Baryt, also termed from its high specific gravity *ponderous earth*, when obtained pure, by the action of a strong heat on its combination with nitric acid, is more caustic than lime, and absorbs water eagerly, forming a very tenacious cement. It is about four times as heavy as water. When covered with water it is dissolved with a hissing noise, and crystallizes in long, transparent, four sided prisms, forming a compages like beaten plaster. It acts on *phosphorus* and *sulphur*, but not on the other simple combustible bodies. Cold water dissolves a 25th part of its weight, and boiling, one half. It is also soluble in alcohol; and is dreadfully poisonous.

It has the greatest affinity with the acids of all alkaline or earthy substances.

6. Strontia is obtained from its carbonate by intense ignition with charcoal; when it appears in greyish, ponderous, porous fragments, possessing an alcaline causticity beyond that of lime, but less than that of pot-ash, soda, or baryt. Like baryt it greedily attracts *water*, which it employs in crystallization, and is specifically heavier than lime. It is visibly precipitated from its solution in 200 parts of water, yielding compressed rhomboidal crystals. It does not separate lime from acids.

It dissolves readily in the *nitric* and *muriatic* acids, producing much heat, and forms, by the addition of the *sulphuric*, an insoluble precipitate: it decompounds, in the moist way, all the saline compounds of the sulphuric acid.

Alone it does not fuse, but glitters with a strong phosphoric flame; but it may be fused if it be mixed with most of the earths.

Either alone, or in combination, it gives a rose-coloured tinge to flames of bodies in combustion.

On the mixture of any of the alkalies with *sulphuric*, *nitric*, or *oxygenized muriatic acids*, a considerable degree of heat is produced, light being evolved at the same time.

Professor *Klaproth* has discovered the *vegetable alkali*, in the fossil called *leucite*. It has also been found in *lepidolite*, *green feldspar*, *basaltes*, *lava*, *pumice*, and *zeolite*. Professor *Abilgaart* found that the *pot-ash* formed a constituent part of animal blood.

Guyton concludes that LIME is composed of *carbon*, *nitrogen*, and *hydrogen*; and MAGNESIA, of *lime* and *nitrogen*; and that POT-ASH is composed of *lime* and *hydrogen*; and SODA, of *magnesia* and *hydrogen*.

Garracque asserts, that the experiments, from which *Guyton* made these inferences, are not to be depended upon, the impurities of the substances employed having misled him.

GLASS is a combination of *silica* with *fixed alkali*: Soda is the alkali in general employed. The mixture is first well calcined, when it is called *frit*; then after complete fusion it becomes *glass-metal*; and the extraneous salts which float on its surface are named *glass-gall*. When formed into the required shapes, it is *annealed* or *tempered* by being placed in a furnace of an appropriate heat.

The fineness of the glass depends on the purity and proportion of the ingredients. A fine crystal glass may be obtained from 16 parts of quartz, 8 of pure pot-ash, 6 of calcined borax, 3 of flake white, and 1 of nitre.

By an over proportion of alkali, 4 to 1 for instance, the glass will become soluble in water, and even deliquescent. Thus dissolved, it is called *liquor silicum*, or *liquor of flints*. Professor *Siegling* having left a bottle of this liquor undisturbed eight years, found transparent rock crystals formed in it, which gave fire with steel. From this solution, pure silica may be precipitated by the addition of any acid.

CALORIC.

Heat, with the various changes produced by it in bodies, is considered, by some, as merely the consequence of certain mechanical changes in bodies; but it is most generally supposed, that these effects depend on a certain matter called *Caloric*, or the *Matter of Heat*.

Caloric appears to be an highly elastic, and imponderable fluid; and is so very subtile, that neither has its gravity been yet ascertained, nor its existence, in a simple and uncombined state, been shewn. It combines chemically with all bodies, in a quantity proportioned to their affinity with it. By its elastic power, or power of repulsion, it constantly tends to separate the particles of matter, in which it is opposed by the attraction of cohesion: hence, attraction* of cohesion predominating, the body exists in a *solid* form: caloric existing in such a proportion as to weaken the attraction of cohesion to a certain degree, the body assumes a *liquid* form; and when the quantity of caloric is increased still farther, the body takes a *gaseous* form.

Heat moves, like light, with vast velocity, and is capable of being reflected and refracted. The radiant solar heat is uniformly mixed or combined with light; its rays, according to Dr. *Herschell*, possessing different degrees of refrangibility, but being for the most part less refrangible than the rays of light.

It was first supposed by some Italian philosophers, and proved by the experiments of Professor *Pictet*, that the radiation of heat, and even its reflection, takes place independent of light: thus a piece of iron heated, but not so high as to emit any light, being placed before a concave mirror, will very sensibly affect a thermometer placed in its focus. On the same principle, if ice be employed instead of heated iron, the thermometer will be affected in a contrary direction.

It constantly tends to form an equilibrium, by passing from bodies of an higher, and diffusing itself through bodies of a lower temperature.

Bodies, which thus transmit caloric, are termed conductors

OF CALORIC; and according to the power of doing this, they are termed *good* or *bad conductors.*

Two bodies of the same nature, unequally heated, on being brought into contact, soon arrive at an equal temperature, the caloric becoming equally divided between them.

But when two bodies, differing in their nature, and differing in the quantity of caloric they possess, are thus allowed to form one common temperature by communication, this will not be found to be an arithmetical mean between the two original temperatures; but the one will be found to have required a greater or less quantity of caloric than the other, to render it of the common temperature.

At the moment of the chemical union of two different substances, the new compound, not perhaps having the same capacity for caloric as its constituents, must either yield a part to neighbouring bodies, or receive it from them; producing thereby a change in their temperature, which is increased in the former, and diminished in the latter case.

The property by which bodies require different quantities of caloric to produce the same temperature, was termed by *Dr. Black* the *capacity for heat;* and the quantity of caloric thus required, *specific heat.* The caloric thus absorbed is termed *latent heat,* or *combined caloric.* But when it is perceptible by the organs of feeling, it is termed *sensible heat,* or *free caloric.*

The caloric which enters into the composition of bodies has been considered as *chemically combined,* or only *adherent.* In the former case new combinations are thought necessary to extricate the combined caloric: but in the latter, mere mechanical pressure, or change in the state of solidity or fluidity in the body, may suffice to set it free.

Thus bodies passing from a solid to a liquid state, or from either of these to a gaseous form, absorb from the surrounding bodies a portion of heat, which is said to become *latent,* and to enter into combination, as one of the necessary constituents of the body, in that state.

Every substance also passing from a state of vapour to that of a liquid, and from this state to the solid state, suffers its combined caloric to escape, which then becomes *sensible* or *free.*

Mr. Tilloch most ingeniously combats the doctrine of *latent* and *sensible heat.* The incontrovertible fact, he observes, that *different substances* have *different capacities* for heat, necessarily embraced another truth which has never been applied as it ought; namely, that, in every chemical combination we effect, we are altering the capacities of bodies for heat, and consequently deranging the equilibrium: for the product differs in its capacity from the ingredients, and the same holds in decompositions. Had this been properly attended to, it would have been found perfectly sufficient, when taken along with that property by which heat tends to equilibrium, to explain the passages of heat from substances to other substances, without ever once supposing the heat changed in its properties. Heat seems to act uniformly, and its effects depend always on its quantity, *not kind*, compared with the capacity of the body into which it enters; but it is continually bandied about, as it were, by the constant changes that are passing upon bodies: by which their capacities for receiving or holding it are altered; so that it is in a constant state of influx and efflux, in and from bodies: and there is going on a constant adjustment, as it were, of the differences existing among them; each requiring its own share of the common stock, and giving off, receiving, or merely transmitting, heat, according to its circumstances. Bodies are continually undergoing changes by the action of heat. This is admitted on all hands. Is it necessary then to look for a change in the *agent* as well as the *patient?* In many respects its action may be illustrated by that of water. Different substances require different substances to dissolve them; and different substances require different quantities to dissolve them. The property which different substances have to take in different quantities of water, may be called their *capacity for water*, but who ever talks of a certain quantity of water, when diffused among any number of substances in proportion to their capacities, being *latent water?* or when an interposed hygrometer is affected by its passage from one substance to another, of its being then *sensible* or *free?*—*Philosophical Mag.* 1800.

If a body be not of a nature to undergo such separation of its parts, by the addition of caloric, as may occasion so obvious an alteration of its form, still an increase of its bulk or dimensions, proportionate to its increase of temperature will take place.

On this principle are CALORIMETERS, or THERMOMETERS, formed; the point at which the mercury in the thermometer rests, when placed in contact with any body, shows the degree of dilatation or contraction the mercury has suffered, during the establishment of an equilibrium between it and the body to which it is applied. The temperature of the body being said to be higher or lower according to the effect thus produced.

Mr. *Wedgwood* constructed a PYROMETER on another principle. It is composed of pieces of nicely gauged clay, which contract by the higher degrees of heat. The scale begins at visible redness, and the extreme heat of a good air furnace of the ordinary construction is 160° of his scale, or a little more.

Ice imbibes the caloric communicated to it by other bodies, until it has absorbed sufficient to render it fluid, the temperature of these bodies descending proportionally. From this circumstance we not only derive a proof of the difference of capacity for caloric, in different bodies, but are also enabled to ascertain the relative quantities of caloric they contain. For since equal quantities of caloric will liquify equal quantities of ice, the quantities of ice liquified by equal quantities of different bodies, will be proportioned to the quantity of caloric those bodies parted with; and will therefore point out the quantities of specific heat they contained, and their respective capacities for caloric.

In general gases are more expansible by heat than fluids, and fluids than solids. Of solids, metals are most expansible, then glass, stony bodies, wood, &c. Of gases, the ammoniacal is the most expansible, and nitrogen perhaps the least. Of fluids, mercury suffers the most regular and equable expansion; and thereby serves to mark the quantity of heat to which it is exposed.

That portion of caloric, according to *Gren*, is only really *calorific*, or producing warmth, the expansive force of which is active; hence the temperature of a body, he thinks, depends principally on that portion of *free* caloric, which is streaming through and issuing from it.

As volume is a characteristic of matter, and as liquids, on being mixed, are reduced in volume, without parting with any thing, except heat, therefore, Mr. Tillock thinks that heat is matter. Heat, he observes, when driven from one body, the volume of which is in consequence diminished, enters into others, and theirs become *visibly* enlarged. Cast metals being specifically lighter than those in which their *moleculæ* have been brought closer together by mechanical means, he adduces as one instance of what he thinks to be universally true, that where the specific gravity is diminished in a body, the absolute gravity is and must be increased; which increase of absolute weight has not been observed, because weighed in air, which is a substance much denser than heat.—*Philos. Mag.* 1801.

Mr. *Astley* thinks, that evaporation should be regarded as a decomposition, a resumption more or less complete of the *discrete* affinities of the constituent parts for caloric taking place.—*Nicholson's Journal.*

Mr. *Dalton* is of opinion, that in mixed aerial fluids the particles of one may possess no repulsive, or attractive power, or be perfectly inelastic with regard to the parts of another; and consequently, that the action of the particles of one fluid on those of the other will be subject to the laws of inelastic bodies, so that if not chemically united, they may exist as distinct fluids, uninfluenced by any other pressure than that arising from the weight of their own particles.—*Nicholson's Journal, Oct.* 1801.

LIGHT.

Light is an elastic fluid, being *reflected* from bodies that it cannot penetrate, in an angle of reflection equal to its angle of incidence. It is projected in every direction from radiant bodies, passing through 167,000 miles in a second. In its passage near any other substance, it is affected by attraction, and suffers a greater or less degree of inflection. In its passage from one medium into another of a different degree of density, it suffers *refraction* or a change in its direction. Combustible bodies possess the greatest refracting power.

Solar light is divisible by the prism into seven primitive rays, in the following order: red, orange, yellow, green, blue, indigo, and violet. It is also possessed of chemical affinities, by which it enters into combination with other substances; sometimes occasioning their decomposition, and sometimes being itself extricated from its combinations. It materially affects the crystallization of salts. It is supposed to yield to vegetables their colour, and to contribute much to their odour, taste, combustibility, and resinous principle. It also enables vegetables to emit torrents of pure air. In fact, it possesses such numerous chemical affinities, that there hardly exists any substance which does not undergo a change from its presence or absence.

Though the phenomena of the reflection and refraction of light are very analogous to those of radiant heat, and though these bodies are usually present at the same time, yet the distinctness between their physical, as well as their chemical powers of action, is sufficient to induce us to believe, that they are perfectly different agents. The heat and light in the solar spectrum produce perfectly different effects; for if muriate of silver be exposed to the different refracted rays, it is found that the invisible heat making rays produce no effect upon it; its colour is altered by the violet rays in about one-eightieth part of the time in which it is changed by the red; and what is very curious, it is likewise acted upon in the space beyond the violet rays. This circumstance has been noticed by Messrs. Ritter and Böckmann, and by Dr. Wollaston. It would appear from it, that invisible rays exist, which, though possessed of chemical agencies, and of the highest degree of refrangibility, are, nevertheless, incapable of producing heat. —*Mr. Davy's Syllabus.*

Light is produced during the combination of oxygen with certain combustible bodies; of the mineral acids with fixed alkalies; of sulphur with the metals; of sulphuric acid with oxygenized muriates.

Brugnatelli thinks that light is either, 1st, chemically united with bodies; and in that case separates itself from them in consequence of its affinity with caloric, occasioning what has been termed the *phosphorism of bodies*, thus, oxide of manganese, calcareous salts, sugar, feathers, cotton, wool, and many other substances shine when placed on a plate of iron heated, but not to redness. 2dly, Merely accumulated in bodies; when it is rendered free by an approximation of their parts, thus quicksilver becomes luminous in the barometer, salts shine at the moment they crystallize, sugar, crystals of tartar, borax, and allum, when struck. Light appears also to be considerably accumulated in quartz, and in certain plants. 3dly, Accumulated in bodies in a visible state, as in the substances called *light magnets* which imbibe it, and then become luminous in the dark, such are the diamond, blende, the carbuncle, bologna, and Canton's phosphorus, putrid animal matters, decayed wood, &c.—*Annali de Chimica*, 1800.

Spallanzani supposes the splendor of natural phosphori to depend on a slow combustion. The Editors of the *Critical Review* object to this opinion, considering light as distinct from heat.

Humboldt thinks the presence of oxygen gas is necessary to the phosphoric appearance of putrid substances.

Dr. *Hulme* concludes, that light is a constituent principle of marine fishes, and is separable from the other principles after death by sea water, a solution of Epsom salts, &c. as by menstrua, through which it may become thoroughly diffused by agitation; a motion always rendering the light more vivid. This light may be extinguished by the addition of various substances, particularly by a *strong* solution of the salts, and may be again revived, in a moment, by a sufficient dilution. It is also extinguished for a time by cold, but is again restored by a moderate temperature. A certain degree of heat, he also found, would extinguish it. This escape of light produced no effect on the thermometer.—*Philos. Trans.* 1800.

The Doctor has since ascertained, that *oxygen gas* does not augment the splendour of this kind of light; that *nitrogen gas* extinguishes the light of rotten wood, and prevents the flesh of fish from becoming luminous; but promotes the splendour of the luminous matter when it is applied upon a cork; that *hydrogen gas* prevents the emission of this light, and extinguishes it when shining; that *carbonic acid gas* has also an extinguishing property, as well as *sulphurated hydrogen gas*; and that *nitrous gas* possesses this extinguishing power in a still greater degree. He also found that this light was extinguished in proportion as the air was diminished in the receiver of an air pump, and that it returned with the influx of fresh air.

The imbibed light in Canton's phosphorus became very splendid on immersion in water heated to about 110°, but in boiling water, and in iron heated just below shining, it glowed vividly for a moment, and then was extinguished. This imbibed light, he finds, appears to be subject to the same laws, as to heat and cold, as the spontaneous light of fishes, glow-worm, &c.—*Phil. Trans.* 1801.

Some think with *Epicurus*, that LIGHT is a continual emanation of the luminous body, which throws to a distance a portion of its substance: and this is the emission of light adopted by Newton. Others, with *Euler*, think it is diffused throughout infinite space, and is acted on by luminous bodies, as air is by sonorous bodies. Some believe it to be an elementary body, and others confound it with fire. *Richter* believes it to be composed of the inflammable principle and caloric. *Prevost*, and others have even endeavoured, but in vain, to estimate its gravity.

Some have doubted whether light is not merely a modification of caloric; and many connect them as cause and effect.

Monge and *Fourcroy* believe light and caloric to be modifications of the same body.

Dr. *G. Pearson* describes fire as consisting of caloric and light; and considers light, not as a distinct species of matter, but as a state of caloric, which is manifested by its producing the sensation termed *vision.—Phil. Journal, and Phil. Trans.* 1797.

Count Rumford concludes from his experiments, that the visible changes produced in bodies by the action of the sun's rays, are effected, *not by any chemical combination* of the matter of light with such bodies, but merely by the heat which is generated, or excited, by the light that is absorbed by them.—*Essays on Heat.*

OXYGEN.

OXYGEN is found only in its combinations, which, from its almost universal agency in the operations of nature, are necessarily numerous. It is absolutely necessary to respiration and combustion; and likewise possesses the property, from which its name is derived, of forming acids by combination with certain substances, which are therefore termed *acidifiable bases.*

Acids, the result of this union, are characterised by a sour taste, by the powers of uniting with alkalies, and of changing vegetable blues red. By their union with other substances hereafter mentioned, they form peculiar salts. The general characters of these are sapidity, ready solubility in water, and incombustibility.

Acids may exist in three states of combination with oxygen—1st, When their bases are *not saturated* with oxygen, which is designated, according to the present nomenclature, by the termination *ous*. 2dly, When *completely saturated* with oxygen, which is pointed out by the termination *ic*; and 3dly, When possessing an *excess of oxygen*, when the substance is said to be *oxygenized*.

Sometimes when metals and various other substances are exposed to its action, the acidifying process takes place, in such a degree as not to produce obvious acidity. The substances are then called *OXIDES*, to denote their being in a state approaching to acidity, and the process may be termed *OXIDIZEMENT*. It is recommended by *Haüy* to adopt the term *OXIDULES* to describe those bodies which have undergone this change in the slightest degree.

The oxides are either acidifiable or not; among the latter is water and several of the metallic oxides. Nitrogen, sulphur, and phosphorus, are all combinable with a smaller portion of oxygen than is necessary to render them acid, and are thus brought to the state of oxides. They in general possess but little taste or smell, and are insoluble, or sparingly so, in water.

Oxygen Gas is the result of the combination of *oxygen* with *caloric*. This substance was one of the important discoveries of Dr. *Priestley*, who called it *dephlogisticated air*. It has neither smell, taste, nor colour; it renders combustion exceedingly rapid, and is capable of being respired three times as long as common air. Water only absorbs about a twelfth part of oxygen gas, which is exposed to its action.

It exists in atmospheric air, in the proportion of 28 to 100, and is more ponderous than the air of the atmosphere, in the proportion of 45 grains in the cubic foot; its specific gravity being to that of common air, as 1103 to 1000.

Black oxide of manganese, red oxide of lead, nitrate of mercury, yield this gas very freely by a strong heat, and even by a very moderate degree of heat, if an equal part of sulphuric acid be added. 1 lb. of the oxide of manganese will yield 40 quarts of this gas. It is also plentifully yielded by the nitrate of pot-ash, exposed to a strong heat, nitrous gas being however first yielded. It is obtained in great purity from oxygenated muriate of pot-ash, also from fresh leaves immersed in water, and exposed to the solar rays.

Its power of accelerating combustion is beautifully shewn by its effects on the flame of a taper; or its wick, immediately on the flame being extinguished; the flame of alcohol, or of ether, red hot iron; or charcoal, phosphorus, and sulphur, in a state of combustion.

COMBUSTION is a process in which this gas is decomposed, the oxygen being absorbed and fixed by the burning body, which has its weight thereby increased, and its nature changed, whilst the caloric, being disengaged, passes off in a state of sensible heat, and sometimes with such a portion of light as gives the form of flame, or the appearance of red heat. From the absorption of oxygen during combustion, acids are formed.

Ignition is said to take place when a red heat accompanies this process, without the appearance of flame; *inflammation*, when light is evolved in the form of flame; *detonation*, when inflammation occurs with great rapidity and noise; and *deflagration*, when the flame is more lasting and the noise less sudden and violent. So high a degree of temperature may be produced by the access of oxygen, that by a stream of inflamed oxygen gas, substances, otherwise refractory, may be easily fused.

The application of a body already ignited is in general necessary to commence the process of combustion in another; but in some cases even inflammation is the result of the mixture of two cold fluids.

Some substances, by some hitherto inexplicable action of their constituent parts on each other, undergo a spontaneous inflammation. This has been found to be the case with hemp, lamp-black, or wool, with linseed oil; also bran of rye, torrefied root of succory, saw-dust of mahogany, pyrites, &c.—*See Nicholson's Chemistry*, B. II. Sect. 5.

From Oxygen Gas being absolutely necessary to respiration, it has been termed *VITAL AIR*; it being absorbed, during respiration, by the blood in the lungs, which thereby acquires an augmentation of its vital powers, and becomes of a vermilion colour. Oxygen is plentifully emitted by vegetables during their exposure to light. But both these processes will be more fully examined, when the other constituents of air and of water have been treated of.

It may be disengaged from its bases by the action of light, and by the application of such substances as have a superior degree of affinity with those bases, as will be shown when treating respectively of each.

HYDROGEN.

Hydrogen, as its name imports, contributes to the formation of water. It has only been obtained in combination.

Hydrogen Gas, sometimes termed *Inflammable Gas*, is formed by the union of *Hydrogen* with *Caloric*. It was discovered by Mr. *Cavendish*. It is about twelve times as light as common air, being the lightest of all the gases we know.

When perfectly pure, it is pellucid, and without taste or smell. It is injurious, but not suddenly, to animals; but is favourable to vegetable life. Although inflammable itself, it extinguishes the flame of a taper plunged into it. If it be mixed with an equal quantity of atmospheric air, or with half its quantity of oxygen gas, it burns with a sudden and violent explosion on an inflamed body being applied to it. The electric spark will also inflame it; hence it is employed in the electric cannon of Volta. This may be termed its rapid combustion. During a slow combustion, when unmixed with atmospheric air or oxygen, the water formed during its combustion may be conveniently manifested on the sides of an inverted jar held over the flame.

This gas is obtained very freely from a mixture of iron or zinc filings with water and sulphuric acid. It is extricated during the resolution of vegetable and of animal substances, of which it is a constituent principle. By the addition of diluted nitric acid these substances yield it very freely.

It is generally mixed with certain impurities, proceeding from the different substances from which it is obtained, and which communicate to it different odours; that which proceeds even from the presence of aqueous vapour is peculiarly disagreeable. It is obtained most pure from zinc, either with, or without the use of acid.

From its great levity, 100 cubic inches weighing only 3 grains, whereas the same quantity of atmospheric air weighs 31 grains, this gas is used to inflate *balloons* for the purpose of aërostation. Soap bubbles inflated with this gas ascend rapidly, and burst with a slight explosion if a lighted taper be applied to them; and with a tolerably loud report if a little *oxygen gas* have been combined with the *hydrogen*.

Hydrogen unites only with three simple substances besides *oxygen*; with *nitrogen*, *sulphur*, and *phosphorus*. The different results of these combinations are very striking. With oxygen, water is formed; with nitrogen the volatile alkali; with sulphur an acid, as it seems, independent of oxygen; and with phosphorus a gas exceeding all others in inflammability.

WATER is an uninflammable fluid, and when pure, is transparent, colourless, and void both of taste and smell. It is formed by the union of *hydrogen* and *oxygen*, and may be considered as an *oxide of hydrogen*: oxygen and hydrogen appearing to unite only in that certain proportion of which water is the result. The proof of its composition is thus obtained: water in a state of vapour, being made to pass over iron wire twisted and made red hot, the iron is oxidated, a considerable portion of the water disappears, and hydrogen gas is produced; the iron depriving the water of its oxygen, by which it becomes an oxide, whilst the hydrogen combining with caloric forms the hydrogen gas. Again, 15 parts of hydrogen gas being burnt in a close vessel with 85 parts of oxygen, water is formed of the same weight as the gases employed. It appearing that, at a temperature lower than that of ignition, the attraction of the respective bases of the two gases to caloric is stronger than their attraction to each other, which prevents their decomposition. But that at the degree of ignition, the attraction of the bases are stronger to each other than to caloric; hence they unite and form water, the caloric and light being disengaged with flame.

The composition of water by the *ponderable* part of these gases is beautifully evinced by the experiments of Dr. *Pearson*, by means of the electric spark.

It enters into the composition of most bodies in the animal, vegetable, and mineral kingdoms, either in a state of combination, or of simple mixture; contributing to the hardness and transparency of some bodies, as saline or stony crystals, and giving fixity to others, as the acids.

At the temperature marke[illegible]ed by 32° F. water parts with caloric, has its volume i[illegible]ncreased by a confused crystallization, and assumes a *soli*[illegible]d form, when it is termed *ICE*. The temperature being increased, it reassumes the *liquid* form of water, in which a considerable quantity of caloric becomes fixed, and is prevented from passing into a state of vapour by the pressure of the atmosphere. But if, in the most common state of the atmosphere, the water be heated so that the intensity of caloric be raised to a degree marked by 212° F. it then boils and is converted into an *elastic* fluid, or *AQUEOUS VAPOUR*.

Although water dissolves neither *hydrogen* nor *nitrogen* alone, it dissolves them freely when combined. It acts very feebly on *carbon*, in the cold; but at a red heat it acts on it very powerfully. It does not unite with *phosphorus* at any temperature, nor does it have any discoverable action on *sulphur*. It does not dissolve, but after a considerable time it decomposes the *phosphorated hydrogen gas*. The more combustible *metals*, especially when aided by heat, fix the oxygen of the water; and separate the hydrogen, in a gaseous form.

By certain natural processes the atmosphere is constantly impregnated with aqueous vapour, since air can dissolve water, and render it gasiform; whilst on the other hand water is able to fix and liquify the air, which it again parts with on freezing or boiling.

When in consequence of cooling or compression, the caloric separates from the finely divided particles of water, which formed the bases of the vapour, and which now approximate to form a liquid again, the appearance termed *FOG*, or *MIST*, takes place, and in the higher regions, *CLOUDS* are formed from the decomposed vapour, the still nearer approximation forming *RAIN*. Thus also may be explained the formation of *DEW*, and of water on the walls or windows of crowded rooms. By the more rapid substraction of caloric the production of *HAIL* and of *HOAR-FROST* may be also easily accounted for.

Water has been supposed to exist in the atmosphere in a decomposed state, in a permanent compound gas, unchangeable, but by an elective attraction superior to that which unites its ingredients. —*Essays of the Exeter Society.*

Mr. *Astley* considers it as entering into the atmosphere, decomposed into the *two original permanent gases* belonging to its constitution, and not as *a permanent compound gas.*—*Nich. Jour. Ap.* 1801.

Water generally contains foreign substances, and when these belong to the mineral kingdom, the waters so impregnated are termed *MINERAL WATERS.* The following table points out, in a general way, the contents of those which have excited most notice by their medicinal properties.

Simpler cold waters	Malvern. Holywell.
Simpler thermal	Bristol. Matlock. Buxton.
Simple saline, containing chiefly neutral purging salts	Sedlitz. Epsom. Sea.
Highly carbonated alkaline	Seltzer.
Simple carbonated chalybeate	Tunbridge.
Hot, carbonated chalybeate	Bath.
Highly carbonated chalybeate	Spa. Pyrmont.
Saline, carbonated chalybeate	Cheltenham. Scarborough.

Hot, saline, highly carbonated chalybeate	Vichy. Carlsbad.
Vitriolated chalybeate	Hartfell.
Cold sulphureous	Harrogate. Moffatt.
Hot, alkaline, sulphureous	Aix. Borset. Barege.

Dr. Saunders's Treatise on Mineral Waters, 1800.

NITROGEN.

Nitrogen, or *Azot*, the *Nitric Radical*, or *acidifiable basis* of nitric acid, has only been obtained in a state of combination.

Nitrogen Gas, which has also been termed *azotic gas*, or *atmospheric mephitis*, is formed by the combination of *nitrogen* with *caloric*. It was discovered by Dr. *Rutherforth*. It forms more than two-thirds of the air of the atmosphere; but alone, destroys animal life, and stops combustion. It is lighter than common air, in the proportion of 905 to 1000, is not acid, has but little smell, and is not absorbed by water. It may be obtained from the atmospheric air, when, by the oxidation of metals, by combustion, or by any other process, the other constituent of air, the oxygen gas, has been absorbed. A solution of alkaline sulphuret, or a paste made with equal parts of sulphur and iron filings moistened with water, will answer this purpose. It is obtained from most bodies in the vegetable and animal kingdom, nitrogen existing in these as a radical principle. It may be readily obtained from animal substances by the action of weak nitric acid.

Nitrogen, as its name imports, is the chief constituent, the base, of the *NITRIC ACID*, the composition of which was proved by Mr. *Cavendish*, who formed it by taking reiterated electric sparks through a mixture of oxygen and nitrogen gas. Nitric Acid, in the state of *gas*, continues so at common temperatures, 100 cubic inches weighing about 76 grains. It is extremely soluble in water, forming the *nitric acid*, or *aqua fortis* of commerce, which is thus obtained.

Nitre being distilled with half its weight of acid of sulphur, a yellow acid liquor yielding reddish fumes, is obtained; as these fumes are separated the liquor loses its colour, and ceases to smoke. This change is effected in less time by the addition of heat or of water, the fumes being dispersed rapidly in both cases, and in the latter the liquor becomes first green, then blue, and lastly white.

Nitric Acid, or *Aqua Fortis*, is the colourless liquid just described, in which the acid exists in a state of complete oxygenation. In proof of which, nitric acid being passed through a red-hot glass tube, is resolved into oxygen gas, and nitrous acid.

Nitrous Acid, or *Glauber's fuming Spirit of Nitre*, is the yellow smoking liquor just mentioned. In this a portion of the nitric radical exists not combined with a full proportion of oxygen, and this suboxidated portion flying off assumes a reddish colour on meeting with oxygen, which it does in the air of the atmosphere; becoming by this access of oxygen, nitrous acid gas, and on being absorbed by water it changes to nitric acid. The acid from which it has escaped also becoming perfect or nitric acid.

Nitrous Gas, which, as Mr. *Davy* remarks, ought to be called *Nitric Oxide*, is a combination in which the nitric radical exists in a yet lower state of oxidation. It is produced by mixing with the nitric acid, charcoal, oil, iron, copper, or any other substance which will attract its oxygen, the atmospheric air being carefully excluded. The gas thus obtained holds so small a portion of oxygen as to manifest no acid properties. It is colourless, and will support neither animal life nor combustion. On meeting with atmospheric air, it is converted into the reddish yellow vapours already described, as convertible into nitric acid by the contact of water, evincing that by the combination of oxygen and nitrous gases nitric acid is generated.

Its composition is proved by burning *pyrophori* in it, the oxygen being absorbed during combustion, leaving unmixed nitrogen gas. *Phosphorus* also burns in it if introduced in a state of vivid inflammation.

Gaseous Oxide of Nitrogen, appears to be the result of a still lower degree of oxidation of this radical. It is obtained by exposing nitrous gas to wetted iron filings, or moist sulphuret of alkali; or any other substance which abstracts a portion of the oxygen.

Mr. *Davy* obtained this NITROUS OXIDE by decomposing nitrate of ammonia at temperatures below 440°. If a higher degree of heat is employed, a detonation succeeds. Nothing is yielded by the process but the nitrous oxide and water. It is heavier than air, does not diminish on being mixed with nitrous gas, is soluble in double its quantity of water, and when given out again possesses its former properties. It yields a sweet taste, and a slight but agreeable odour, and does not manifest actual acid properties. It is decomposable by ignited combustible bodies, which burn in it with a vivid light; a taper burning in it with an additional flame of a blue colour: and a mixture of it with hydrogen detonates on the application of a lighted taper. It is combinable with alkalies in its nascent state, but is insoluble in most of the acids. If an acid, Mr. *Davy* says, it is the weakest of the acids; but ought rather to be considered as a body *sui generis*. He found it to be respirable, producing extraordinary effects on the nervous system.

From Mr. *Davy's* experiments it appears that NITRIC ACID contains oxygen in the proportion of 2,389 to 1 of nitrogen; bright yellow nitrous 2,344; orange coloured 2,292; and dark green 2,230.

NITROUS ACID, he thinks with Mr. *Thompson*, is *nitric acid holding nitrous gas in solution*, and that the salts, termed *nitrites*, must be ternary combinations, consisting of nitric acid, nitrous gas, and salifiable bases.

NITROUS GAS, he finds, is composed of 56 oxygen, and 44 nitrogen.

NITROUS OXIDE, he says, consists of 37 oxygen to 63 nitrogen. —*Researches Chemical and Philosophical*, 1800, *and Lectures*, 1802.

The nitric acid unites with oils, and forms with them a sub-resinous substance, somewhat resembling musk, and sometimes produces inflammation. It rapidly corrodes organic bodies, staining skin, hair, and other animal matters, of a permanent yellow. It oxidates, iron, zinc, copper, &c. very speedily, nitrous gas, as already observed, being at the same time formed.

From the facility with which nitric acid parts with its oxygen, it is employed as a proper vehicle in which the oxygen may be applied to certain acidifiable bases, to procure the peculiar acids of those radicals. For this purpose the nitric acid is added to the substance, containing the radical or base, and distilled from it, it passing over in the state of nitrous acid, nitrous gas, or even nitrogen, according to the quantity of oxygen which has been substracted from it by the acidifiable bases, now rendered a peculiar acid. Thus are acids obtained from sugar, arsenic, &c. as will be hereafter shown.

Mr. *Mayer* first conjectures that nitrogen was composed of oxygen and hydrogen—a water changed into gas.—*Gren's Journal*, vol. v.

Mr. *Girtanner* finding nitrogen gas produced by passing water through tubes of heated earth, concluded, that the oxygen of the water partly united itself with the earth, forming an earthy oxide, and that the remainder, still united to hydrogen, combining with caloric, formed the nitrogen gas. He therefore described nitrogen as *water deprived of a part of its oxygen*, and considers it, with *Meyer*, as a *compound of oxygen and hydrogen*, terming it an *oxide of hydrogen*.—*Ann. de Chim.* No. 100.

Berthollet agrees, with *Dieman*, *Van Trooftwyk*, and *Lauwrenberg*, in denying this formation of nitrogen gas from water; and in asserting, that it proceeds from the exterior air, deprived of its oxygen gas, by the fire in which the tubes are placed.—*Ann. de Chim.* No. 103.

Dr. *Mitchill*, of New York, supposes the matter of pestilence to be Septon (nitrogen) chemically united with oxygen, base with base, before they had attracted caloric enough to convert them to gases, and give them the repellency incidental to that condition, as is the case when the two distinct gases are merely mixed, as in atmospheric air.

Atmospheric Air, that transparent, colourless fluid, which every where invests this globe, possessing permanent elasticity and gravity, is composed of *nitrogen* and *oxygen gas*, in the proportion of 78 of the former, and 21 of the latter, with one part of carbonic acid gas, in a state of mixture, not of intimate combination; and is soluble in about 30 times its bulk of water. Sixteen cubic inches weigh about 5 grains.

The constituent principles of atmospheric air are rendered evident by the following experiment: Quicksilver being inclosed in a proper vessel of atmospheric air, on heat being applied, the air will be diminished, and the quicksilver lose its splendour, and gradually change to a reddish powder; acquiring, at the same time, an augmentation of weight. When neither the air nor the quicksilver suffers any farther change, the separation of the principles has taken place: the one, the gas remaining in the receiver, is now unfit for supporting flame, or maintaining respiration, and is nitrogen gas; the other is absorbed by the quicksilver, whilst reducing to the state of an oxide, and may be extricated from it on the application of heat: when the powder, to which the quicksilver is reduced, will be restored to its metallic state, but will have lost the weight it had gained during its oxidation; this deficiency being exactly equal to the weight of the evolved gas, which is oxygen gas.

These separated gases, thus differing in their properties from each other, and from atmospheric air, being again mixed, form atmospheric air of the ordinary degree of purity.

M. Humboldt is of opinion that the composition of atmospheric may so vary, that the oxygen may exist in it in the proportion of from 0,23 even to 0,29.

It must, however, be acknowledged, that in thus forming respirable air, an aëriform fluid is obtained, differing in some trifling respects from the ordinary air of the atmosphere.

F. Von Humboldt supposes, that our not being able to form an aëriform fluid, perfectly similar to that of the atmosphere, does not proceed from our ignorance of the quantity or quality of the gaseous bases, but from a difference in their union; that in the atmosphere they may be considered as in a state of chemical combination, but in the artificial, merely as a mixture.—*Journal de Physique*, 1798.

Respiration and combustion depending on the presence of oxygen, these processes will always be affected by the proportion in which the oxygen gas exists in the air in which they are performed. The atmosphere also contains foreign matters, such as other gaseous bodies, water which it holds in solution, minute detached particles of bodies, &c.

Mr. *Davy* states, that the atmospheric air, differs very little in the proportion of its ingredients in different parts of the world, that of Europe, Asia, America, and Africa, being all found to contain 0,22 of oxygen in volume.—*Journal of the Royal Inst.* No. 3.

Mr. *Dalton* considers the general atmosphere as a compound of *four* fluids principally, or *four particular atmospheres: nitrogen gas* pressing with a force equal to 21,2 inches of mercury, *oxygen gas* equal to 7,8 inches, *aqueous vapour* varying from 1 to, 1, or less, and *carbonic acid gas* which may be equal to half an inch. These, he supposes press *separately* on the earth, and any one may be withdrawn, or any one added, without materially disturbing the rest, or affecting their density; the force of vapours from any fluid, he also believing to depend solely upon temperature.—*Nicholson's Journal*, Oct. 1801.

From the avidity with which *nitrous gas* absorbs oxygen to form nitric acid, it has been employed by *Priestley, Ingenhousz*, and *Fontana*, as an Eudiometer to measure the quantity of oxygen in the atmosphere; the diminution of volume in a given quantity of atmospheric air, to which the nitrous gas is applied, giving the quantity of oxygen absorbed, and the quantity which the given quantity of atmospheric air contained.

But the results of these experiments are not always the same, nor can it be said how much of the diminution is attributable to the concentration of the nitrous gas itself.

Combustion with *hydrogen gas* has also been employed for the same purpose by *Volta*, and with more precision; but it requires a more complicated apparatus, the results are not constant, nor can it be ascertained how much of the diminution is to be attributed to the hydrogen, and how much to the oxygen gas.

By the exposure to a *liquid sulphuret of alkali*, a more correct comparison of different airs is obtained, the whole diminution being attributable to the oxygen gas; but this acts very slowly, nor can it be known even after several days that the process of diminution is completed. *Guyton* proposes to employ dry and heated sulphuret of alkali.

Gren and *Berthollet* recommend the measure of the oxygen to be obtained, by the combustion of phosphorus in the air intended to be examined.

Mr. *Davy* employs for eudiometrical experiments a fluid, made by transmitting nitrous gas through green muriate, or sulphate of iron, dissolved to saturation in water. This fluid rapidly condenses the oxygen gas without acting upon nitrogen. As the oxygen is absorbed the solution becomes brown, and when the impregnation is completed, almost black. The process is apparently owing to a simple electric attraction; in no case is the gas decomposed, but under the exhausted receiver assumes its elastic form, leaving the fluid, with which it was combined, unaltered in its properties.

A graduated tube, filled with the air to be examined, is introduced in the solution, when the air is rapidly diminished, and the whole of the oxygen is condensed by the nitrous gas, in the solution, in the form of nitrous acid.—*Journal of the Royal Institution*, 1801.

The gravity or pressure of the atmospheric air varies at different times. To mark this variation an instrument called the BAROMETER is employed. This instrument is a tube containing a column of mercury 28 inches in height, which is known to be the exact counterpoise of a column of air of the height of the atmosphere. This tube being open at the lower end, and having a vacuum above, the mercury rises and falls in it according to the varying pressure of the circumambient fluid.

The atmosphere also varies as to the quantity of water it contains. To estimate this variation HYGROMETERS are employed, which are formed of substances which readily shrink by dryness, or swell by the application of the smallest quantity of moisture.

AMMONIA, or the *Volatile Alkali*. This has been proved to be a compound of *nitrogen* and *hydrogen*, uniting in their nascent state. It seems to owe its origin to animal and vegetable decomposition. It is distinguished from the other alkalies by its pungent smell, and great degree of volatility. 1000 parts contain 807 of nitrogen, and 193 of hydrogen.

Ammonial gas is transparent as air, and like it elastic, but is not much more than half as heavy. Its smell and taste is sharp and caustic. It destroys animal and vegetable life, and extinguishes flame, the volume of which it first enlarges. *Light* does not change it, nor does its exposure to a *red heat*; but the *electric spark* separates it into its constituent principles, *nitrogen* and *hydrogen*, and each of these in the state of gas. It is decomposed by *oxygen gas* at a red heat; water and nitric acid being formed. It does not appear to be altered by the exposure to *nitrogen* or *hydrogen gas*. With *red* *hot charcoal* it forms prussic acid: at a red heat doth its principles separately combine with *phosphorus;* aided by heat it also unites with *sulphur.* *Water* will dissolve half its weight of this gas, having its volume thereby increased and its specific gravity diminished in the proportion of 897 to 1000. On being mixed with *acid gases* clouds are produced by the formation of neutral ammonial salts; this is particularly the case with the *muriatic acid gas.* With the *oxy-muriatic gas* a mutual decomposition takes place with the disengagement of light, from the inflammation of the hydrogen by the oxygen, water and muriate of ammonia being at the same time formed. The *boracic acid* does not absorb the ammonial gas.

Liquid Ammonia is formed by the solution of ammonial gas in water, which takes place very rapidly. Its properties may be inferred from those of its gas.

NEUTRAL SALTS are formed by the union of the several acids with certain bases. When the acids in these compounds are completely saturated with oxygen, it is designated by the word which describes them, terminating in ATE, and when containing a more limited proportion of oxygen, by the termination of ITE.

Nitrates are *Neutral Salts,* formed by the combination of nitric acid, with certain bases. They are not changed by the action of *light,* of *oxygen* or of *nitrogen gas;* but are acted on in a very rapid manner by *combustible bodies* in this act of combustion; deflagrating and even detonating with most. The nitrates are here ranged according to the degree of attraction of their bases for the acid.

Nitrate of Pot-ash, *Nitre, or Saltpetre,* is produced spontaneously in various situations, sometimes efflorescing on the surface of the earth, and on the walls of old buildings; it is also found in some vegetables, in mineral waters, dunghills, &c. It may be artificially produced by the concurrent corruption, not strictly, putrefaction, of animal and vegetable substances. Light earths, such as lime and marle, the refuse of soap manufactories, ashes, &c. being stratified for this purpose with straw, dung, and animal and vegetable substances; wetted with urine, blood, dunghill-water, and the mother waters of saltpetre; and turned and exposed to the current of air.

When putrefaction takes place, the nitrogen uniting with hydrogen forms ammonia; but in this stage of corruption, in which nitre forms, the nitrogen as it is extricated combines with oxygen, which is also separated, and forms nitric acid. This on its formation meeting with some earthy or alkaline base, instead of escaping, becomes fixed in a neutral salt. It is also met with in various plants, such as borage, tobacco, &c.

Nitrate of pot-ash crystallizes in hollow striated hexahedral prisms, terminating in hexahedral pyramids. It yields a pungent taste, and impresses the sensation of coldness on the tongue. It is soluble in seven parts of cold and one of hot water. By distillation, it yields 12000 cubic inches of oxygen gas for every pound of nitre, caustic or pure alkali being left behind. Thrown on burning coals it yields a white flame, and fuses at a moderate heat, from the water of crystallization it contains. If fused until its water of crystallization is dissipated, and cast into moulds, it becomes a nitrite of pot-ash, which has been called *crystal mineral*, or *sal prunel*. Mixed with an equal quantity of sulphur, and fused in a red hot crucible, the substance called *sal polycrest* is formed.

Charcoal at the temperature of ignition totally decomposes the nitric acid. Nitrate of pot-ash and charcoal therefore being mixed in a state of ignition, this decomposition takes place with detonation. This experiment being made by detonating one part of charcoal and three of nitre, in a proper vessel, the nitric acid disappears; the carbon takes from it oxygen, forming the carbonic acid, part of which is found in the form of gas, and the other part is united to the pot-ash of the nitre, forming a carbonate of pot-ash, which remains, and was formally called *fixed nitre*, and in a state of solution in water, *liquid fixed nitre*, or *Glauber's universal alkahest*: the acidifiable base or the nitrogen forming nitrogen gas.

100 grains of nitrate of pot-ash contain 30 of acid, 63 of pot-ash, and 7 of water; and a mixture in this proportion, will, on evaporation, yield crystals of the purest nitre, formerly called *regenerated nitre*.

Acidulous Nitrate of Pot-ash, or *Nitrated Nitre*, is formed, if the nitric acid be employed beyond the point of saturation.

Gunpowder is formed of 75 parts of *nitre*, 16 of *charcoal*, and 9 or 10 of *sulphur*. The sulphur renders it more readily ignited. These ingredients, duly moistened, are ground together, in *gun-powder-mills*. The *powder paste* is afterwards *grained*, and for nice purposes *glazed*. Its excessive power appears to proceed from the sudden extrication of carbonic, hydrogen, and nitrogen gases, with an immense quantity of caloric.

The matter which remains after the explosion of gunpowder, consists of *pot-ash* united with a small proportion of *carbonic acid*, *sulphate of pot-ash*, a very small quantity of *sulphuret of pot-ash*, and unconsumed *charcoal*, 100 grains yielding 53 of this residuum. *Cruickshank*, 1800.

Nitrate of Soda, *Cubic* or *Rhomboidal Nitre*, so called from the form of its crystals, is produced by the artificial combination of *nitric acid* with *soda*, it not having been found in a native state.

It has a cool bitter taste, slightly attracts the humidity of the atmosphere, is soluble in three parts of cold water, and but little more soluble in hot water. It fuses on burning coals with a yellow flame; its other properties resembling those of nitrate of pot-ash. 100 grains contain 29 of acid, 50 of alkali, and 21 of water.

Nitrate of Strontia forms octahedral crystals, and gives to the flame of alcohol a bright carmine red. It contains 48,4 of acid, 47,6 of strontia, water 4,0.

Nitrate of Lime, formerly termed *Nitrous Selenite*, is found adhering to, and embodied in, calcareous stones, and dissolved in various mineral springs. It is formed near inhabited places, and is yielded by the lixiviation of old plaster, and by the mother waters of saltpetre, as they are termed by the manufacturers. It forms hexahedral acidular crystals of a sharp and bitterish taste, which readily deliquesce, and are very soluble in water. It fuses when exposed to heat, parting with its acid in the form of nitrogen and oxygen gases; the earth which remains, after the fire has been considerably urged, is phosphorescent, and is called Baldwin's phosphorus. The fixed alkalies and baryt precipitate the lime. Sulphuric acid unites with the lime, and disengages the nitric acid. 100 parts contain 43 of acid, 32 of lime, 25 water of crystallization.

Nitrate of Ammonia, is formed either by the combination of the nitric acid gas with ammonial gas, or by adding nitre to a saturated solution of sulphate of ammonia, which evaporated twice at about 250°, deposites sulphate of pot-ash in crystals, and leaves a solution of nitrate of ammoniac, which at 212 forms beautiful flexile needle-like crystals, of a cooling but acrid taste. Exposed to the fire, it fuses, dries, forms a vivid flame, and detonates with considerable noise. 100 parts contain 46 of acid, 40 of ammonia, and 14 of water.

Nitrate of Magnesia is found in decayed walls, &c. It forms tetrahedral columnar crystals, with obliquely truncated ends, which taste acrid and bitter, are deliquescent and readily soluble, either in water or spirit of wine. It is decompounded by lime, baryt, and fixed alkalies, and by the sulphuric and fluoric acids. In 100 parts are 36 of acid, 27 of magnesia, and 37 of water.

Nitrate of Ammonia and Magnesia is best formed by mixing a solution of the two nitrates. It forms a salt of a sharp, bitter, and ammonial taste, which crystallizes in fine needle-like prisms.

Nitrate of Glucine is obtained in a pulverulent form, and has a sweetish taste. It fuses readily, and is very soluble in water.

Nitrate of Alumine forms in small prisms, which are deliquescent, and give an astringent taste. In the fire they swell, and are decompounded, losing their oxygen.

Nitrate of Zircon forms in small silky needle-like crystals, of a styptic taste. It is very soluble in water, and most easily decomposable by heat.

Nitrate of Baryt, has not yet been found native. It crystallizes difficultly in octahedral crystals, and though deliquescent, requires a considerable quantity of water for its solution. Neither alkalies, nor the other earths, decompose it. But the sulphuric acid is detected in any mixture by this salt, since by uniting with the baryt, it forms sulphate of baryt, which is precipitated. By exposing this salt to a violent heat, pure baryt is left more caustic than quick-lime. This salt gives to alcohol the property of burning with a whitish yellow flame. It contains of acid 38 parts, of baryt 50, and of water 12.

NITRATE OF YTTRIA is sweet, very deliquescent, and not crystallizable; instead of drying, by the fire, it becomes soft like honey, but when dried it is as solid and as hard as a stone.—*Vauquelin.*

NITRITES have been very little attended to. They are formed by depriving the nitrates of a portion of their oxygen by a partial decomposition by the action of heat.

SULPHUR.

SULPHUR is a simple, inflammable, acidifiable, brittle, yellow substance, yielding a peculiar odour when heated, and manifesting electric powers on being rubbed. Its sp. gr. is about 2.

It is found in and on the surface of the earth, both pure and in a state of mixture. It is said also to exist in certain vegetables, and to be separated during the putrefaction of animal and vegetable substances. It is cleared from its impurities by sublimation, the external air being excluded to prevent its inflammation, when it is termed *sublimed sulphur*, or formerly *flowers of sulphur*. By a moderate heat it may be fused, when it will crystallize in thin needles, mostly of an octahedral form; and in this state it may be poured into moulds, and formed into rolls or sticks.

Neither *nitrogen*, nor *carbon*, enter into a binary combination with sulphur: nor is it acted on by water; but that *hydrogen* may enter into combination with it will appear from the combination next mentioned.

Sulphur combines with the fixed and volatile alkalies, and with all the earths, except alumine. The compounds being termed ALKALINE, or EARTHY SULPHURETS. It also combines and forms sulphurets with *phosphorus* and with the *metals.*

SULPHURET OF POT-ASH AND OF SODA, or *Alkaline Liver of Sulphur*, is obtained by melting two or three parts of the alkali with one of the sulphur, or by the decomposition of alkaline sulphates by charcoal, at a high degree of heat, the sulphuret in this case being formed without either of the substances assuming a fluid form. They burn when intensely heated, and, with vividness, under a stream of oxygen gas. This compound is a hard substance, of a brown liver-colour, which soon imbibes moisture from the atmosphere; when it emits an odour resembling putrid eggs. This odour, which proceeds from a gas formed in consequence of the decomposition of the water, is also produced on its solution in water; for sulphur thus combined with alkalies or earths, is enabled to attract the oxygen of the water, and form with it sulphuric acid, which combining with the alkali produces sulphate of alkali. The hydrogen of the water thus relinquished by the oxygen, takes up another part of the sulphur, and forms with it sulphurated hydrogen the basis of this gas; but which being retained by a separated portion of the alkali requires the addition of an acid, and the aid of heat, to produce the separation of the gas. The sulphur itself is then precipitated very pure in a white powder, which has been called *milk of sulphur.*

Sulphuretted Hydrogen Gas, or *Hepatic Gas*, which is thus evolved, is distinguished by a peculiar disagreeable smell. It blackens most of the metals, and their oxides, destroys life, reddens vegetable blues, combines with *alkalies*, and is soluble in *water*, appearing to be a true acid, formed without the manifest influence of oxygen. Though it extinguishes the flame of a lighted candle, it will itself burn with a light blue flame, in contact with oxygen, depositing, at the same time, sulphur, and forming water. It is also decompounded by the electric spark. The cubic inch weighs .34 of a grain.

This gas may exist in two degrees of impregnation with sulphur; 1. that which contains but little sulphur: this is obtained by exposing hydrogen gas to *sulphur* in a state of fusion, and manifests feeble acid properties; this is the *sulphuretted hydrogen gas*; 2. that which contains a larger portion of sulphur, and is obtained by the action of an *acid* on *sulphuret of pot-ash.* This latter is heavier, less fœtid, and more pungent than the former. This may be termed *hydroguretted sulphureous gas.*

Its solution in water added to the nitrous metallic solutions occasions precipitation.

The *mineral sulphureous waters* are formed by saturation with this gas.

Hydroguretted Sulphuret of Pot-ash, or of Soda, of *Chevenix*, or *hydro-sulphurets* of *Berthollet*, is formed when *sulphuretted hydrogen gas* is absorbed and condensed by a *solution of potash*, which it saturates, and thus forms a substance, crystallizable in transparent crystals. *Berthollet* says, the combinations of sulphur with alkalies may be distinguished into 1. *sulphurets*, or the simple combinations of sulphur with alkali, which give only sublimed sulphur without sulphurated hydrogen by sublimation; 2. *sulphuretted hydrogurets*, where the alkali is saturated with sulphurated hydrogen, and which, on the addition of acids, give sulphurated hydrogen, but no precipitate; and 3. *hydroguretted sulphurets*, containing both sulphur and hydrogen, and yielding both on the addition of acids.

Sulphuretted Hydroguret of Ammonia is formed by passing *sulphurated hydrogen* into *liquid ammonia*. It does not possess the fœtid odour of sulphurated hydrogen, and is capable of crystallization.

Hydroguretted Sulphuret of Ammonia, or, as it was formerly called, *Boyle's* or *Beguine's fuming Spirit*, or *Volatile Liver of Sulphur*, is obtained in the form of a yellow fuming liquor, by the ammonia and sulphur uniting, whilst in a state of gas, during distillation, from one part of sulphur, two of ammonia, and six of quick-lime. Like the other sulphurets it is decomposed by acids: and if the concentrated sulphuric acid is employed, a dangerous degree of heat, and explosive effervescence will be produced.

Sulphuret of Lime, formerly called *Hepar of Lime*, is formed either in the dry or moist way. When recent and dry, it absorbs light, and shines in the dark, and when equal parts of pulverized oyster-shells, and of sulphur are kept in a covered crucible for an hour or two in a strong heat, a sulphuret is obtained, which if first exposed to the day-light, will appear luminous if conveyed to a dark place, this is termed, from its inventor, Canton's phosphorus.

It speedily loses its taste and smell, by exposure to the atmosphere; and suffers decomposition by acids, like the other sulphurets, sulphurated hydrogen gas being disengaged.

Sulphuret of Baryt. This combination also absorbs light, and shines in the dark; this is the bolognian phosphorus. Ponderous spar, or *Sulphate of Baryt*, made into little balls, with mucilage of tragacanth, are heated with charcoal in a crucible, for this purpose; the sulphate being deprived of its acid, the sulphur, which it leaves, combines with the earth, and forms the sulphuret of baryt.

SULPHURET OF MAGNESIA, or *Hepar of Magnesia*, is formed by the digestion of equal parts of sulphur and magnesia in water. The magnesia is precipitable by fixed alkali, which has a stronger affinity with the sulphur. It affords small crystalline needles by spontaneous evaporation.

Sulphurets combined with nitre, in the proportion of one part of the former to two of the latter, or of one part of sulphur, two of dry carbonate of pot-ash, and three of nitre, form *fulminating powder*, which being placed in a small quantity on a shovel, and gradually heated until it melts, the mass swells, a slight flame is perceived, and, in that instant it explodes with much violence, by the inflammation of an extremely inflammable fulminating gas, formed by the hepatic gas from the sulphuret and the oxygen from the nitre.

Sulphur melts at about 214°, and at a little higher degree of temperature it burns with a feeble blue flame; at a still higher, it burns more vividly and intensely; and in oxygen gas, the flame is still more brilliant. At 600° F. it assumes a gaseous form.

During its combustion, oxygen combining with its acidifiable base forms an acid more or less perfect according to the greater or less rapidity of the combustion. The union of sulphur with phosphorus and with the metals will be described in the sections under which the latter substances are treated of.

SULPHURIC ACID, formerly called *Spirit* or *Oil of Vitriol*, is formed by the combination of the full portion of oxygen with its basis. It is obtained by the combustion of sulphur in oxygen gas, or with nitrate of pot-ash, which furnishes oxygen abundantly. It is also obtained by distillation from sulphur and nitric acid, in the proportion of 48 ounces of the acid to two ounces of the sulphur. 100 parts contain 55,56 of sulphur, and 44,44 of oxygen, according to *Thenard*; or rather according to Mr. *Chevenix*, of 61,5 of sulphur, and 38,5 oxygen.—*Transact. R. I. Acad.* 1801.

It is nearly twice as heavy as water. It suffers congelation by intense cold, is unctuous to the touch, attracts moisture from the atmosphere with great avidity, and when mixed with water, produces heat beyond that of boiling water. It acts rapidly on all inflammable substances, rendering them black, the acid itself becoming brown or even blackish, by the addition of the carbon of the inflammable substance; whilst the acid is robbed of a portion of its oxygen, which unites with the carbon, and flies off as carbonic acid gas.

SULPHUREOUS ACID is formed in the above instance, the proportion of oxygen being less and of sulphur greater than in the sulphuric.

SULPHUREOUS ACID GAS may be obtained in all those processes in which the sulphuric acid is deprived of a part of its oxygen. It is obtained for the purpose of experiment, by exposing *sulphuric acid* to *mercury*, or any of the metals which act on it by substracting a portion of its oxygen. It is a compound of sulphur and oxygen, the latter being in a less proportion than in the sulphuric acid, with a certain quantity of caloric. This gas has an acid taste, and the acrid and penetrating smell of burning sulphur. It destroys animals, and extinguishes ignited combustible substances. It unites rapidly with ice, which melts by the heat disengaged during its fixation.

The composition of this acid is proved by passing the sulphureous acid gas with hydrogen gas through a heated porcelane tube, when sulphur will be found to be separated.

SULPHATES are neutral Salts, formed by the sulphuric acid with certain bases. They are here ranged according to their degree of attraction for the acid. They are not changed by *light*, *oxygen gas*, or *nitrogen gas*; but are acted upon by *combustible bodies* if aided by heat. The *nitric* and *muriatic acids* partially decompose them, assisted by heat, but the *weaker acids* have no action on them.

SULPHATE OF BARYT, or *Ponderous Spar*, or *Baroselenite*, is generally found in rhomboidal plates, refracting double. It is not soluble in water by art; when heated it becomes luminous, and by violent heat vitrifies. Neither the other alkalies nor acids have any action on this sulphate. 100 parts contain 30 of acid, 67 of baryt, and 3 of water, the native containing much more acid than the artificial. That which comes from *Mount Paterno*, in *Bologna*, in *Italy*, has been called the *Bolognian stone*, which, when heated, becomes the BOLOGNIAN PHOSPHORUS.

SULPHATE OF POT-ASH, formerly called *Arcanum Duplicatum*, *Sal de Duobus*, *Vitriolated Tartar*, *Vitriol of Pot-ash*, &c. It forms in crystals of hexahedral prisms, with rectangular faces, terminating in hexahedral pyramids, with triangular faces, the triangles being isosceles, as in the rock crystal. It gives rather a penetrating bitter taste, and is soluble in 16 parts of cold water. 100 grains contain 0,40 of acid, 0,52 of alkali, and 0,08 of water. It decrepitates on hot coals; but with greater heat it fuses, and is volatilized without decomposition.

Sulphureous acid is, in fact, produced by a partial decomposition of the sulphuric; but a total decomposition of this acid, an entire separation of its oxygen, and the reproduction of its base, sulphur, may even be obtained. For this purpose equal parts of this salt, and fixed alkali, with a fourth of the whole of charcoal being melted together, the ignited carbon seizes the oxygen of the sulphuric acid, and forms with it carbonic acid gas, the regenerated sulphur combining with the alkali and forming an alkaline sulphuret.

ACIDULOUS SULPHATE OF POT-ASH, is produced by supersaturation with one-third of its acid. This salt effloresces in the air, and strongly retains the superadded acid.

SULPHATE OF SODA, formerly called *Glauber's Salt*, *Sal Mirabile*, *Vitriol of Soda*, &c. is found in various mineral waters, and is yielded very plentifully by the *tamarix gallica*, on the sea coasts, in the south of France.

It has a very bitter taste, crystallizes in large striated hexahedral prisms, with hexahedral or dihedral summits, flattened, by two opposite sides being larger than the others, terminating generally in dihedral ends. It swells and boils upon heated coals, effloresces in the air, and is soluble in less than its own weight of boiling water, and in three parts of cold. 100 parts contain 27 of acid, 15 of alkali, 58 of water. It is decomposed by pot-ash and baryt.

SULPHATE OF STRONTIAN is earthy, has no taste, contains 54 of strontian and 46 of acid, and is scarcely soluble in 100 parts of water.

SULPHATE OF LIME, or *Selenite*, or *Gypsum*, is mostly of a white colour, and is found either in foliated, fibrous, or laminated irregular masses, or in crystals, deriving their form from the straight quadrangular prism, the bases of which are oblique-angled parallelograms of angles of 113d. and 67d. Refracts double. Exposed to fire, it is reduced to a white powder, called *burned gypsum*, or *plaster of Paris*. Water is speedily absorbed by this powder, rendering it a paste, which soon hardens. In this state it is employed as a *mortar*, and for *stucco works*.

It is difficultly fusible *per se*, but melts at 130° on clay. It requires 500 parts of cold water to hold it in solution. 100 parts contain 32 of lime, 46 of sulphuric acid, and 22 of water. It is considered as of posterior formation to the primitive mountains, and sometimes is obviously produced by the decomposition of pyritical matter in the neighbourhood of calcareous substances.

Sulphate of Ammonia, called formerly *Glauber's Secret Ammoniacal Salt*. It is very bitter, and forms into thin hexahedral prisms, terminating in hexahedral pyramids. It contains acid 42, alkali 40, water 18. It is dissolved in its own weight of boiling water, and twice its weight of cold water. It yields its acid to fixed alkali, baryt, and lime.

Mr. *Hatchet* observes that, as well as all, or most of the other ammoniacal salts, it may be decomposed merely by heat. Mr. *Davy*, by passing it through a tube heated red-hot, resolved it into sulphur, nitrogen, and water.

Sulphate of Magnesia, also called *Epsom Salts*, or *Sal Amarus*, is found in various mineral waters, and even in a solid form in the fissures of rocks. Its crystals are tetrahedral smooth prisms, terminating in dihedral and tetrahedral prisms, but in general they are acicular: their taste is very bitter. 1000 parts of cold water dissolve about 800 of this sulphate, but 1000 parts are dissolved in only 666 of boiling water. It is decomposed by lime and baryt, which unite with the acid, and deposit the magnesia.

Magnesia is obtained generally by decomposing this sulphate, by the addition of fixed alkali to its solution; the magnesia which is precipitated in a state of combination with the carbonic acid, being afterwards cleared from its impurities by repeated ablutions, and if required to be perfectly pure, by exposure to a considerable degree of heat. By the addition of a small quantity of sal soda to the vegetable alkali, the magnesia is obtained beautifully light.

100 parts of this sulphate contain 33 of acid, 19 of magnesia, and 48 of water. So much heat is excited on pouring concentrated sulphuric acid on magnesia, that in a dark place, sparks may be perceived.

Sulphate of Ammonia and Magnesia forms in brilliant crystals deriving their figure from the regular octahedron. Its taste is bitter and sharp. It is a real triple salt or *trisule*, and is less soluble than either of the salts which form it. 100 parts contain 68 of sulphate of magnesia, and 32 of sulphate of ammoniac.

Sulphate of Glucine has a sweet subastringent taste; is very soluble in water, and crystallizes difficultly. It is yet but little known.

Sulphate of Alumine is divided, in consequence of the discoveries of *Vauquelin* into the following kinds:

I. *Sulphates, containing the acid and alumine only*; of this species there are two varieties, 1. that in which the acid prevails; 2. that which is saturated with alumine.

II. *Acid Sulphate of Alumine and of Pot-ash, or of Ammonia. ALUM*, formerly considered only as a compound of sulphuric acid and alumine, is really a triple or even a quadruple salt; formed by alumine, with a little pot-ash or ammonia, or both, and a portion of acid a little exceeding the quantity necessary for the saturation of the bases. These three varieties of alum, agreeing in their specific properties, crystallize in various forms derived from the regular octahedron; the integrant molecules of which are regular tetrahedra.

Its taste is astringent and yet sweetish, and it reddens vegetable blues. Native alum almost always contains pot-ash, and is perhaps generally derived from argillaceous earths, blended with pot-ash and sulphur, or sulphuret of iron, by the action of volcanoes. When it does not naturally exist in the sulphate, the addition of pot-ash converts it to alum. It soon melts, swells, and loses its water of crystallization, by heat becoming a very light, spongy, acid substance, called *burnt alum*: but if the heat is continued, the acid is dissipated, and the tasteless earth is left. The alum of commerce is formed by 0,49 of sulphate of alumine, 0,07 of sulphate of pot-ash, and 0,44 of water. This triple or quadruple salt possesses the property which the former species does not, of dissolving a farther portion of alumine. Thus a solution of alum remaining on alumine forms a salt less sharp, as well as less fusible and soluble, and which crystallizes in cubes, whence it is called *cubic alum.* If the solution be boiled in alumine a pulverulent salt precipitates, which is the triple or quadruple salt, saturated with alumine.

Five parts of burnt alum and one of charcoal intimately mixed; or three parts of alum with one of sugar, honey, or flour melted together and kept over the fire until it has become blackish, being put in an earthen bottle, about two-thirds full, and kept in a red-hot state, surrounded with sand in a crucible, as long as a blue flame is perceived at the mouth of a bottle, the PYROPHORUS of HOMBERG is obtained, which burns on being exposed to moisture. Mr. *Bewley* obtained *pyrophorus* by nearly filling the bowl of a tobacco pipe with two parts of burnt alum, one of charcoal, and one of salt of tartar, pressing it down and filling up the bowl with fine sand, and exposing it to a red heat for three quarters of an hour, a longer time doing it no injury. He also obtained it from powdered charcoal, with double or treble its weight of calcined blue or green vitriol, or of sulphate of zinc; and from a mixture of charcoal, well calcined sulphate of pot-ash, or of soda, and from pot-ash and vegetable or animal coal.—*Priestley on Air.* vol. III.

One part of sugar and two of charcoal treated as above also forms a *pyrophorus.*

The *pyrophori* thus formed contain an *hydrogenated sulphuret of pot-ash and of alumine* mixed with extremely divided charcoal.

A *pyrophorus*, it is said, is immediately formed by rubbing together in a mortar 54 grains of sulphur, 36 of very dry willow charcoal, and 3 of common phosphorus.—*Journal de Physique*, 1780.

The above experiment was made to shew that the combustibility of pyrophori depended on their containing a small quantity of phosphorus. *Savigny* attributed it to the sulphuric acid heated by the moist air, and inflaming the disengaged sulphur. *Proust* denied the presence of sulphuric acid; and Mr. *Bewly* imputed it to the attraction of the nitrous acid from the air, and the heat generated by its union. Dr. *Gren* accounts for it by supposing a sulphuret formed, the alkali of which rapidly attracts moisture, by which heat, and the subsequent combustion is produced.

Sulphate of Zirconia becomes soluble by excess of acid, and gives tetrahedral prisms of an astringent taste.

Sulphate of Yttria forms in brilliant grains, requires 50 parts of cold water for its solution. It has a sweetish taste, with some degree of astringency, like the salts of lead.—*Vauquelin.*

Of the other Sulphates but little has been noticed.

Sulphites are neutral salts, formed by the union of *sulphureous acid* with certain bases. *Fourcroy* and *Vauquelin*, examining the properties of sulphureous acid and its combinations, observe that the sulphites differ very much from the sulphates, and that they possess 1. A sulphureous taste, similar to that of the acid. 2. They are decomposable by fire, either by the escape of their acid, without alteration; or by losing a portion of sulphur, and becoming converted into sulphates. 3. They are converted into sulphates, by the contact of air, or of any substance capable of affording oxygen, and their weight is increased by this conversion. 4. They are decomposed by most acids, which expel the sulphureous acid with effervescence, and the production of a strong penetrating odour. 5. They burn rapidly and with flame, when heated with super-oxygenated muriate of pot-ash, and with salt-petre, and become sulphates. 6. Lastly, the sulphite of lime is not decomposed by the alkalies, like the sulphate.

Thenard and Vauquelin discovered that sulphite of soda and hydrosulphuret of the same base, would unite and form a complicated salt, a true hydrosulphuretted sulphite of soda.

CARBON.

Carbon, or the *Radical of Carbonic Acid*, has not, unless the *diamond* be admitted as such, been yet obtained in a separate state: charcoal, which was once so esteemed, appearing to be a compound substance. Nor is it ever found united with caloric, in a gaseous state, unaccompanied by some third principle. Its taste, smell, and colour is unknown. It is infusible and indissoluble by *caloric*, and is hence esteemed the most refractory substance in nature. It has no evident attraction for *nitrogen* alone, but combines with it by the intervention of other principles. With *hydrogen* it has a strong affinity, uniting and forming a gas termed carbonated hydrogen; *hydrogen gas* having the power of holding it in solution.

THE DIAMOND, which exceeds all other gems in hardness, density, and refraction of the rays of light, crystallizes in two tetrahedral and trihedral pyramids, united base to base, or in hexahedral prisms terminating in trihedral summits, or in irregular polyhedral grains. At a very high temperature it burns, becomes black and opaque, and is converted into gas. Sp. gr. about 3,5.

Newton conjectured the diamond to be a combustible body. *Guyton* in 1785 inferred its similarity to charcoal, from its leaving an effervescent alkali, after combustion in fused nitre. *Lavoisier* found that on burning it in closed vessels, it yielded carbonic acid. This has also been proved by Mr. *Tennant*, who performed the combustion in a crucible of gold. *Bertholet* considered it as *crystallized charcoal.*

Since this, *Guyton* having burnt the diamond in oxygen gas, by the solar rays, and thereby having obtained carbonic acid without residue, he presumed that he had ascertained the diamond to be *pure carbon*, or the *pure combustible matter of the carbonic genus*, yielding the *pure acidifiable basis of the carbonic acid.* He found its combustion required a much higher temperature than charcoal; but this he observes, takes place with other acidifiable bases, their first degrees of oxidation being difficultly produced, although their subsequent acidification is easy. It also required more oxygen for its complete combustion than charcoal; one part of diamond absorbing four of oxygen, and producing five of carbonic acid; this he remarks is not to be wondered at, since being pure carbon, it contains none of the oxygen principle, and therefore demands more. In proportion therefore as substances contain pure combustible matter, will, in fact, be the difficulty of their combustion, their first degrees of oxygenizement proceeding so slowly. Thus he accounts for Plumbago, or black lead, which is a carbonic combustible, richer in combustible matter than charcoal itself, not burning, but at a very high degree of temperature: and thus he accounts for the incombustibility of Anthracolite, Kilkenny coal, the brilliant charcoal of certain vegetables, &c. The diamond is therefore to be considered as pure carbon—plumbago, carbon oxygenized in the first degree;—charcoal, an oxide of the second degree, and carbonic acid, the result of the complete oxygenation of carbon.

M. *Guyton* having also heated some alumine and lime with diamond, the alumine, notwithstanding repeated edulcorations, still retained some sulphuric acid, hence sulphuret of lime was formed, and the diamond was encrusted with a black matter (carbon) formed at the expence of the diamond, which had lost above a third part of its weight.—*Ann. de Chem.* No. 93.

Charcoal is a black, sonorous, and brittle *Oxide of Carbon*, obtained from various substances in the animal, vegetable, and mineral kingdoms, generally by volatilizing their other constituent parts. When obtained in a state of purity, it resists the strongest heat in closed vessels. It decomposes sulphuric acid, from its affinity with oxygen exceeding that of sulphur. It decomposes nitric acid with great rapidity, and if the charcoal be first powdered, and the acid strong, and allowed to run down the side of the vessel, to mix with the charcoal, it burns with rapidity, with a beautiful flame, throwing up the powder so as to resemble a beautiful fire-work. With nitrate of pot-ash, it detonates in a hot crucible, leaving a fixed alkali behind. It is dissolved by the alkalies, and by the sulphurets of alkali, both in the dry and moist way. It does not unite with metals, but restores their oxides to a metallic state.

Charcoal possesses the power of absorbing several gases, which thus condensed retain their properties, and even exert them in some instances more powerfully.—*Rouppe, Ann. de Chem.* No. 93.

It decomposes water at the common temperature, carbonic acid and carbonated hydrogen being separated.—*Lampadius.*

If burnt in contact with common air, its acidifiable base attracts oxygen, and this peculiar acid is formed, which, with a certain portion of caloric, assumes a gaseous form.

If burnt in *oxygen gas*, its peculiar acid is plentifully formed, the charcoal burning with considerably increased rapidity, and if the lighter charcoal made from bark is used, a very brilliant effect is produced from the numerous vivid corruscating sparks.

Carbonic Acid Gas, formerly termed *fixed air*, or *aërial acid*, was discovered by Dr. *Black*; it is formed during the combustion of diamond, charcoal, and other carbonaceous matters, in contact with oxygen gas, or mixture of it with other gases, such as the common atmospheric air. Its composition appears to be 28 parts of carbon, and 72 of oxygen, with a certain portion of caloric. Pure charcoal being burnt in a vessel of oxygen gas, carbonic acid is directly formed, in a quantity precisely equal to that of the charcoal and oxygen employed. It is heavier than the air of the atmosphere, as is shown by pouring it into an open vessel, in the bottom of which a taper is burning, the taper being directly extinguished. The cubic inch weighs about 46 parts of a grain. It has a penetrating odour and sour taste, and will serve neither for respiration nor combustion. It is found in a gaseous and pure state in many subterraneous places. It is generated during the decomposition of animal and vegetable substances, particularly during the fermentative process, and is found in the air of the atmosphere in a very small proportion. No action takes place between the carbonic acid and *oxygen*, nor between it and *hydrogen*, *nitrogen*, *sulphur*, *phosphorus*, or the *hydrogen gas*, impregnated with these two latter combustible substances. Exposed to the air it is slowly dissolved by it, layer after layer. *Iron* appears to be capable of decomposing this acid when united to one base, as in the marble; but of the other metals, those only act on it which have the strongest attraction for oxygen, and then only when water is present, and suffers decomposition at the same time. It is condensed and liquified by water, which absorbs it most freely at two or three degrees above the freezing point, and especially if the gas be condensed by pressure, or much agitated with the water. This is *liquid carbonic acid*: it gives a peculiar pungent taste, and is manifestly acid. Heat or congelation again separates the gas from the water.

It exists in a concrete state, in combination with alkalies; and with the earths, particularly with the former; causing these substances to exist in a mild state, which always, when perfectly pure, manifest a considerable degree of causticity. It also renders them effervescent with acids, from its liberation in a gaseous state, in consequence of the new combination. It is frequently obtained in this way. It is also procured copiously by heat, from carbonate of ammonia, the gas being passed through water.

The superior degree of attraction of carbon for oxygen, renders this gas very difficult of decomposition, neither *phosphorus* nor *sulphur* has any direct action on it.

Mr. *Smithson Tennant*, however, by exposing carbonic acid gas to phosphorus, and calcareous earth, in a red heat, obtained a decomposition of the gas. The oxygen united with the phosphorus, and composed the phosphoric acid, which united with the calcareous earth, the carbon deposited resembling the charcoal yielded by vegetable matter.—*Phil. Trans.* 1791.

It is not known to have any chemical action on phosphorised, or sulphurated hydrogen; but it is frequently mixed with these gases, the inflammability of which it impairs.

Dr. *Pearson* made several experiments by which the carbonic acid was decompounded, and resolved into respirable air and charcoal.—*Phil. Trans.* 1793.

Professor *Göttling* informs us that, by heating over a charcoal fire, in a glass vessel, a mixture of phosphorus and carbonate of soda, or carbonate of pot-ash, the phosphorus will be kindled, and its greatest part consumed, and that the residuum is of an uniform black colour, the salts of which being dissolved in water, there remains an insoluble carbon, of a deep black colour.—*Göttling's Almanack.*

Carburetted Hydrogen, or *Hydrocarbonate Gas*, consists of *carbon*, united with or held in solution by *hydrogen*, with a small portion of oxygen, and converted into the gaseous state by *caloric*. It may be obtained by distillation from *wet wood*, or *moistened charcoal*. The purest of these gases are obtained from *camphor*, by passing its vapour through a red hot tube; from *ether*, by the same process; from *animal substances*, and from some *vegetables*, by destructive distillation; also from the *air of marshes*, when freed from its carbonic acid by washing. When pure, and freed from carbonic acid gas, they are lighter than common air in the proportion of 15,5 to 23,5, or 2 to 3 nearly: 2 parts by measure require no less than 3½ of pure oxygen to saturate them, the products being 2¼ parts carbonic acid, with some water. One of their most remarkable properties is, that when mixed with about two-thirds of their bulk of *pure oxygen*, and fired by the electric spark, instead of a diminution, there is considerable increase of volume, notwithstanding carbonic acid is at the same time produced. This increased gas is found to differ from the original carbonated hydrogen, requiring, bulk for bulk, only about one quarter of the quantity of oxygen to saturate it. But if the same carbonated hydrogen be exploded with about twice its bulk of the *oxy-muriatic acid gas*, we have a great diminution, much charcoal, and only a small proportion of carbonic acid gas; the remaining small quantity of gas, is inflammable, and appears to be the gaseous oxide. Thus with the same inflammable gas, equal quantities of oxygen under different circumstances, produce very different effects.—*Nicholson's Journal.*

Heavy carburetted Hydrogen is that which is obtained by the decomposition of alcohol by heated sulphuric acid. It burns with a blue lambent flame, and is insoluble in water. The cubic inch weighs 26 parts of a grain.

Light carburetted Hydrogen is obtained from the decomposition of the wood and charcoal; this also is the gas which remains after the combustion of heavy carbonated hydrogen with oxygen gas. The cubic inch weighs 15 parts of a grain.

The proportions of their respective constituent parts are not yet exactly known. That hydrogen, carbon, and oxygen enter into their composition is proved by their decomposition by heated sulphur, charcoal and sulphurated hydrogen being thus formed. The flame is bluer than that of the heavier. A small portion of wood will yield a vast quantity of this gas. It is this gas which produces the flame in ordinary wood fires, and which has been employed in France for a novel mode of illumination, in what has been called the *thermo-lamp*. Where pit coal is employed, bituminous oil contributes to the formation of the flame.

They are both found in nature, and are very favourable to vegetation, being probably absorbed without any alteration; and are perhaps caught up in their nascent state, whilst separating from different manures. They are both highly noxious to animals. The *coal damp* of coal mines is a mixture of light carbonated hydrogen with atmospheric air.

A very extraordinary property of this gas is that of its forming an oil on being mixed with oxy-muriatic gas, as may be seen under the article Ether.

Gaseous Oxide of Carbon. Dr. *Priestley*, whose numerous and valuable discoveries have so much enriched the science, but who still firmly opposes those doctrines which his experiments confirm, discovered that a peculiar inflammable gas was yielded by grey oxide, finery cinder, or forge scales of iron, and charcoal, and concluded, as no water was present, this production ought to be considered as confirming the phlogistic theory.

Mr. *Cruickshank* repeated the Doctor's experiments, and ascertained that this gas did not resemble, as the Doctor thought, the gas from moistened charcoal, or any of the carbonated hydrogen, being much heavier, and yielding a greater proportion of carbonic acid when combined with a given quantity of oxygen.

This gas, which he names the *gaseous oxide of carbon*, he therefore considers as *carbon*, united with or dissolved by *oxygen*, and deriving a gaseous form from *caloric*: the oxygen and carbon existing in it, nearly in the proportion of 2 to 1. A small additional quantity only of oxygen being required to convert it into carbonic acid, hence he concludes it holds the same relation to pure carbonated hydrogen and carbonic acid as the nitrous gas does to pure hydrogen and nitrous acid. He obtained it from mixtures of charcoal, in the driest possible state, with the metallic oxides, and particularly from the oxide of zinc, the metal being revived, having parted with its oxygen to form gaseous oxide and carbonic acid. He likewise obtained it by an analysis or a partial decomposition of the carbonic acid itself. This was performed by exposing to a high temperature a mixture of clear iron filings, or rather zinc, and chalk, from which a small portion of carbonic acid, but a much greater of gaseous oxide, was produced, part of the oxygen of the carbonic acid having quitted it for the metal which became oxidated, whilst in consequence of suboxidation, so much of the carbonic acid is converted into gaseous oxide. This change was accomplished not only whilst the carbonic acid was in its nascent state, but whilst it possessed its gaseous form. He also obtained the gaseous oxide without the aid of metals, their oxides, or even the carbonic acid, from a mixture of *oxygenated muriatic acid* gas with the pure *hydrocarbonates*. Here the oxygenated acid gives out its excess of acid to the carbon and hydrogen of the inflammable gas, from a superior affinity, in consequence of which we have four new compounds, viz. common muriatic acid, water, carbonic acid, and gaseous oxide of carbon. One part of inflammable gas being mixed with two of oxy-muriatic gas, both carbonic acid and gaseous oxide is produced, the excess of oxygen not being sufficient to convert the whole into carbonic acid: but if one of inflammable is mixed with four of the oxygenated muriatic gas, the whole is converted into carbonic acid and water, the excess of oxygen being sufficient for this purpose.

When mixed with common air or oxygen, and ignited, this gaseous oxide burns with a blue lambent flame, without any visible explosion, much carbonic acid with a little water being produced. When mixed with nitrous gas no diminution or sensible change is perceived, which proves that its oxygen is in a combined, and not in a disengaged state.

Gases obtained from charcoal, however well dried, mixed with metallic oxides, always yield a little water, when burned with common air or oxygen, which Mr. *Cruickshank* attributes to hydrogen contained in the charcoal itself.—*Nicholson's Journal, Apr. and Sept.* 1801.

Two parts of oxygen gas and one of gaseous oxide of carbon being inflamed by the electric spark, they unite and form carbonic acid gas.

Guyton and other French chemists suspect the above gas to be merely a carbonated hydrogen with an excess of carbon.

In illustration of the different states of composition in which the constituent principles of nitrogen enter into the formation of bodies, *Girtanner* observed, that charcoal, or the oxide of the diamond, is found in many bodies, and the diamond itself in none. We obtain, by our chemical decompositions, charcoal and not diamond. We know no diamantic acid, although well acquainted with carbonic acid. No chemist speaks of our exhaling diamond by respiration, but many of charcoal and carbon. The diamond itself is, perhaps, not a simple body, it still probably contains oxygen, for if I do not deceive myself, all transparent bodies contain it more or less—*Ann. de Chim.* 100.

When it is considered that the diamond and not charcoal is the real base of this acid, surely the language of Dr. *Pearson* is to be preferred, and DIAMOND being the *base*, PLUMBAGO, should be considered as an *oxidule of diamond*, CHARCOAL, as an *oxide of diamond*, and that which has been hitherto termed *carbonic acid*, should be termed the ACID OF DIAMOND.

A TABLE, shewing the Analysis, &c. of the different Species of CARBURETS of HYDROGEN, or HYDROCARBONATES, and of the GASEOUS OXIDE of CARBON. By Mr. CRUICKSHANK.

Gases, and the different Substances from which the Gases are obtained, &c.	Weight of 100 Cubic Inches, or Grains.	Proportion of Oxygen necessary to saturate 100 Measures of the Gas.		Products when combined with Oxygen.				Hence the Gases consist of			
				Carbonic Acid.		Water produced.	Water held in Solution by the Gas.	Oxygen.	Carbon.	Hydro.	Water.
	Grains.	Measures	Quan. of Grains.	In Vol. Meas.	In Quan. Grains.	Grains.	Grains.				
Pure Hydrocarbonate from Camphor, &c.	21	176	59,8	116	54,5	18	8 or 9	none	11	2+	8 or 9
—— from Ether	20	170	58	108	50,5	18	9	none	9	3	8
Hydrocarb. from Alcohol . . .	16	118	40	75	36	13	7	none	7	1,9	7
———— wet Charcoal	14,5	66	22,4	40	19	9	9	none	4	1,3	9
Gaseous Oxide from Charcoal and metallic Oxides	30	44	15	76	35,5	about 8	prob^y none	about 15	nearly 15	1+	uncertain
———— from Iron Filings, and Carbonate of Lime, or Barytes	30	40	13,6	92	43,2	none	none	21+	8,6	none	none.

Nicholson's Journal, April 1801.

CARBONATES are neutral salts, composed of the *carbonic acid*, and certain *bases*. Owing to the weakness of this acid, the characters of their bases are generally most predominant.

The carbonates are not acted on by *light*, *oxygen*, or *nitrogen*. Nor do they deliquesce with the moisture of the atmosphere. Although *charcoal* decomposes the phosphoric acid alone, the carbonates are decomposed by *phosphorus*; this difference arises from the attraction which the phosphoric acid exercises on the base of the carbonate; from similar causes the effects of different combustible bodies on them vary much. All the other acids having a greater attraction for the earthy and alkaline bases than the carbonic; that acid being disengaged from the carbonates by their addition. So feeble is this acid that it is separated from most of its bases by heat only.

CARBONATE OF BARYT, *Barolite, Kirw. Witherite, Werner.* This combination has no taste, is not altered in the air, is almost insoluble in water, and retains its acid even at a high temperature. It is found either in striated, compact, semitransparent, white, or greyish white masses, or in hexahedral crystals. Sp. gr. 4,3 to 4,33. 100 parts contain 0,80 pure baryt, 0,20 acid. Dissolved in water impregnated with carbonic acid, it is the most effectual test of the presence of sulphuric acid.

CARBONATE OF STRONTIAN, is found at *Strontian*, in Scotland, formed in small striated hexahedral prisms, of a light green, and not quite opaque. By heat it loses a part of its acid, melts into a green glass, and gives the flames of coals a purple hue. Sp. gr. 3,658. It contains acid 0,30, strontian 0,62, water 0,08.

CARBONATE OF LIME, also called *mild calcareous Earth*, exists in the form of *chalk*, *marble*, *lime-stone*, *calcareous spar*, *stalactite*, *&c.* It has not been crystallized by art, but is found variously crystallized in its native state, in different modifications of the obtuse rhomboid. It has then a laminated texture, separates into rhomboidal fragments, and yields a double refraction. It contains 0,55 lime, 0,34 acid, water 0,11. By intense heat, the acid is disengaged, and *pure lime* remains; this, by exposure to air, falls to pieces; but in time recovers its original hardness, by re-absorbing carbonic acid gas. It is decomposed by almost all the acids, by their superior degree of attraction for lime; when other calcareous salts are formed, the carbonic acid, escaping in a gaseous form, and occasioning effervescence.

Acidulous Carbonate of Lime is formed by the solution of this carbonate in water impregnated with carbonic acid.

Carbonate of Pot-Ash, formerly called *aërated Pot-ash*, or *aërated vegetable Alkali*, is made by exposing a solution of alkali to the carbonic acid gas until saturated, when it will yield tetrahedral prisms, terminating in dihedral truncated summits. It is also left after the distillation of ammonial gas from a mixture of carbonate of ammonia and the common carbonate of pot-ash, which is far from being saturated. Silica and alumine decompose this carbonate with effervescence.

It still changes the infusion of violets green. It does not attract moisture from the air, but rather parts with its water of crystallization. By exposure to heat, it loses its acid, is rendered pure alkali, and capable of uniting with silex and forming glass; it is decomposed by quick lime, and by all the acids. Four parts of cold water are required for its solution. 100 parts contain 23 acid, 70 alkali, and 5 water.—*Bergman.*

In consequence of the carbonic acid having a greater affinity with lime than with alkalies, the former being added to a solution of the latter, it seizes the carbonic acid, and the *pure alkali* is left.

Carbonate of Soda, formerly termed *aërated mineral Alkali* and *Natron*, when completely saturated with carbonic acid, yields crystals in the form of rhomboidal plates, or of rhomboidal octahedra, of an urinary taste. It is more easily decomposable by phosphorus, than the other carbonates; for in passing the volatilised phosphorus through the heated carbonate in powder, a phosphate of soda is formed, and a pure light charcoal deposited. It soon parts with its water of crystallization; contains in 100 parts, 16 acid, 20 alkali, and 64 water; and for solution requires two parts of cold, but only its own weight of hot water.

Carbonate of Magnesia, not fully saturated, or the magnesia of the shops, is not found in this combination, but is obtained by precipitation with the carbonates of alkali from the sulphate of magnesia. It is soluble in water, in the proportion of several grains to an ounce. It loses its water and acid by calcination, the residue being *pure magnesia*, sometimes called *calcined magnesia*. Cold water dissolves more than hot, it is therefore precipitated by heating the solution.

When fully saturated with carbonic acid, it becomes more soluble, and by slow evaporation, will crystallize in eight sided prisms, truncated at their ends.—*Gren.*

Magnesia, in powder, not saturated, contains magnesia 0,40, acid 0,48, water 0,12. In saturated crystals magnesia 0,25, acid 0,50, water 0,25.—*Tab. de Fourcroy*. 1800.

Carbonate of Ammonia, or *concrete volatile Alkali*, may be obtained from many animal substances. It may be formed, by passing the carbonic acid gas through a solution of ammonial gas; by exposing the ammonia in a vessel of the carbonic acid gas; or by distilling it from a mixture of ammonia and the carbonate of pot-ash, or carbonate of lime, or other neutral salts containing this acid. It dissolves in its own weight of cold water, and contains in 100 parts, 45 acid, 43 alkali, and 12 water. Its crystals are tetrahedral, or octahedral prisms, from having four angles truncated, with dihedral summits. It is very volatile in the fire, and changes in its composition, with every change of its temperature, giving out carbonic acid when heated, and absorbing it again as it cools: when passed through a tube heated red, it is decompounded into water, carbon, nitrogen, and carbonated hydrogen gas.

Carbonate of Glucine is a light, white, soft, and insipid powder, unchangeable in the air, soon loses its water and acid in the fire, and is insoluble in water even though aided by its proper acid.

Carbonate of Alumine has been said to have been found near *Halle*, in Magdebourg.

Saussure asserts, that alumine will not form with carbonic acid a concrete carbonate of alumine: the supposed artificial concrete carbonate of alumine being the result of the union of alumine with alkali and carbonic acid; and native clays did not appear to him in the state of carbonates. 1801.

Carbonate of Zirconia is insipid, and indissoluble in water. It contains 55,5 of zirconia, and 44,5 of acid and water.

Ammoniaco-magnesian Carbonate forms, when the two salts meet; it is crystallizable, and less soluble than the salts by which it is formed.—*Fourcroy Tableaux Synoptiques*, 1800.

PHOSPHORUS.

PHOSPHORUS was discovered by *Kunckell* in Germany, and by *Boyle* in England. It is a solid, inflammable, and hitherto undecompounded body, obtained chiefly from substances of the animal kingdom. When crystallized it is generally in an octahedral form. It is at first transparent and of a light yellow colour, but after some time keeping it becomes opake and white; but if kept in the sun, it becomes of a deeper yellow. Its specific gravity is to that of water as 2,033 to 1. It assumes a liquid form at 100° Fahr. and becomes aëriform at 554°. It burns with a blue feeble flame in atmospheric air, at even below 50°, and with an intensely vivid flame at 122°. In oxygen gas it burns with the most vivid flame that can be conceived, on the application of heat. Its most generally interesting property is, that of its being luminous in the dark.

Girtanner conjectures phosphorus to be hydrogen in the purest state.

It is soluble in oils, more especially in volatile oils, which then become luminous: every time the bottle is opened a phosphorus flash is seen. A phosphoric gas may be extracted from phosphorus, which takes fire by the mere contact of air. Thus the nitric acid being digested on phosphorus, a gas escapes, which takes fire in the receiver, affording the appearance of flashes of lightning striking through the cavity of the vessels.

It dissolves in *hydrogen*, and may be then united with *oxygen*. It separates the oxygen from the oxy-muriatic acid. Water suspends little atoms of phosphorus only. Atmospheric air dissolves it at the moment of burning, and becomes phosphorescent.

Fourcroy observes, that it undergoes no change in pure *oxygen*, unless heat is applied; and accounts for its combustion on the application of a portion of other gas to the oxygen from there being a necessity for the presence of this other gas to commence its fusion. *Nitrogen* gas dissolves it, and becomes luminous on the admission of a portion of oxygen. Its affinity with *carbon* is not ascertained. *Brugnatelli* observes, that it shines better in carbonic acid gas, to which a little oxygen is added, than in atmospheric air.

Phosphorus is not luminous in pure nitrogen gas, as was maintained by Prof. *Goëttling;* the presence of oxygen appearing to be necessary to produce this effect.—*Jacques, Heldibrand, Van Mons.*

Gren says, that phosphorus not shining in pure oxygen air, but requiring a little portion of nitrogen, is owing to the same reason that other substances, such as sulphur, require the medium of some other substances, to enable them to attract oxygen.

At about 100° of Fahrenheit, it takes fire with decrepitation, burns with a very bright flame, and emits a very abundant white fume, which is luminous in the dark. The residue of the combustion is a red caustic substance, which attracting the humidity of the air, is dissolved into a liquor.

Phosphorus surrounded by cotton rubbed in powdered rosin, and placed under a receiver, takes fire after exhaustion; and displays very beautiful phenomena, especially on the gradual admission of the air.—*Van Marum.*

A very thin slice of phosphorus being placed on an anvil with a few grains of nitrate of silver, and smartly struck with a hammer, a strong detonation is produced. The lapis infernalis and all the metallic nitrates being thus treated, violent detonations are produced. The experiment also succeeds with the common nitrate of pot-ash, but the hammer requires to be heated.—*Brugnatelli.*

The oxides of gold, silver, and mercury, by fire, occupy the first rank among fulminating substances. Two grains and a half of oxygenated muriate of ammonia, with four grains of phosphorus, being gently crushed on the anvil, will produce a most terrible detonation.

Phosphorus precipitates some metallic oxides from their solutions, in a metallic state, and the phosphoric acid is formed; the oxygen quitting the metal to unite with the phosphorus.

Phosphoric Acid may be obtained by the action of sulphuric acid on the phosphate of lime, or earth of bones, but it is obtained in a state of greater purity by the combination of oxygen with the phosphorus during combustion, at above 122°, and particularly if the combustion be carried on in the oxygen gas.

Light has no action on phosphoric acid. Being saturated it exercises no attraction for *oxygen*, neither does any action appear to take place between it and *nitrogen* or *hydrogen*, *sulphur* or the *metals*. It combines, however, with the *metallic oxides*, and is decomposed by *charcoal* at a red heat, carbonic acid being formed by the union of charcoal with its oxygen.

Phosphorous Acid is produced by the slow combustion of phosphorus at the common temperatures. It is fluid and inodorous. The water in which phosphorus is kept, contracts acidity in time, the water yielding oxygen to the phosphorus.

Sulphuret of Phosphorus may be formed in different proportions by fusing sulphur and phosphorus together, but this should be done with a moderate degree of heat and under water, lest an explosion take place from the too rapid evolution of phosphorated hydrogen. It is more fusible than sulphur, and so combustible as to inflame in the atmosphere by mere friction. It inflames with great rapidity in oxygen gas, and spontaneously in muriatic acid gas, even when containing about a sixth part only of phosphorus. It is employed, for forming phosphoric matches and tapers, which inflame merely by friction.

Phosphuret of Lime is formed by putting some fragments of phosphorus at the bottom of a glass tube, over which five times its weight of lime may be added. The part of the tube containing the lime is to be first heated, and then that in which the phosphorus is placed. This being sublimed will directly unite with the heated lime, and form a solid brown mass, which on the addition of water gives out phosphorated hydrogen gas. If the phosphorus be diffused through a larger portion of lime it affords a powder which burns with a phosphoric light on being dispersed in a warm air. It enters into similar but weaker combinations with *baryt* and *strontian*.

Phosphuretted Hydrogen, or *Phosphorised Hydrogen Gas*, discovered by *Gingembre*, is obtained from the decomposition of water by heating caustic alkalies, or quick lime, with phosphorus and a very small quantity of water.

This gas may also be obtained by the action of water upon phosphuret of lime, a substance formed by diffusing phosphorus in vapour through ignited lime.—*Mr. Davy's Syllabus.*

Mr. *Davy* obtained this gas still more readily by putting into a wine glass a piece of phosphorus, some filings of zinc and water, and adding to them sulphuric acid, when the hydrogen uniting at the moment of its formation with the phosphorus, this gas is produced.—*Mr. Davy's Lectures.*

This gas detonates and burns with a brilliant flame on the access of atmospheric air, occasioning, when the air is calm, an undulating and increasing ring of smoke. It burns with vast splendour in oxygen gas, with which also it suddenly unites, the two gases seeming mutually to penetrate each other, and are totally converted into water and phosphoric acid.

On being mixed with oxygenated muriatic gas a loud explosion and a brilliant flash is produced, water and phosphoric acid being formed. Oxygenated muriate of pot-ash and phosphuret of lime being put into a glass of water, and sulphuric acid added, the phosphoret is seen to burn under the water.

This gas is decomposable by the electric spark, and is soluble in four times its weight of water.

PHOSPHATES, the result of the union of phosphoric acid with certain bases, are generally crystallizable, slightly pungent, and of considerable gravity. They are unchanged by *light*, by *oxygen*, or by *nitrogen*, and even by *heated hydrogen* and *charcoal*, which are capable of decomposing the phosphoric acid itself. The alkaline and earthy phosphates are the following.

PHOSPHATE OF BARYT is tasteless and insoluble, and convertible by fire into a glass. It is obtained in a pulverulent state.

PHOSPHATE OF STRONTIA is soluble, when the acid is in excess, and forms tabular crystals. In fire it fuses into a mass like porcelain, shining with a phosphoric light.

PHOSPHATE OF LIME is white, friable, insipid, opake, and insoluble in water. It exists in the bones, the urine, and in several other parts of animals. It is formed by phosphoric acid 41 parts, and lime 59 parts.

PURE PHOSPHATE OF LIME is best obtained by dissolving calcined bone in muriatic acid, and precipitating by ammonia, in its state of greatest causticity.—*Chenevix.*

PHOSPHATED LIME, *apatite* or *phosphorite*, has been found in an amorphous state in Hungary, and forming entire mountains in Spain. It is also found in truncated hexhedral, longitudinally striated prisms, laminated in their transverse fracture, and generally with tin and fluor. *Klaproth* found it to contain acid 45, lime 55. The *chrysolite* is also considered as a saline combination of this species. Its composition is 54 of phosphoric acid, and 46 of lime.

Acid phosphate of Lime is formed either by taking away a part of the base by sulphuric, nitric, or muriatic acid, or by superadding phosphoric acid to the last described phosphate.

Phosphate of Pot-ash forms a very soluble salt, in a gelatinous form. It swells on hot coals, is rather difficult of fusion, and forms a transparent vitreous mass.

Phosphate of Soda forms in rhomboidal crystals which effloresce in the air. Its crystallization is improved by its holding an excess of soda. This like the former phosphate melts into a glass when ignited. It has been introduced into medicine by Dr. *Pearson*, as a useful and almost tasteless cathartic. It enters into a state of vitrification with the metallic oxides, and with most of the earths.

Phosphate of Ammonia forms in tetrahedral crystals, easily soluble in water. It readily fuses into a transparent glass, when it parts with its ammonia.

Phosphate of Ammonia and Soda exists in human urine. The ammonia is by degrees dissipated, and leaves an acid phosphate of soda. Its composition is phosphoric acid 32 parts, soda 24, ammonia 19, water 25.

Phosphate of Magnesia is difficult of solution, but becomes more easily soluble, crystallizable, and fusible, the more it contains of phosphoric acid.

Phosphate of Ammonia and Magnesia has been found in the intestinal concretions of horses, and in the urinary concretions of the human race. It forms in spathose semitransparent lamellæ.

Phosphate of Glucine forms in a white powder, or a mucilaginous mass. It is tasteless; it is not decomposable, but is fusible by heat.

Phosphate of Alumine forms in thin flattened needle-like crystals, obliquely truncated at both ends. It deliquesces in the air, and, in a melting heat, fuses into a glass.

Phosphate of Silica is that vitreous combination of this acid and earth, which, being so very transparent, hard, dense, indissoluble, and fusible, is so often employed in the formation of artificial gems. It is indecomposable by the acids, and even the alkalies with intense heat combine with it without altering it.

Phosphites, or combinations of phosphorous acid with various bases, are never found native. They differ from the phosphates in yielding a fœtid alliaceous odour. They are decomposable by all the *acids*, whilst the phosphates yield only to the strongest. But like these, they are not decompounded by *combustible bodies*. They are fusible, and when fused yield a portion of phosphorus, and become phosphate.

Phosphite of Ammonia appears to be the only one requiring to be particularized.

It is obtained by uniting the phosphorous acid with ammonia or carbonate of ammonia, and evaporating the solution slowly.

By distillation it is decomposed, part of the ammonia comes over in a liquid form, and another part in the form of gas, and holding phosphorus in solution, which does not inflame instantaneously, but gives a phosphoric light in contact with oxygen gas, the vitreous phosphoric acid remaining in the retort.

If this phosphite be melted with the blow pipe on charcoal, it emits a bright phosphoric light, vitrifies, and darts forth bubbles of gas, which inflame in the air with a bright flame, and form a white ring of vapour of phosphoric acid ; vitreous phosphoric acid remaining on the charcoal.

If this salt be heated in a glass, the tube of which is plunged under mercury, bubbles of phosphuret of hydrogen are yielded, which spontaneously inflame in the air, and give the white circular coronet which characterizes the inflammation of this gas, and which in this case is formed of phosphate of ammonia. The ammonia, the phosphorus, and the water of the phosphite, are raised in vapour, and the water is decomposed, its oxygen uniting with a part of the other two principles, and its hydrogen with another part. The latter combination is that on which these phenomena depend.

MURIATIC ACID.

Muriatic Acid, formerly termed *Marine Acid*, or *Acid of Sea Salt*, &c. has never been yet decomposed, and is conjectured, from analogy, to consist of *oxygen*, in combination with a peculiar, but hitherto *unknown basis**, which has the strongest degree of attraction for the acidifying principle. It is obtained by distillation from a mixture of muriate of soda, or of muriate of ammonia, with half its weight of sulphuric acid.

Muriatic Acid Gas is a permanent gas, at all known temperatures; it has a strong smell, and is pungent to the taste, without being caustic. It is heavier than common air, and extinguishes flame; first enlarging it, by a greenish or bluish circumambient flame. It suffocates animals by its strong action on the glottis, and inflames the skin, without corroding or discolouring it. It is unchangeable by light, caloric, or combustible bodies. It acts on metals only by the water it has attracted, and unless it obtains an union with water, it does not displace the carbonic and other weaker acids. It forms a white cloud with the water contained in the atmosphere, uniting with water with great rapidity and heat, and forming the liquid muriatic acid.

On being mixed with ammoniacal gas, muriate of ammonia in the form of white vapours is directly formed.

Liquid muriatic Acid, when pure, is colourless; and when fully charged with gas, its weight to that of water is as 1200 is to 1000. It has a peculiar suffocating smell, and copiously emits vapours, which are rendered more visible by their mixture with the moisture of the atmosphere. It takes part of its oxygen from nitric acid. It does not act on combustible bodies, nor on oxygen

* *Girtanner* supposed this radical to be *hydrogen*; *Berthollet* thinks the muriatic acid is a triple compound of *oxygen*, of *hydrogen* in small quantity, and *nitrogen* in a greater proportion; and *Armet* thought it to be the metal *zinc*.

Mr. *W. Lambe* supposes that *sulphuretted hydrogen* is the base of muriatic acid, he having obtained oxy-muriatic gas by dropping sulphuric acid on the residuum left, after evaporating water impregnated with hepatic gas, in which iron and manganese had been digested.—*Manchester Mem.* vol. v.

gas, but readily seizes the oxygen of oxided bodies. It absorbs the carbonic acid, and its affinities with baryt, pot-ash, soda, strontia, lime, ammonia, magnesia, and alumine, appear to be in the order they are here placed.

Oxygenized muriatic Acid Gas, discovered by *Scheele*, is formed by the addition of *oxygen* to the *muriatic acid*, with which it readily unites when in a nascent state. It is therefore readily obtained by distillation of the muriatic acid from substances containing much oxygen; such are the oxides of metals, particularly the native oxide of manganese. It is much heavier than atmospheric air. Its vapour irritate the larynx violently, and produce a defluxion from the nostrils, &c. It destroys the colour of most substances.

It retains its gaseous form at common temperatures, but is condensable by cold and absorbable by water, 1 part of water absorbing 5 of gas.

It is so little affected by heat as to pass through a red hot tube unchanged. It has no action on *nitrogen* or *oxygen gas*, nor on *hydrogen* in the cold. It inflames *phosphorus* and *phosphuretted hydrogen* gas, and pure *hydrogen* also, at a red heat. It inflames melted *sulphur*, and forms *sulphuric* acid. It acts not at all on *carbon*. If mixed with an equal quantity of *carburetted hydrogen* gas only, the latter burns on the application of a taper. From a mixture in a certain proportion, a real oil is produced.

It burns all, and inflames several of the metallic substances, on their being thrown into it in fine filings.

Phosphorus, charcoal, sulphur, camphor, alcohol, ether, and other inflammable bodies, burn in it, and yield phenomena different from those proceeding from their combustion in common air. Camphor burns with a vivid light, but a large portion of dense black smoke is evolved.

It displaces the carbonic acid from its combinations, and is itself displaced from water to which it has been united, by the simple muriatic acid gas.

The agencies of this acid appear to resemble those of the atmosphere except in degree; it effecting that with rapidity which the air does slowly.

Liquid oxygenized muriatic Acid is formed by the absorption of this gas by water, which is much assisted by pressure.

Its colour is a yellowish green, its taste corrosively pungent, and its smell exceedingly strong and disagreeable; its vapours irritating the larynx violently and producing a flow of thickened mucus from the neighbouring glands. It renders vegetable blues colourless, separating and combining with the colouring matter, and in the same manner destroys the colours of most substances. It rapidly oxidizes metals, and thickens oils. When about the freezing point, it crystallizes in quadrangular spiculæ.

Exposed to the light, oxygen gas is separated, and ordinary muriatic acid is left; as its loss of oxygen is in a direct *ratio* of the quantity of light, the oxy-muriatic acid has been proposed as a *PHOTOMETER.*

It seems to differ from the common muriatic acid, on the same principle as the nitric and sulphuric acids differ from the nitrous and sulphureous; the simple or the oxygenized muriatic acid appearing to be formed, according to the greater or less quantity of oxygen, united to the pure radical. Dr. *Gren*, therefore, proposes the substitution of the terms *muriatous* for *muriatic*, and *muriatic* for *oxygenated muriatic*; by analogy from *sulphureous* and *sulphuric*, *nitrous* and *nitric*, *&c.* Supposing the ordinary *muriatic acid* to be an *imperfect acid*, and the *oxy-muriatic* to be a *perfect acid*, but not a super-saturation with oxygen.

Mr. *Chevenix* proposes to substitute *muriatic radical*, or some single word of similar import, instead of *muriatic acid; muriatous acid* for *oxygenized muriatic acid*; and *muriatic acid* for *hyperoxygenized muriatic acid.—Philos. Trans.* 1802.

It is much less powerful in the liquid than in its gaseous state, not even displacing the carbonic acid. Whether in the gaseous or liquid form the oxygen appears to be but weakly retained.

When it is mixed with ammonia, decomposition, with great effervescence, takes place; no neutral salt is formed; but the hydrogen of the ammonia, combining with the superabundant oxygen of the acid, forms water; the nitrogen escapes in the form of gas, and common muriatic acid is left. If the acid and the ammonia are mixed in the state of gas, considerable detonation and even inflammation succeed.

Phosphorus immediately unites with its oxygen, and forms phosphoric acid.

It removes the stain of common ink, though it does not affect printer's ink. It is therefore recommended for cleaning old books and prints. Half an ounce of minium being added to three ounces of common muriatic acid, will render it fit for this purpose.—*Fabroni Giornale Litt. di Napoli.*

Guitand discovered that *sulphuret of ammonia* and *prussiate of pot-ash* revives writing effaced by this acid. 1800.

It also powerfully bleaches linen, cotton cloths, and paper. It is supposed to destroy certain infectious matters.

MURIATES are neutral salts, formed by the *muriatic acid* and certain *bases*. *Light* does not act sensibly on them, nor does *oxygen* or *nitrogen*. With heat they decrepitate, melt, and sublime; but very rarely suffer the separation of their acid: and a distinguishing characteristic of these salts is, that they are not acted on by *combustible bodies* at any temperature.

Muriate of Baryt does not seem to exist native. When obtained artificially, it forms generally in tabular octagonal crystals, which do not suffer any change in the air, and but little in the fire, and have a nauseous and burning taste. The sulphuric and nitric acids decompose it very readily; hence this salt is highly useful to detect the presence of these acids in any mixture; one drop of its solution producing an evident precipitate from water holding only 0,0002 of sulphuric acid. This salt produces the same effect on the flame of alcohol as the nitrate of baryt does, giving it a yellowish white hue. 100 parts contain 60 of baryt, 24 of acid, and 16 of water.

Muriate of Pot-ash, the *febrifuge Salt of Silvius*. It contains in 100 grains, 29,68 acid, 63,47 alkali, and 6,85 water. It is found in sea water, in old plaster, and in vegetable and animal fluids. It crystallizes in cubes, or rectangular parallelipepids, which have a strong, bitter, disagreeable taste.

Muriate of Soda, *Marine Salt, Common Salt, Rock Salt, Bay Salt,* or *Sal Gem*, contain in 100 grains 43 acid, 46 alkali, and 11 water. It is found native, in mines, in many places, but particularly in Poland and Hungary. These mines appearing, from the shells, madrepores, &c. which are found in them, to have been formed by the drying up of vast lakes. It is also obtained by extracting it from sea water, by evaporation, putrefaction, &c. It is not decomposed by silica, and but slightly by clay. It however occasions clay to fuse readily, and is thus employed in glazing *pottery:* it assists the fusion of *glass* also. It has a penetrating pleasant taste, decrepitates on hot coals, and by great heat, is volatilized without decomposition. It crystallizes in cubes, and in hollow tetrahedral pyramids, soluble in 2,5 their weight of cold water.

It is very slightly deliquescent; the deliquescence of common salt depending on that of the earthy muriates it contains.

The soda is advantageously obtained from it by the addition of nitric acid, and the oxides of lead. The soda is also separable by baryt, pot-ash, and particularly by the vegetable acid combined with lead; the muriatic acid uniting with the lead, and forming a muriate, whilst the soda combines with the vegetable acid, from which it may be afterwards freed by evaporation and calcination.

Proust has discovered mercury in the *muriatic acid*, in the state of corrosive sublimate, arising from mercury which is naturally contained in sea salt.—*Journal de Physique*.

MURIATE OF STRONTIA forms small hexahedral prisms. It gives to the flame of alcohol a bright red colour. Its composition is strontia 36,4, acid 23,6, water 40.

MURIATE OF LIME, *Calcareous Marine Salt*, or *Glauber's fixed Sal Ammonia*, is found in mineral waters, but particularly in the waters of the sea, to which it contributes to give their bitter taste. It constitutes the residue of the distillation of 3 parts of lime, 1 of water, and 1 of muriate of ammonia. It speedily deliquesces, and therefore crystallizes with difficulty, in hexahedral prisms, with hexahedral summits. 100 parts of lime take up 86 of real marine acid. It fuses with a moderate heat, loses a large portion of its acid, and becomes the *Phosphorus of Homberg*, which gives light when struck upon or scratched. A very strong solution, being mixed with the concentrated sulphuric acid, a solid precipitate is formed, and the acid disengaged in vapours; the two liquids appearing to be instantly transformed into a solid. An inspissated solution being agitated concretes into a solid mass, giving out a considerable portion of caloric. The salt produces the lowest degree of cold on mixture with snow of any saline substance. Like the nitrate of lime, this salt renders the flame of alcohol red.

MURIATE OF AMMONIA, or *Sal Ammonia*, is found native in many parts, particularly in the neighbourhood of volcanos. It is obtained artificially, by distillation from the soot formed by the combustion of the excrements of animals which feed on saline plants. 100 parts contain 52 acid, 40 ammonia, and 8 water. It crystallizes in quadrangular prisms, or in rhombic or octahedral crystals; of a sharp, acid, urinous taste, showing a slight degree of ductility under the hammer. It dissolves in three parts and a half of water, at 60°. It is not decomposed by clay, nor entirely by magnesia: but is completely decomposed by lime, and fixed alkalies, the ammonia being disengaged in the state of gas, leaving a muriate of lime or of alkali. If the lime or fixed alkali is pure, *caustic or pure ammonia* is obtained, but if the carbonate of lime or of alkali be employed, then a *carbonate of ammonia* is the result of the process.

Muriate of Magnesia exists in the mother water of salt works, in springs, and in the waters of the sea. It forms acicular, but deliquescent crystals, of an acrid and bitter taste. 100 parts contain 34 of acid, 41 of magnesia, 25 of water. This muriate suffers decomposition by heat.

Muriate of Ammonia and Magnesia forms very readily in polyhedral crystals, whose figure is not yet ascertained. It is decomposable by heat. Its composition is muriate of magnesia 73, muriate of ammonia 27.

Muriate of Glucine forms in sweet and very small crystals. It is decomposed by heat and by the sulphuric and nitric acid.

Muriate of Alumine crystallizes with difficulty, leaving generally, after evaporation, a saline astringent mass, of a gummy consistence.

Muriate of Zircon forms in indeterminate acicular crystals, deliquescent, easily decomposed by fire, and possessing a sharp, austere taste.

Muriate of Silica is obtained by the action of this acid on the silica in a state of division with alkali. It may, by slow evaporation, be rendered a transparent jelly, but by boiling the earth is precipitated.

Muriate of Yttria resembles, in its properties, the nitrate of this earth.

The Hyper-oxygenized Muriates are formed by the union of the oxygenated muriatic acid with the alkaline and earthy bases. This combination only takes place when the acid is employed in its gaseous form; its union with water lessening its attraction to the base. The base, it must be observed, does not partake of the acid uniformly; but one portion becomes saturated with the acid in a simple state, whilst another portion becomes united not merely with the oxygenized acid but with that portion of oxygen which has quitted that part of the acid which forms the simple muriate, and which hyper-oxygenizes this portion of the acid, and consequently the muriate it forms.

They scintillate, with noise, by simple trituration. They are decomposed by a low red heat, and give out oxygen as they become simple muriates, never retaining that proportion of oxygen which would constitute oxygenized muriates. They inflame all combustible bodies with violence, and if acted on, in contact with them, by trituration or percussion, decrepitation or detonation, with deflagration is produced. They are soluble in water, and some of them in alcohol. The acid is expelled, without heat, with particular phenomena, by the sulphuric, nitric, and muriatic acids; and a little below boiling heat by phosphoric, arsenic, oxalic, tartareous, and citric acids, the three latter producing the evolutions of a gas of a peculiar nature, not yet examined. The stronger acids disengage the acid, with a flash of light, more frequently from the earthy than from the saline hyper-oxygenized muriates. All the hyper-oxygenized muriates are, indeed, decomposed by the acids, and often with violent decrepitation, disengagement of a yellowish green vapour, and a powerful smell. This vapour, according to *Berthollet*, is hyper-oxygenized muriatic acid. It is heavy, and falls in greenish drops, forming streams like oil.—*Mr. Chevenix.*

Hyper-oxygenized muriate of Pot-ash is formed by introducing the oxygenized muriatic gas into a solution of pot-ash; the common muriate being formed at the same time. But as the hyper-oxygenized muriate is less soluble than the other, and its crystals form speedily, they are therefore easily separated. Its crystals are flat hexahedral prisms, obliquely truncated at their ends, and of a silvery hue. They give a faint taste, with a sensation of coldness in the mouth, and crackle and sparkle on being rubbed.

If concentrated sulphuric acid be poured on this salt, and the slightest heat be applied, a violent explosion and sometimes a flash takes place, and a thick heavy vapour of a greenish yellow colour is disengaged, smelling something like nitrous gas, but more fœtid. At the bottom of the vapour may be seen a bright orange coloured liquor, the hyperoxygenized acid, but impure, though as pure as it has yet been obtained. If the acid be diluted, the heat may be applied with more safety. It is also decomposed by the other stronger acids. If different combustible bodies and hyper-oxygenized muriate be thrown into the sulphuric or other strong acids, various phenomena with detonation and flame succeed.

It appears to contain more oxygen than an equal weight of oxygenated muriatic acid in water: hence the acid, combined in the muriate, is supposed to be super-oxygenated.

Heat and light separate its oxygen from it, in the form of oxygen gas, 100 grains yielding 75 cubic inches of oxygen gas.

On being brought into contact with inflamed bodies it detonates with more violence than nitre. When mixed with a third part of sulphur it explodes, by mere trituration; and sometimes spontaneously. If the mixture be rubbed hard, reports as loud as those of a pistol are made, with flashes of light. If the mixture be struck with a hammer on an anvil, a very loud explosion ensues. These effects, but in a less degree, may be produced if charcoal be employed instead of sulphur; but if three parts of the hyper-oxygenized muriate be rubbed with a sixth of sulphur and as much charcoal the detonations are more violent, and the light more vivid. This salt being rubbed with an equal quantity of phosphorus, a violent explosion follows with a flash of light; with pit-coal, sparks, and some small reports are produced; and with sulphuret of pot-ash, and of the metals, the same effects follow, but in a higher degree. Detonations in various degrees are occasioned by its being rubbed with loaf sugar, oils, camphor, rosin, gum-arabic, indigo, &c. Most of the metals being mixed with it will detonate in the same manner.

If any of the preceding mixtures are dropt into concentrated sulphuric acid, a most vivid flame is produced, with detonation. The muriate alone being thrown into concentrated sulphuric acid, a violent detonation with a red flame ensues, and a brown vapour, smelling of the oxygenized acid, is separated, which sometimes will explode on the application of flame with more violence than the original mixture. If a small piece of phosphorus be added with the muriate to the sulphuric acid the explosion takes place still more rapidly: heat also increases these effects to a very high degree.

Phosphorus may, by means of this salt, be made even to burn under water, it being introduced in its divided state into water, in which hyper-oxygenized muriate of pot-ash has first been put; sulphuric acid being then added, the hyperoxygenized muriatic acid is separated, and acting in its nascent state on the phosphorus, immediately inflames it. In this manner also may the inflammation and detonation of different combustible bodies be produced.

A grain or two of phosphorus being dropped in a solution of the oxygenized muriate in nitric acid, a great number of vivid flashes appear in the liquor.

Being employed in the fabrication of gun-powder instead of nitre, the effects produced by its ignition are augmented to a four-fold degree; but as the mixture will explode by mere trituration, it cannot be safely employed.

The hyper-oxygenized muriate of pot-ash increases the blackness of ink, used in the proportion of 1 to 5 of the sulphates contained in the ink. The colours of logwood, weld, cochinelle, and archil, are improved by it, if no heat be employed. Being blended with soap, the soap is improved in its qualities.—*A. J. Forsyth, Nicholson's Journal, July* 1799.

Hyper-oxygenized muriate of Soda differs from that of pot-ash, in being more disposed to effervescence, and to solution in alcohol.

Of the other hyperoxygenized muriates there is but little remarkable. *Van Mons* says, he formed the Hyperoxygenized muriate of Ammonia; but *Gren* asserts that such a combination cannot exist, he arguing from the property which oxygenized muriatic acid possesses of decomposing ammonia; but Mr. *Chevenix* observes that the affinity of the hyperoxygenized acid may favour the quiescent affinities, and he says, that if carbonate of ammonia be poured into any earthy salt of this genus, a double decomposition takes place, and hyperoxygenized muriate of ammonia is formed. Mr. *Chevenix* has never perceived that any portion of *silica* has been dissolved by this acid.

Nitro-muriatic Acid, or *Aqua Regia*, is formed by the mixture of the *nitric* and *muriatic* acids, in the proportion of two parts of the former, and one of the latter. Four ounces of sal ammonia dissolved gradually, in the cold, in one pound of nitric acid, forms an *aqua regia*. The muriatic acid, in these processes, attaches to itself a portion of the oxygen from the nitric acid, and thus oxygenised escapes in a yellow fume; whilst the nitrous gas, which belonged to the nitric acid, thus deprived of its oxygen, is absorbed by the unaltered portion of nitric acid, which it discolours and changes to nitrous, thus forming a mixture of muriatic and of nitrous acid.

The nitro-muriatic is of a yellow colour, and its specific gravity is less than that of either of the acids employed. It readily dissolves gold, which is not done by either of the acids of which it is composed. It is employed by the dyers for the solution of tin, which nitric acid corrodes, and oxidizes without dissolving.

Mr. *Chevenix* has ascertained that muriatic acid does exist in the form of oxygenised and hyperoxygenised muriatic acid, and that in either state it is capable of entering into saline combination. The muriatic acid, he observes, has acid properties of the strongest kind, and is therefore supposed, though perhaps too hastily, to contain oxygen; since for all that we know it is a simple body. The oxygenised acid, he finds, is composed of 84 parts of muriatic acid and 16 of oxygen: the hyperoxygenised acid, of muriatic acid 35 parts, and of oxygen 65; and the hyperoxygenised muriate of pot-ash, of oxygen 38,3, and muriatic acid 20, forming hyperoxygenised acid 58, 3, with pot-ash 39,2, and water 2,5. In the formation of the hyperoxygenised muriates, he supposes that the acid combines with the alkalies in the state of oxygenised muriatic acid; and that the separation into muriate and hyperoxygenized muriate, is produced by a subsequent action among the elements of oxygenised muriate of pot-ash, which genus of salts he thinks does really exist previous to the formation of the hyperoxygenised muriate.—*Philos. Trans.* 1802.

ACID OF BORAX.

Acid of Borax is an undecompounded acid, formerly called *Homberg's Sedative Salt.* It has been found naturally formed in several parts, but it is generally found in combination with soda, forming *borax*, from which it is obtained by sublimation, or crystallization. The nitric and muriatic acids may be employed for this purpose; but half its weight of sulphuric acid poured on borax, yields the acid by sublimation, in a beautiful state. It is also obtained by crystallization, by adding sulphuric acid to a solution of borax in hot water. The acid is deposited on the sides of the vessel, of a white, scaly, glittering appearance, as the mixture cools: it is also separated by the vegetable acids. The process by sublimation should be adopted only for the indissoluble borates; and the other, by which the acid is obtained most pure, should be employed for the more soluble.

It yields a saline cool taste, and reddens the blue vegetable infusions. It requires one pound of boiling water for the dissolution of 183 grains, but is dissolved more easily in alcohol; the solution being of a beautiful green, and burning with a green flame. Exposed to the fire, it becomes a vitriform and transparent substance, if dry; but if moist, it sublimes, being mechanically raised up with the aqueous vapours. But its fixity in fire greatly distinguishes it from the other mineral acids.

This acid is considered by *Fabroni* as merely a modification of the muriatic acid, but this is by no means certain; its acidifiable base has, however, not yet been separated. It is not acted on by *light*, *oxygen*, nor *nitrogen*; nor by *hydrogen*, *carbon*, nor the other *combustible bodies*. It is among the weakest acids, and acts least powerfully on the *metals* and their oxides.

Borates are combinations of boracic acid with various bases. The earthy and alkaline borates have in general an acrid taste, and are unchanged by oxygen, nitrogen, or by combustible bodies. They combine with and form coloured glasses with the metallic oxides. The carbonic acid is the only acid which manifests no action on them, and although so weak an acid, yet from its fixity it will remain attached to its bases whilst the stronger acids are driven off by a high temperature.

BORATE OF SODA, or *Borax*, is formed by the combination of *acid of borax* and *soda*. The borax of commerce is a borate super-saturated with soda. It is found in a crystallized state, at the bottom of certain salt lakes, in a barren, volcanic district of the kingdom of Thibet, invested in a greasy covering, and is called *brute borax*, *tincall*, or *chrysocolla*. It is also found in a purer state in the mines of Riquintipa, and of Escapa. A still purer kind comes from China. It is best purified by long boiling; the crystals this affords, being again purified by a second filtration and crystallization. When purified, it is white and transparent, with somewhat of a greasy fracture. It has a pleasant acid taste, renders the blue vegetable infusions green, and forms in hexahedral prismatic crystals, two sides of which exceed the others in breadth, terminated by three sided summits. It requires twelve times its weight of cold water to dissolve it; but is dissolved in six times its weight of boiling water. On rubbing two pieces together a phosphoric light is produced. Exposed to a moderate heat, it melts with its water of crystallization, and is reduced into a white opake light mass, when it is commonly called *calcined borax*. In a more violent heat it is fused into a transparent greenish yellow glass, soluble in water, and efflorescing in the air. Baryt, magnesia, and lime, decompose borax. It serves as a flux to vitrifiable earths; it also vitrifies clay, but less completely. It is employed in forming reducing fluxes. It unites with the metals, and forms with them coloured glasses. It may also be used in re-producing the fusion of glass; and in soldering metals it is highly useful, cleansing the surface of the metal, and assisting the fusion of the solder.

BORATE OF POT-ASH, formed by the combination of the *acid of borax* with *pot-ash*, is obtained either by adding pot-ash to a solution of borate of soda, or by directly combining the acid with the pot-ash. It crystallizes in parallelopepidons.

BORATE OF AMMONIA forms in small rhomboidal crystals, easily decomposed by fire.

BORATE OF MAGNESIA is of very difficult solution in water. It yields crystalline grains by evaporation, and is decomposed by lime.

Borate of Alumine is not very soluble, and melts in the fire into a glass. Lime, magnesia, and the alkalies decompose it.

Borate of Lime, or *Boracite*, has been found in the *gypsum of Luneburg*, in crystals whose form appears to be a cube truncated all round on its corners and edges. It is insoluble in water, cuts glass, and strikes fire with steel.

Borate of Baryt, and of Strontia, have not yet been sufficiently examined.

With Silex in the dry way borax forms a vitreous substance by fusion: but does not unite with it in the humid way.

FLUORIC ACID.

Fluoric Acid, discovered by *Scheele*, is derived from the spar, formed by this *acid*, and *calcareous earth*, and which, from its property of accelerating the fusion of other stones, is termed fluor spar. It is thus obtained: the stone is distilled in a leaden retort, with its own weight of sulphuric acid, when a permanent gas, termed fluoric acid gas, is detached, which forms the fluoric acid, on coming in contact with water; the sulphuric acid, at the same time, forming gypsum, by combining with the calcareous earth. Being distilled in glass, it seizes the siliceous earth of the glass, and volatilizing it with itself, renders it aëriform, changing the solid substance of flint to an invisible gas, and then deposits it as a siliceous crust on the surface of the water in the receiver. If it be received under water, the upper hemisphere of the bubble becomes a siliceous crust, and thus rises to the surface. In smell and taste it resembles the muriatic acid. It is heavier than air; it extinguishes flame, and kills animals.

It does not act on *metals*, but combines with their oxides. No action takes place between it and *oxygen*, nor with *hydrogen*, *carbon*, *phosphorus*, *sulphur*, or other *combustible bodies*. With *water* it unites eagerly, and aided by its oxidizing power, it acts on the metals, which would resist its direct action.

From its power of dissolving siliceous earth, it is employed for the purpose of etching on glass. For this purpose the distilled acid is employed; but for common experiments the sulphuric acid may be poured on the powdered spar, strewed over a glass properly prepared with wax; the fluoric acid acting directly as it is disengaged.

The fluoric acid presents an excellent means of detecting the presence of lime, it taking it even from the sulphuric acid and immediately precipitating with it.

Its radical is not yet known, but it appears not to be saturated with oxygen, *Gren* therefore thinks we have not had it in its *perfect* or *oxygenized* state, and that it therefore deserves farther investigation.

FLUATES are formed by the fluoric acid and certain bases. The alkaline and earthy fluates in general have a slight salt, bitter, but not disagreeable taste. Some of them, when heated, decrepitate and shine with a phosphoric light. They are decomposable in the cold by sulphuric, nitric, and muriatic acids, and with heat even by the phosphoric and boracic.

FLUATE OF POT-ASH is a gelatinous substance, which readily dissolves in water, deliquesces in the atmosphere, and is with difficulty crystallized. It is decompounded by lime, the lime uniting with the acid, and forming regenerated fluor: it is decomposable also by the sulphuric acid.

FLUATE OF SODA is not readily soluble in water. It forms small cubic or oblong tetrahedral crystals, which decrepitate like common salt, and are decomposable in the same manner as the former.

FLUATE OF AMMONIA shoots into small columnar crystals, which have a bitter taste, and are deliquescent. It is perfectly sublimable by heat, and forms, when dry, a substance resembling flint.

FLUATE OF LIME is of a compact sparry texture, of various colours, hard and brittle. Sp. gr. 3,09 to 3,19, nearly insoluble in water, and becomes phosphorescent with a moderate heat, and is of itself fusible into a transparent glass, without loss of weight or change of principles. From this property, and its promoting the fusion of other earthy substances, it is also called *fluor spar*. Its general form of crystallization is that of the cube, and of its more simple modifications. It contains acid 16, lime 57, water 27.—*Scheele.*

The amorphous and earthy has, according to *Pelletier*, acid 28,5, lime 21, water 1, silex 31, alumine 15,5, iron 1, muriatic acid 1, phosphoric acid 1.

This fluate is not acted on by the earths or alkalies, except combined with carbonic acid, when the decomposition may take place from a double attraction.

Fluate of Baryt is a salt, rather soluble. The fluoric acid takes this base from the nitric and muriatic acids, but yields it with effervescence to the sulphuric. Fluate of strontia resembles that of baryt in its properties.

Fluate of Magnesia, according to *Bergman*, is unalterable by heat, or in the wet way by acids. But *Fourcroy* suspects his experiments were made on a triple salt, in the composition of which silex had entered without his knowledge.

Fluate of Silica is formed in every instance where this acid is distilled in vessels containing silica. The acid holds it in its gaseous form, and does not deposit it wholly when it comes in contact with water. This, however, must be considered as an acid fluate, the acid in general predominating. If kept a long time, and slow evaporation permitted, small, hard, bright, and transparent crystals form, being the true fluate of silica.

Fluate of Alumine has been found in Greenland. It is formed of whitish semitransparent laminæ, which subdivide themselves into right prisms, which, according to *Haüy*, appear rectangular. The combinations of this acid with the other earths have not been much attended to.

These fluates act on silica, and by dissolving it, become *siliceous fluates.*

As an examination of the different substances from which the acids are obtained, cannot but facilitate the knowledge of the nature of the acids themselves, the remaining acids will be treated of, when the analyses of the respective substances from which they are produced, are described. This is the more necessary, since, as several of these acids appear to owe their existence to certain processes of animal and vegetable life; these can also be taken into consideration at the same time.

METALS.

Metals are simple bodies, characterised by their absolute *opacity*, great degree of *gravity*, peculiar *brilliancy*, and *insolubility* in water. Some of them possess a considerable degree of *ductility*; but this property is not common to them all. Almost all the metals seem to be capable of impressing the organs with a peculiar *taste* and *smell*.

The names of such metallic substances as are at present known, are,

1. Platina. 2. Gold. 3. Silver. 4. Quicksilver. 5. Copper. 6. Iron. 7. Lead. 8. Tin. 9. Zinc. 10. Antimony. 11. Bismuth. 12. Cobalt. 13. Nickel. 14. Manganese. 15. Uranium. 16. Tellurium. 17. Titanium. 18. Chrome. 19. Arsenic. 20. Molybdenum. 21. Tungsten. 22. Columbium.

The three first, undergo no oxygenizement in our furnaces, but their oxides may, however, be obtained by other means; and differ from those of the other metals in this, that they, as well as that of quicksilver, are reduced to a metallic state by mere heat; whereas those of the other metals require the addition of a combustible matter. Those which are not at all, or slightly malleable, have been termed *semi-metals*, or *imperfect metals*. The five last are capable of such complete oxygenizement as to be converted into real acids, and are therefore called *acidifiable metals*.

They are concealed in the earth, and form *ores*, which existing in crevices of rocks, are called *veins*, and are distinguished into *level*, or into *inclined*, *direct*, or *oblique*, according to the angle they make with the horizon. The part of the rock resting on the vein, is termed the *roof*; and that on which the vein rests, the *bed of the vein*. When found in spherical parts, or masses, they are called *bellies* or *stockworks*.

Metals are *assayed*, and their species ascertained, by the *Docimastic Art*, or *DOCIMASIA*. The metallic part is first cleared, as much as possible, from the foreign, or stony substances, with which it is blended, and which is called the *gangue*, by first reducing the ore to powder, in which state it is called *slick*, and then by washing. It is then *torrefied* to dissipate the sulphur and arsenic; and lastly, *fused* by the addition of some flux, containing the coaly principle, to disengage the oxygen, with which the metal has been impregnated, during the previous calcination, or torrefaction. Two parts of tartar and one of nitre form what is termed the *black flux*, and with equal parts is formed the *white flux*.

They are found, 1. in the form of a native metal; 2. in the form of oxides; 3. combined with arsenic, or sulphur. When nature has bestowed on them their proper metallic appearance, or they are only alloyed with other metals, or semi-metals, they are said to be *native*. When combined, as they commonly are in mines, with some unmetallic substance, they are said to be *mineralized*; the substance that sets them in that state, is called a *mineralizer*; and the compound of both, an *ore*; which term is applicable, when stones, or earths, contain metallic substances, whether native or mineralized, in a notable proportion. They are commonly mineralized by oxygen, in its concrete state, to which is often super-added, the carbonic acid. Next to these, sulphur, and arsenic, in its oxidated state, occur; these last generally communicate a metallic lustre. The sulphuric, muriatic, phosphoric, arsenic, and molybdenic acids, are less commonly met with.

They fuse at a certain degree of heat, and obtain a convex surface; and if suffered to cool slowly, they exhibit crystallizations of considerable regularity. If continued in a state of fusion, they lose their brilliancy, and become an opake powder, or metallic *oxide*, acquiring weight, and absorbing a certain portion of oxygen, during the transition. If this be absorbed to saturation, the oxide may be called *perfect*, if not, *imperfect*. If urged by a stronger heat, all the oxides, except of quicksilver, are converted into a vitriform substance, or METALLIC GLASS.

These mixed with other glasses form *glass pastes*, and *artificial gems*, *pigments* for enamel and porcelain, *enamel* itself, and the *finer glazings*.

All the metals are combustible, but in different degrees of heat: burning with a flame tinted with various hues of green, blue, or red, according to the kind of metal. Zinc and tin burn at a little above a red heat, iron requires a white heat; but platina, gold, and silver, flame only with the intense heat produced by the electric or the Galvanic spark.

That metals are calcined, or rather oxygenized, in consequence of their absorbing oxygen, is proved by this process taking place only when oxygen is present; and by their giving it out, in exactly the same quantity and proportion, on their reduction, or return to the metallic state. They undergo this process of calcination, or oxygenizement, also from the action of humidity: the water is decomposed; its hydrogen being dissipated, whilst its oxygen combines with the metal. The baser metals have their surfaces tarnished by exposure to the air, being acted on by the carbonic acid and oxygen, the *tarnish* or *rust* being a *carbonated oxide* of the metal. They are also acted on by light. They are all soluble in *acids*, and precipitable therefrom by alkalies; or, platina excepted, by Prussian alkali. Acids are decomposed, during their combination with metals, their oxygen combining with the metal, and forming a metallic oxide: this is either dissolved, and forms a metallic salt, or the metal is only corroded and the oxide precipitated

Hyperoxygenized muriatic gas dissolves all the metals, and if it be applied in a nascent state inflammation ensues: but the salts thus produced are merely muriates. To form hyperoxygenized muriates, the metal must be taken in its fullest state of oxydizement.—*Chevenix*.

The Metallic Oxides are decomposed by *carbon*, aided by *heat*; and *phosphorus* and *phosphoretted hydrogen* decompose several of them, even in the cold. *Hydrogen* decomposes all those whose metallic radicals do not decompound water, and, of those which do, it even sometimes takes up the last portions of their oxygen. *Sulphur* decomposes very few, but the *sulphuretted hydrogen* acts on the oxygen with its hydrogen, whilst the sulphur unites with the de-oxygenized metal.

The metallic oxides are affected by *liquid ammonia* in four different ways: 1. they are merely dissolved, and form saline compounds; this is the case with the oxides of zinc, tin, silver, &c. 2. A partial decomposition ensues; a part of their oxygen is taken up by the hydrogen of the ammonia to form water, whilst the other principle, nitrogen, is liberated, and the oxide approaches to a metallic state. 3. Some oxides, as those of silver and gold may suffer entire decomposition by ammonia, the sudden union and expansion of the oxygen and hydrogen, and the disengagement of the nitrogen, producing a violent detonation. 4. Some oxides, as those of mercury, lead, and manganese, form, by the reciprocal decomposition of the oxide and ammonia, both water and the nitric acid.

Metals may be dissolved by means of alkaline sulphurets, and the metal and the sulphur may be precipitated together. This precipitate is a combination of the metal with the basis of sulphurated hydrogen gas, and is called a METALLIC HYDROGENIZED SULPHURET.

If calcined, and not too volatile, the metals communicate a tinge to *borax* and the *alkaline phosphates*. Thus cobalt gives a blue colour; manganese, purple; copper, green; iron, black. When perfectly fused, they are, for the most part, miscible, or combinable with each other; but excepting iron, refuse to mix with their own oxides, or with most other unmetallic substances. They however unite with *sulphur*, *phosphorus*, and *charcoal*. Thus we have *metallic* SULPHURETS, PHOSPHURETS, and CARBURETS. Some of their oxides also enter into combination with *water*, and other with *ammonia*.

METALLIC SULPHURETS are formed by the union of *metals* with *sulphur*. They are opaque, solid bodies, of a high degree of specific gravity, and are conductors of the electric fluid. They are often found native, when they generally possess a metallic lustre. These are commonly called *pyrites*, or *marcasites*. They are formed artificially by uniting, by a due degree of heat, the metal with the sulphur; the union taking place with different proportions of sulphur. Silver, lead, copper, and other metals, attract the sulphur contained in sulphuretted hydrogen, and become tarnished by the formation of sulphuret on their surface. They possess alone neither taste nor smell, and are not, strictly speaking, soluble in water, a mutual decomposition actually taking place.

A solution of *sulphuretted hydrogen* added to a solution of the different metallic nitrates, produce differently coloured precipitates; that of silver being black; of bismuth, yellow; of copper, brown, &c. The substances here precipitated are sulphurets, which are thus formed by the action of a double affinity. The sulphuretted hydrogen parts with its hydrogen to unite with the oxygen, which held the metal in solution, and forms with it water, whilst its sulphur joins the metal and forms the sulphuret.

Mr. *Davy* is of opinion, that the native metallic sulphurets may thus be formed; by the solution of sulphuretted hydrogen thus decomposing the various solutions of metals. On this principle are *sympathetic inks* formed, the invisible writing with metallic solutions, such as the acetite of lead, being made to appear, even on the approximation of a solution of sulphuretted hydrogen, or rather the contact of the gas. Their affinity for *oxygen* is very considerable, and they are all decomposable at certain degrees of *heat*; burning with different appearances in the flame of alcohol; the sulphuret of iron inflaming in oxygenized muriatic gas, even at the common temperature.

The sulphuret of iron, or common pyrites, gives sparks very freely by collision with steel, and is so hard as to cut glass with more facility than flint. The iron pyrites are known from those of copper by their colour being whiter, the latter possessing a yellowish red colour.

Vauquelin divides the combinations of metals with sulphur into three orders: 1. *metals and sulphur*, or *sulphurets*; 2. *metallic oxides* and *sulphur*, which are the *sulphuretted metallic oxides*; 3. *metallic oxides, with sulphur and hydrogen*, which triple combinations he calls *metallic hydro-sulphurated oxides*; but which, perhaps, should rather be called *hydroguretted sulphuretted oxides*.

Pyrites, or *Marcasites*, are native metallic sulphurets, which are formed by the union of metals with *sulphur*. The most common of these are the sulphurets of iron.

Proust has ascertained that the *metallic sulphurets* may exist in two states: since he found, that iron could fix at a high temperature 60 *per cent.* of sulphur, being then sulphurized to the *minimum*; and that then, in a lower temperature, it would unite with half this weight more of sulphur, holding then 90 parts of sulphur, and being sulphurized to the *maximum*. Pyrites is a sulphuret at the *maximum* of sulphurization, and may be imitated by the foregoing process. It also may be reduced to the *minimum* state of the artificial sulphuret by being heated with half its weight of iron filings; when it is acted on by acids, and hydrogen is liberated, which is not the case when the sulphur exists *ad maximum*. He also ascertained that these sulphurets contain no oxygen, and that the artificial pyrites, thus sulphurized *ad maximum*, agree with the native in every thing, but that aggregate condensation which art could not imitate. The natural pyrites he believes to be formed in the humid way.

During the formation of sulphurets, either metallic or alkaline, a curious phenomenon appears. On acquiring a moderate degree of heat, the mixture suddenly melts, becomes red hot, and glows as though acted on by a bellows. A similar appearance is observable when phosphorus is employed instead of sulphur.

The pyrites most charged with sulphur resists the action of the elements the longest. By slow decomposition, oxygen, which they did not originally possess, is substituted for sulphur, and they are rendered a red oxide, the yellow ochres proceeding from the decomposition of the spathose ores, and contain lime and manganese.

Mercury unites with sulphur in preference to oxygen, not being able, like zinc, tin, antimony, &c. to combine with sulphur without abandoning the oxygen. Mercury being poured into liquid sulphurets of pot-ash, or ammonia, unites with the sulphur, and becomes cinnabar, leaving the pot-ash or ammonia alone. Thus also do the nitrates, muriates, sulphates, and mercurial oxides form ethiops on being thus mixed with sulphurets.

A solution of hydroguretted sulphuret in water poured into a solution of sublimate of mercury, decomposes it into mild muriate and muriatic acid; but if the solution of mercury be poured into the solution of the sulphuret, the whole is precipitated in the form of an ethiops, the muriatic acid remaining alone—*Proust.*

The sulphurets of arsenic contain no oxygen. Like the pyrites of iron, those of copper contain a surcharge of sulphur and no oxygen. The sulphuret of copper, when pure, is of an indigo or violet blue colour; but is liable to be disguised by admixtures of carbonate of copper, red oxide of iron, other sulphurets, &c. With the sulphuret of iron it gives the copper coloured pyrites.

Metallic Phosphurets are formed by the addition of *phosphorus* to the *metals*, at a degree of heat even below that of their fusion; they may also be formed by exposing the metals to phosphorus at the moment of its separation from its acid by ignited charcoal; the charcoal seizing the oxygen to form carbonic acid, and the phosphorus uniting with the metal. They are opaque, and possess great specific gravity; and some of them have a degree of malleability and of splendour. They burn and become luminous, if ignited and put into oxygenized muriatic gas, or oxygen gas; and this in proportion to the degree of affinity which the metal possesses for oxygen. Thus if the experiment be made with the phosphuret of zinc, bismuth, &c. both the phosphorus and the metal burn; but if it be made with that of gold, silver, or platina, the phosphorus alone is burnt, and the metal remains unaltered. They decompose water, separating phosphuretted hydrogen; this, however, is accomplished very slowly without heat; but it is formed much more rapidly if sulphuric acid be added to the mixture of water and phosphuret. They are fusible, and capable of decomposition at high temperatures; they may be also decomposed by a long continuance, even of the lower temperatures.

Carburets, or compounds of *metal* with *carbon*, can only be instanced in those of iron, zinc, and manganese: and those of the two latter are hitherto but very little known.

There are no known combinations of the metals with *nitrogen* or *hydrogen*; although the *sulphuretted hydrogen* is capable of holding metals in solution, particularly iron, zinc, and arsenic.

PLATINA comes to us in a granular state, from Peru. It has no known ore, but is found in a metallic state, only among alluvial gold ores.

Its colour is of a light grey. Sp. gr. 22,5, being the most ponderous of all known bodies. It may be rendered malleable and ductile; but it is harder than all the metals except iron. Its fusion takes place beyond the highest degree of *Wedgwood's* pyrometer, in the heat produced by powerful burning glasses, or that excited by ignited oxygen gas; and it can only be made to burn by the *galvanic* or *electric* spark.

It is often mixed with quicksilver, and gold, and is generally combined with iron, and therefore magnetic. The mercury may be driven from it by heat, and the iron may be separated from it by dissolving it in eight times its weight of nitro-muriatic acid, and either precipitating the iron, by Prussian alkali, or the platina itself by muriate of ammonia. This precipitation of platina, by the muriate of ammonia, affords a simple method of ascertaining the mixture of this metal with gold, since the muriate of ammonia has no visible effect on the solution of gold.

It is neither altered in its colour or brilliancy by long exposure to the *air*. Nor does it act on *water*, except where the water is held in the state of vapour in any gas in which the electric spark is taken, the metal attracting oxygen, as do gold and silver, at the moment of its being separated, heated, and perhaps minutely divided.

Amongst the combustible bodies, *phosphorus*, and most of the *metals*, are alone capable of entering into union with platina.

It only acts on *muriatic acid, oxygenized* in the ordinary way, or the same acid charged with nitric oxide, or mixed with nitric acid, and forming *aqua regia*.

The saturated solution is of a dark red colour. It is precipitable from this solution, by pot-ash, and muriate of ammonia; less freely by soda, and not visibly by the Prussian alkali, nor at all, by a dilute solution of sulphate of iron: these properties distinguish it from gold. *Berthollet* found it in a great measure acidified, when in solution, which accounts for some of its singular properties. The solution deposits small irregular fawn-coloured crystals, the MURIATE OF PLATINA; and if concentrated, it yields larger crystals, sometimes of an octahedral form.

In the distillation of nitro-muriatic acid upon platina, oxygen is absorbed by the metal; and yet, not only oxygenized, but also hyperoxygenized muriatic acid is formed.—*Chevenix*.

No action takes place between it and the *earths* or *alkalies*, nor hardly between it and the *salts*, except the *nitrate of pot-ash* and the *hyperoxygenized muriate* of the same base, which act feebly on it during its fusion.

With *bismuth* it unites easily, and yields a mass of little ductility: with *antimony*, its fusion is facilitated, but its weight and ductility are lessened: and by *zinc* it is rendered more fusible, the alloy being very hard. It unites easily with *tin*, the alloy being very fusible, and unless the tin is in large proportion, very brittle.

It unites very well with *lead*. One ounce of platina being cupelled with 20 ounces of lead, the platina gains the power of being forged and soldered completely, without the assistance of any other metal—*Baumé*.

It will not unite with *forged iron*, but melted with *crude iron*, the alloy is so hard, the file will not touch it; it is ductile in the cold, but breaks short when hot.—*Lewis*.

With *copper*, the alloy is ductile: when the copper is in the proportion of three or four to one, it takes a fine polish, and does not tarnish in the space of ten years. With *silver*, the alloy is hard, without ductility, and tarnishes. But with *gold*, it can only be alloyed by the most violent heat; the colour of the gold being prodigiously altered, and the alloy possessing considerable ductility.

GOLD.—Its colour is orange red, or reddish yellow. Sp. gr. 19,3. It melts at 32° *Wedgwood*, and burns only when submitted to the galvanic or electric spark. It may be volatilized and calcined in high and long continued heats. It is the most ductile and malleable of all the known metals. Its form of crystallization is generally the aluminiform octahedron.

It is more extensively diffused, though in exceeding small quantities, than any other metal, except iron. It has been obtained from *vegetables*, by *Becher*; from *rotted manure*, *garden mould*, and *uncultivated earth*, by Monsieur *Sage*; from *ashes*, by *Berthollet*. Gold may therefore be said to exist in *vegetables*.

It does not unite with *sulphur*; nor does it act on *water* or the *metallic oxides*.

It is not attacked by the *sulphuric*, *muriatic*, *phosphoric*, or *fluoric acids*, and is very slightly acted on by the *nitric acid*; but is attacked with most power by the *nitro-muriatic* acid, or *aqua regia*, as it is called. In this case the solution appears to be effected by the oxygen of the nitric oxide, with which the muriatic acid is impregnated, uniting with the gold, which then becomes soluble in the muriatic acid. To be assured of success in this solution, the two acids should be used in equal quantities, and only mixed at the moment they are added to the metal, the portion of oxygenized muriatic acid, formed by the union of the acids, and which promotes the solution, being soon dissipated. The *oxygenized muriatic acid* alone speedily dissolves gold.

This solution yields yellow crystals, resembling topazes, in truncated octahedra, these crystals being a true MURIATE OF GOLD. It tinges animal substances purple, and by distillation, yields an acid coloured red by gold, which was called by the adepts, *the red lion.* An OXIDE OF GOLD is precipitated from this solution, in a *yellow powder*, nearly in a metallic state, by *lime, magnesia*, and by *alkalies*; the precipitate being soluble in the *sulphuric, nitric*, and *muriatic acids.*

THE AMMONIAL OXIDE OF GOLD, or *Fulminating Gold*, is formed from a *nitro-muriatic solution*, mixed with three or four times its weight of distilled water, by the addition of *ammonia*, until the precipitation is completed, but not beyond that point. The precipitate which will weigh about a fourth more than the gold, is to be carefully washed and dried on paper. It is also formed whenever ammonia is introduced, in any manner, into the solution, and a precipitation is effected by any alkali. This precipitate explodes with considerable noise by the application of a slight de[illegible] of heat, or by pressure, or by percussion.

[illegible]his fulmination results from the sudden and violent disengage[illegible]t as well as condensation of the hydrogen of the ammonia and the oxygen of the oxide, whilst uniting to form water, and the rapid escape of the nitrogen; the gold being left, restored to its metallic form.

It is precipitated from its solution by several of the *metals*, such as lead, iron, silver, copper, bismuth, mercury, zinc, and tin. This last precipitates it in a powder, much used in *porcelain manufactories*, termed, THE PURPLE POWDER OF CASSIUS. It may be instantly precipitated, and revivified by *ether*, the gold immediately forming a stratum at the surface of the now colourless liquor.

It may be obtained pure, by precipitation, with a dilute solution of *sulphate of iron*, from a solution of gold, in nitro-muriatic acid.

It is also precipitated in a solid metallic form on the surface of a stick of *phosphorus.*

Phosphorus, hydrogen gas, and burning *sulphur* precipitate the gold in a metallic form from a solution of its muriate. The ingenious Mrs. *Fulham* advises the gilding of stuffs and paper by first moistening them with the dissolved muriate, and then exposing them to the action of these combustible bodies. As this effect takes place only whilst the substances are moist, Mrs. *Fulham* supposed a decomposition of water was necessary, but with this opinion *Fourcroy* does not coincide.

It is in the state of purple, and chiefly, of yellow oxide, that it unites with the earths vitrified by alkalies, forming beautiful violet and purple enamels, or glasses resembling topazes.

Gold is also dissolved completely by the *sulphurets of alkalies*, merely by fusing equal parts of sulphur and pot-ash, with one-eighth of the total weight of gold in leaves; it may then be poured out, pulverized, and dissolved in hot water, being an HYDROGURETTED SULPHURET OF GOLD. *Stahl* affirms, that by this process *Moses* dissolved the golden calf.

It unites with most of the other metals; and is rendered brittle by *arsenic*, as well as by *bismuth*, *nickel*, and *antimony*, and unites well with *tin*, and *lead*, but loses all its ductility.

With *iron*, it forms a very hard and useful alloy; and by *copper*, it is made more fusible, and rendered of a redder colour. This alloy is employed for *coin*, *toys*, *gold plate*, *&c.* It is rendered very pale by *silver*. This alloy forms the *green gold* of goldsmiths.

Gold, from its extreme ductility, is drawn into very fine wire, for *embroidery*, and into leaves of the greatest tenuity, one grain being capable of extension over 56¾ square inches.

Gold is employed for the purposes of GILDING the surfaces of copper, brass, and silver, in the following different processes: 1st. *Hot gilding*, for the *Or Moulu*; the metal to be gilt is first washed with a solution of nitrate of mercury, or *amalgamating water*; this gives a mercurial surface, to which an amalgam of gold and mercury is applied; from which the mercury is driven off by heat. The colour is then heightened, by burning on it a covering of *gilder's wax*, formed of wax, verdigris, and blue vitriol; it is then polished, and brightened by a boiling solution of common salt and cream of tartar. 2d. *Grecian gilding of silver*, which is performed by a solution of gold in nitric acid, to which sal-alembroth (a triple salt formed by sal ammonia and corrosive sublimate) has been added. This solution of gold, evaporated to the consistence of oil, is applied to the silver, which it blackens, but which appears gilded after being heated. 3d. *Cold gilding*, which is performed by rubbing the metal with the ashes of a linen rag, which has been impregnated with a solution of gold. 4th. *Wet gilding*, by merely dipping the work into a solution of gold.—*Gren.*

SILVER is of a pure bright white. Sp. gr. 10,510. It is malleable and ductile in a high degree, though inferior in these respects to gold, and is not oxidated by the contact of air, the bluish coat acquired by old silver, being a sulphuret of silver. A wire 1-10th of an inch will support 270 pounds.

It is fusible at 28°, or rather it remains in fusion at that degree, for it requires a higher degree to bring it into fusion *.

Gold and silver readily combine, and form an useful alloy. Having different solvents they may be *PARTED* three different ways. 1st. By dissolving the silver of the alloy by nitric acid; but as for this process it is necessary first to take care that the gold is not more than a quarter part of the mass, the process is called *quartation*. 2dly. By *cementation* or *parting by concentration*, the alloy being placed in a crucible, in *strata* with the *cementing powder*. The ingredients of this powder must be such that by an intense heat it will yield either *pure nitric* or *pure muriatic acid* vapours, as these will lay hold of the silver and leave the gold untouched. 3dly. By *dry parting*, which is by fusion with sulphur, the silver quitting the gold to unite with the sulphur.

By long exposure to violent heat, it becomes volatilized, and it may be converted into a vitreous oxide of an olive green colour. In the focus of a burning glass, it yields a white pulverulent oxide.

In all cases of the employment of intense heat, the silver reflects the light so brilliantly as to give the appearance of corruscations. It is made to flame by the electric or galvanic spark.

It does not appear that any action takes place between silver and *water*, nor between it and the *metallic oxides*.

Both *phosphorus* and *sulphur* unite readily with it. *Hydrogen*

* This distinction is applicable to the degrees of heat, requisite for the fusion of most metallic substances.

and *carbon* decompose and reduce its oxides; and the former even without heat.

With *sulphuric acid*, if concentrated and boiling, sulphureous gas is disengaged, and the silver is converted into a true OXIDE OF SILVER, mixed with a small quantity of SULPHATE OF SILVER, in small needles, or in plates formed of these needles, united lengthways. The *sulphureous acid* dissolves only its oxide.

It is dissolved in *nitric acid* with rapidity, if water be added to the acid, and much nitrous gas is disengaged. The solution is at first blue, from the nitrous gas, which had been disengaged, becoming dissolved in the acid; but this colour dissappears when the silver is pure, and degenerates into a green, if it be alloyed with copper. Nitric acid will dissolve more than half its weight of silver, the solution letting fall crystals in hexagonal, triangular, or square plates, which are called NITRATE OF SILVER, or *lunar crystals*, *lunar nitre*, *&c.* This melted with a gentle heat, and poured into moulds as soon as fused, forms the *lapis infernalis*, or *lunar caustic*.

A layer of dry *nitrate of silver* being placed on a piece of burning charcoal, it deflagrates and throws out most beautiful scintillations, the surface of the charcoal being richly coated with the reduced silver.

By *fixed alkalies* it is precipitated from its solution white; by *lime water*, olive green; and by *ammonia*, grey; and if the alkali is in excess it redissolves the precipitate, and forms a triple salt of silver.

It may be precipitated from a dilute solution, by a plate of copper. The silver adheres like moss to the copper, and the liquid acquires a blue tinge from the copper, which is dissolved in the room of the silver.

An *amalgama* of four parts of silver leaf and two of mercury being dissolved in a sufficient quantity of nitric acid, and diluted with thirty-two times the weight of the metal, of water, and a ball of the amalgama being placed in the liquor, a precipitation soon begins to take place in the form of a vegetation, known by the name of the TREE OF DIANA, *Arbor Dianæ*, *&c.*

Nitrate of silver is reduced by *hydrogen gas*. Mrs. *Fulham* has given several very pleasing experiments of its reduction on the surfaces of silk and paper, which had been imbued with it.

It is also reduced by *phosphorus*, the silver forming in a solid crust on a stick of phosphorus immersed in the solution.

Nitrated silver, being precipitated from its solution by *lime*, and placed on filtering paper to separate it from the moisture, is then to have a small portion of *liquid ammonia* poured on it. The mixture having remained ten or twelve hours, if a bright pellicle appears, more ammonia is to be added. The fluid is afterwards to be decanted from the black precipitate, and evaporated in a retort, when it will become full of opaque crystals of a metallic appearance, which fulminate with violence on being touched, even under water. Both these crystals and the precipitate exceed in power gun-powder, and even fulminating gold. AMMONIAL OXIDE OF SILVER, or *fulminating silver*, once thus obtained, can no longer be touched without a violent detonation: no more than one grain being sufficient to give rise to a dangerous fulmination. After this fulmination, the silver is found reduced or revivified; its oxygen having combined with the hydrogen of the ammonia, by which, water, in the state of vapour is produced. This water, instantly vaporized, and possessing all the elasticity, and expansive force of that state, is the principal cause of the phenomenon, in which the nitrogen of the ammonia, with its whole expansibility, bears a part.

It does not combine with *the muriatic acid*, unless in the state of oxide; the MURIATE OF SILVER being precipitated, on adding this acid to a solution of silver in the nitric acid. This muriate is very fusible, running into a grey and transparent substance, like horn, and is then called LUNA CORNEA, or *horn silver*: this being fused with four parts of pot-ash, the silver is found in the purest state, under a stratum of muriate of pot-ash, and the remaining alkali. It is by this precipitation that the nitrate of silver so effectually detects the presence of the muriatic acid.

The muriate of silver, exposed to the light of the sun, soon becomes brown, oxygen gas being disengaged. Nitrated silver, and most of the solutions of metals thus emit their oxygen, and become coloured.

Mr. *Chevenix* having added phosphate of silver to some of the hyperoxygenized muriates, obtained an HYPEROXYGENIZED MURIATE OF SILVER, which crystallized in dull opaque small rhomboidal crystals. It is somewhat soluble in alcohol, and is decomposed by the muriatic, nitric, and even acetous acids, a muriate of silver being left. When mixed with half its weight of sulphur, even without charcoal, it detonates in the most violent manner, half a a grain with a quarter of a grain of sulphur exploding with as much force as five grains of hyperoxygenized muriate of pot-ash with the due quantities of sulphur and charcoal.

Phosphoric, *fluoric*, *boracic*, and *carbonic* acids act on silver only in its state of oxide.

An ALKALINE SULPHURET OF SILVER may be obtained by fusion with *alkaline sulphuret*, and from the solution of this an HYDROGURETTED SULPHURET OF SILVER may be obtained by precipitation by an acid.

PHOSPHURET OF SILVER may also be obtained by the fusion of *silver* and *phosphorus*.

It is capable of entering into union with almost all the *metals*; very few of these alloys however are of any known utility. With *mercury* it forms an *amalgama* which ramifies in forms resembling those of vegetables.

When alloyed with *copper*, it is rendered hard, and fit for silver-smiths work, and for coinage. The alloy for the *British* coinage, is 11 ounces, 2 pennyweights fine.

Mr. *Keir* discovered that *a mixture of the sulphuric and nitric acids* in a concentrated state, has a peculiar faculty of dissolving silver copiously: and at the same time, oxidizing tin, mercury, and nickel; dissolving, however, a small quantity of the latter, and having little or no action on other metals. By dilution, the mixture becomes less capable of dissolving silver, and more capable of acting on other metals.—*Phil. Trans.* 1790.

QUICKSILVER is of the colour and lustre of polished silver. Sp. gr. 13,568. It is volatile in heat, and boils, in the same manner as other liquids, when heated to 600°, suffering no change, but a minute division of its particles, if there is not too much access to the oxygen of the atmosphere. If inclosed in a well soldered globe of iron, and thrown into a furnace, it bursts the globe with a violent explosion. An experiment of this kind on a small scale may be made by inclosing quicksilver in a glass bubble, hermetically sealed.

It becomes solid at 40° below 0°. *Lowitz* discovered that it may be congealed by cold, and then possesses malleability. It may be frozen by a mixture of snow and nitric acid, each being at +70°. By ground ice, and nitric acid at +10°. To make it perfectly solid and hard, a mixture of diluted sulphuric acid and nitric acid should be used with the powdered ice, but then the materials should not be less than —10° before mixing.—*Phil. Trans.* 1795.

Mr. *Pepys* and Mr. *Allen* congealed fifty-six pounds of mercury into a solid mass, by mixtures of muriate of lime, and uncompressed snow, in equal weights. The mass was broken by accident, the larger pieces were kept for some minutes before fusion took place, whilst others were twisted and bent into various forms.—*Philos. Mag. Feb.* 1799.

At the moment of its congelation it contracts so suddenly as to give a slight concussion to the vessel which contains it. This considerable contraction has given rise to error, since when the effect has been produced in a thermometer, the contraction of the metal has lowered much beyond the point which would otherwise have marked the diminution of temperature.

Mercury mixed with *sulphur* forms the RED SULPHURETTED OXIDE, or the BLACK SULPHURETTED OXIDE, called also *cinnabar*, and the *æthiops*.

Four ounces of sulphur may be triturated with twelve ounces of sublimed sulphur, or four ounces of sulphur may be fused in a crucible, and one ounce of mercury extinguished in it, or the sulphur of pot-ash may be added to mercurial water. By all these means the *black sulphuretted oxide of mercury*, or mineral æthiops, is formed.

By subliming these æthiops, the *red sulphuretted oxide of mercury* is obtained, called *cinnabar*.

The Count *Appollos de Moussin Pousschin* prepared a beautiful cinnabar by triturating mercury and flowers of sulphur with a solution of caustic vegetable alkali, keeping it at a proper temperature, and afterwards washing it repeatedly by boiling water, which carries off a small portion of æthiops, not sur-composed.—*Nicholson's Journal.*

It does not enter into combination with *hydrogen*; but *hydrogen gas* passed through a heated tube, containing the red oxide, seizes the oxygen, which appears, indeed, to be held but weakly by the metal, and produces a detonation, the oxide being at the same time reduced to a black colour. Its union with *phosphorus* is very slight, and difficult to be obtained. It does not appear to exert any action on *water*, even though aided by heat.

Quicksilver frequently yields light by agitation, in such a vacuum as even that of a barometer; but this appears to be only an electrical phenomenon, proceeding from the friction of the mercury against the sides of the glass vessel.

It is slowly oxidized by the air, especially by long agitation in it, when it forms a BLACK, but *imperfect* OXIDE, formerly called *Æthiops mercurii per se*, containing 0,5 or 6 oxygen; but when acted on by heat at the same time, it gradually loses its fluidity, and at the end of several months forms a RED, and *perfect* OXIDE, called *Precipitate per se*, or *calcined mercury*, containing 0,14 to 0,16 oxygen. This oxide gives out its oxygen by simple heat, one ounce affording a pint, and the mercury resuming its metallic form. Exposed to heat, in close vessels, the oxide sublimes in beautiful red crystals.

Almost all the acids enter into action with quicksilver, or with its oxide. The *sulphuric acid* acts on mercury, only if assisted by heat, rendering it an oxide, and then dissolving the oxide.

As the quicksilver absorbs oxygen from the acid in proportion to the elevation of temperature, its varieties in solution depend rather on this circumstance, than on the quantity of acid employed.

Thus at nearly a boiling heat the mercury decomposes the sulphuric acid; attracting its oxygen, and detaching sulphureous acid: and if the operation be stopt whilst the mercury is white, and whilst it is still covered with a liquid, the mass contains sulphuric acid, and is the ACID SULPHATE OF MERCURY. This sulphate is very acrid, and does not become yellow by contact with the air, nor is it decomposed by water; provided it be slightly washed with cold water, to remove the superfluous acid, as it might become coloured by the heat produced by the reaction of this part of the acid and the water contained in the atmosphere.

If this sulphate be repeatedly washed with small parcels of cold water, to carry off the sulphuric acid, a truly neutral metallic salt remains, the SULPHATE OF MERCURY, which is crystallized in fine white needle-like crystals, which require 500 parts of water for their solution. The taste of this sulphate is not very pungent: its composition is 75 parts of mercury, 8 of oxygen, 12 of sulphuric acid, and 5 of water.

If instead of stopping the operation at the period above mentioned, the sulphuric mercurial mass be allowed to inspissate, more sulphureous acid is detached, and more mercury oxidated: and if water be poured upon it, particularly if boiling, a precipitate is thrown down of a bright yellow colour. This is the YELLOW SULPHATE OF MERCURY WITH EXCESS OF OXIDE, which used to be named *turbith mineral*.

The sulphates may therefore exist in three different states: 1st. With excess of acid. 2d. Neutral. 3d. With excess of oxide.

The *nitric acid* dissolves mercury even without heat, nitric oxide being disengaged in a moderate quantity; one part of the acid oxidizing the metal, whilst the other dissolves it, as it is oxidized. Here, as in the cold sulphuric solution, the mercury has been able to separate but a small portion of oxygen from the acid, and no precipitate is thrown down on the addition of water to the solution. But if heat be employed, nitrous gas is very copiously evolved; and the acid becomes loaded with an excess of mercurial oxide, which it lets fall on dilution with water. If the solution be made in the cold, and left to spontaneous evaporation, the crystals are tetrahedral prisms, truncated near their base, and having the angles, resulting from the junction at the bases of their pyramids, likewise truncated; if heat be employed during the solution, or the evaporation, long and acute blades are obtained, striated obliquely across.

On the same principle that there exists three species of sulphates of mercury, so there may exist three species of *nitrates*: the *neutral*, the *acid*, and the one *with excess of mercurial oxide*; and these are affected by water in the same manner as the sulphates are.

The NITRATE OF MERCURY is corrosive; when very dry, it detonates upon coals, and emits a brilliant white flame. Fused in a crucible, or better in a retort, with any combustible matter, it yields nitric oxide, the mercurial oxide becoming yellow, and at length a lively red, being the RED OXIDE OF MERCURY BY NITRIC

ACID, or *red precipitate*. As soon as it has acquired a red colour, nothing but pure oxygen gas is evolved from it, until towards the end, when a small portion of nitrogen is separated. If fresh nitric acid be distilled from it three or four times, the precipitate is in small crystals of a very superb red colour. The solution of mercurial nitrate forms *mercurial water*. It is of use to ascertain the presence of sulphuric and muriatic salts in mineral waters. The nitrate of mercury even acquires a yellow colour by the oxygen it gains from the air.

FULMINATING MERCURY is thus obtained: one hundred grains of quicksilver dissolved with heat in a measured ounce and half of *nitric acid* of 1,3. sp. gr. being poured cold *upon* two measured ounces of alcohol of about ,849, and a moderate heat applied, a powder precipitates, which is to be immediately washed on a filter, and dried with a heat little exceeding that of a water bath. This powder takes fire at 368 Fahr. it explodes by friction, by flint and steel, and by being thrown into concentrated sulphuric acid. It is equally inflammable under the exhausted receiver as surrounded by air, and it detonates loudly both by the blow of a hammer, and by a strong electrical shock.

This powder appears to be composed of the *nitrous etherized gas*, and of *oxalate of mercury with excess of oxygen*. The superabundant nitrous acid of the mercurial solution first acts on the alcohol, and generates ether, nitrous etherized gas, and oxalic acid. The mercury unites to the two last in their nascent state, and relinquishes fresh nitrous acid to act upon any unaltered alcohol.—*Howard. Phil. Trans.* 1800.

Berthollet observes, that Mr. *Howard's fulminating mercury* does not hold any oxalic acid, but that it contains ammonia; differing from fulminating gold and silver, by a portion of altered alcohol, which enters into the combination, and which, when decomposed, produces carbonic acid.

From the solution in the nitric acid, the mercury is precipitated in the state of oxide, of different colours, by the acids, alkalies, earths, and some of the metals. Those by the carbonate of ammonia and lime water, as well as that of the muriate of mercury by lime water, fulminate when mixed with a small quantity of sublimed sulphur, and exposed to heat, leaving a small quantity of a bluish powder, which is a *sulphuret of mercury*.

Both the sulphates and the nitrates admit the formation of a triple salt with ammonia, being an AMMONIAL SULPHATE or NITRATE OF MERCURY.

The *muriatic acid* does not act on mercury, except by long digestion, when it oxidizes a part, which oxide it dissolves. It completely dissolves the mercurial oxides; and when these, being charged with a small quantity of oxygen, are nearly in the metallic state, the MURIATE OF MERCURY is formed. When, on the contrary, the oxide is saturated with oxygen, *corrosive sublimate of mercury* is formed. This may be obtained either in the dry way, by sublimation from equal parts of nitrate of mercury, or any oxide of mercury, decrepitated muriate of soda, and sulphate of iron calcined to whiteness, or from equal parts of sulphate of mercury, and decrepitated muriate of soda. In the humid way it [illegible] be obtained by dissolving mercury in the oxygenized muriatic acid; concentration producing very fine corrosive sublimate. This salt, placed on hot coals, dissipates in fumes; and in proper vessels, rises in flattened prismatic crystals. Added to lime-water, it forms *phagedenic water*, a yellow precipitate falling; fixed alkali precipitates an orange coloured oxide; and volatile alkali, a white powder, which becomes brown in a short time.

To obtain the MILD MURIATE OF MERCURY, *mercurius dulcis*, or *calomel*, equal parts of quicksilver, and of oxygenized muriate, are completely blended by trituration, and this mixture exposed to sublimation. The reguline mercury becomes oxidized at the expence of the oxygen of the oxide, and yields the mercurius dulcis, which is insipid, insoluble in water, and which, if slowly sublimed, forms in crystals of the form of tetrahedral prisms, terminated by tetrahedral pyramids. Mr. *Baumé* remarks, that if less mercury be added, a proportional quantity of mercurius dulcis only sublimes, and the rest rises in the form of corrosive sublimate; and if too much mercury be added, the excess remains in the form of running mercury; there being no intermediate state between mercurius dulcis, and corrosive sublimate. By repeated distillations, such a decomposition takes place as produces corrosive sublimate; the common method of frequent distillations is therefore absurd. To be certain that the mercurius dulcis holds no corrosive sublimate, it should be washed with tepid water. Mercurius dulcis may also be made by subliming the white precipitate made by decomposing mercurial water by a solution of the muriate of soda.

Mr. *Chevenix* remarks, that the CORROSIVE SUBLIMATE is a *real muriate*, the excess of oxygen existing in the metallic oxide, and not in the acid. He says, the oxide of mercury in corrosive sublimate is composed of mercury 85, and of oxygen 15 parts, and that the corrosive sublimate is composed of mercury 69,7, with oxygen 12,3, forming 82 parts of oxide of mercury, which are united with 18 parts of muriatic acid. The oxide in calomel is composed of 89,3 of mercury, and 10,7 of oxygen, and calomel is composed of mercury 79 parts and oxygen 10,7, forming 88,5 of oxide, which are combined with 11,5 of muriatic acid.

HYPEROXYGENIZED MURIATE OF MERCURY may be obtained by passing a current of oxygenized muriatic acid gas through water, containing red oxide of mercury. It is more soluble than corrosive sublimate, requiring only about 4 parts of water to retain it in solution. From this property it is separable from the corrosive sublimate which is formed at the same time.—*Chevenix.*

Borax being added to mercurial water, a yellow precipitate falls, being a combination of the acid of borax and mercury: this salt forms brilliant crystals by evaporation, the BORATE OF MERCURY. It is in this manner, by double attraction, that the *phosphoric*, *fluoric*, and *carbonic* acids are made to unite with mercury.

The muriate of mercury is decomposed by the *earths* and *fixed alkalies*; but with *ammonia* it unites, and forms a triple salt. It is also decompounded by different *metals*. An amalgam of tin and mercury being slowly distilled, a brown liquor is obtained, which, in contact with atmospheric air, emits white fumes for a considerable time. This is termed FUMING SPIRIT OF LIBAVIUS; it is a true *oxygenated muriate of tin*, formed in consequence of the oxygenated muriatic acid quitting the mercury and uniting to the tin.

The *acetic acid*, with a boiling heat, dissolves the red or yellow oxides, or the precipitate, by pot-ash, from the nitrous solution, and yields white foliated crystals, the ACETATE OF MERCURY. The acetate of mercury is the basis of *Keyser's Pills.*

Mercury does not unite directly with the *phosphoric acid*; but if an alkaline phosphate be poured into a solution of nitrate of mercury, a mercurial phosphate is formed.

As quicksilver precipitates silver but not copper from the nitric acid, it furnishes an easy mode of separating silver from copper.

Mercury amalgamates with most other metals: on this property is founded the art of gilding. Mercury is also employed in painting, in forming mirrors, philosophical instruments, &c.

COPPER is of a brownish red colour, malleable, and ductile; but inferior in these respects to silver. Of native copper, Sp. gr. 8,584.—*Haüy.* A wire 1-10th of an inch, will support 299½ pounds. It melts at 27° *Wedgwood.* When exposed to a very strong heat, it burns with a green coloured flame, which colour its salts yield to the flame of alcohol. Heated in contact with air, it burns at its surface, and suffers oxidizement; and although the colour varies in different processes, *Proust* thinks that the results are only different modifications of the same oxide, which always contains 0,20 of oxygen. The blood red coloured surface acquired by a violent heat appears to proceed from a species of vitrification. If melted and cooled slowly, it forms in quadrilateral pyramids, or in octahedra, proceeding from its primitive form, the cube.

It has but little, if any, action on *water;* it attracts *oxygen* slowly from the air, and yields oxygen to many of the metals; but takes it from *mercury* and *silver*. *Carbon* and *hydrogen* appear only to act on its oxide, attracting its oxygen, and reducing it to its metallic state. This effect, however, is only produced by hydrogen on these, as well as on other metallic salts and oxides, whilst they are dissolved or diffused in water; it not taking place whilst they are in a dry state.

It combines readily with *sulphur*, forming a very fusible mass, termed SULPHURET OF COPPER. This sulphuret yields a curious phenomenon. Filings of copper mixed with sulphur being held in a glass vessel, closed, in heated charcoal, so as to melt it, or only even soften, a red and bright shining light is seen, which the Dutch chemists have supposed to have proceeded from a real combustion without access of oxygen, but which *Fourcroy* supposes to be simply a phosphorescence of the compound. It also unites readily with *phosphorus*, forming a grey brilliant PHOSPHURET OF COPPER. It readily acts on rancid *fat* and *oils*.

It is acted on by the *sulphuric acid*, only when concentrated, and very hot. It is then oxidized by it, and affords blue oblong rhomboid crystals, being the SULPHATE OF COPPER, *blue vitriol*, *cyprian vitriol*, *blue copper*, *&c.* composed of oxide 0,32, acid 0,33, water 0,35. Lime and magnesia, as well as ammonia, precipitate the copper of a blueish white; but the precipitate from the latter is dissolved at the instant it is formed, and the result is a beautiful blue liquor, called *aqua cœlestis*.

This sulphate is decomposed by heat, the acid escaping, and the black oxide remaining. This sulphate is not acted on by any acid, but is readily decomposed by the earths and alkalies. If a very small quantity of pot-ash be added to a solution of this sulphate, a light flocculent greenish precipitate forms, which is, according to *Proust*, a sulphate with its *minimum* of acid, being the oxide of copper, with a small portion of the acid, it containing 0,68 of oxide, 0,18 sulphuric acid, and 0,14 of water. But if the alkali be added in excess, a *blue* precipitate falls, being a combination of water with the oxide, and is called by *Proust* HYDRATE OF COPPER; and by *Chevenix* the HYDRO-OXIDE OF COPPER. The *sulphureous acid* attacks the oxide, only, of copper, which gradually loses its water, the black oxide being only left.

Copper is decomposed by diluted *nitric acid*, with slight effervescence, abundance of nitrous gas, or nitric oxide, being emitted. A blue solution is thus obtained, yielding crystals of NITRATE OF COPPER, in long parallelopepids. Lime added to a solution of nitrate of copper obtains a blue colour from the precipitate, the hydro-oxide of copper, it throws down. It is used in *paper staining*, and is called *cinder-blue*.

It is not dissolved by the *muriatic acid*, unless boiling and concentrated. The solution affords cubic crystals, the MURIATE OF COPPER, of a fine grass green. Ammonia does not dissolve the oxide of this muriate, with the same facility as that of other cupreous salts.

When acted on by the *acetic acid*, it is corroded, and yields the substance, known by the name of *verdigrise*. Being combined with oxygen, it becomes more readily soluble in vinegar. The oxide of copper dissolved in vinegar, forms the ACETATE OF

COPPER, *distilled verdigrise*, or *crystals of Venus*. The *phosphate*, *carbonate borate*, &c. of copper are but little known. The blue solutions of copper, indicate the less, and the green, the greater degree of oxygenation.—*Morveau.*

Copper also unites with the *arsenic acid*. Mr. *Chevenix* found the natural *arseniates of copper* in three different states of combination; the first containing 14, the second 21, and the third about 29 per cent. of acid.

The *fixed alkalies*, and even many *neutral salts*, act on it, and it is said, most powerfully in the cold, and when exposed to the atmosphere.

If some crystals of *nitrate of copper* be folded in a fine sheet of tin, and be slightly moistened, heat is evolved, nitrous gas is disengaged and even a species of deflagration is produced: so great is the energy with which the oxygen is attracted by the tin.

Muriate of Ammonia mixed with a sixtieth part of green oxide of copper, being sublimed by heat, a slight decomposition takes place, a small portion of muriate of copper is formed, which is carried up with the muriate of ammonia.

Copper filings being added to a caustic solution of *ammonia*, no solution takes place, except air be admitted; and if this be only admitted for a short time, though the solution takes place, it remains colourless; but if air be admitted, it becomes blue at the surface and then through the whole solution. If it has not been too long exposed, and fresh filings be added, and the bottle closed, it will lose its colour, and only regain it by admission of air.

The decoloration arises from the precipitation of the oxide, which, on the admission of air, takes from it its oxygen, and becomes again dissolved.

It is precipitated from its solutions, in its metallic form, by many of the metals, but particularly by a plate of iron, the iron appearing to be converted into copper. The copper thus obtained, is known by the name of COPPER OF CEMENTATION.

It unites with the earths, only by vitrification.

It mixes with most of the metals and semi-metals, forming, 1. With *arsenic*, or *zinc*, the WHITE TOMBAC. 2. With *bismuth*, an alloy of a reddish white colour, with cubic facets. 3. With *antimony*, a violet coloured alloy. 4. With *zinc*, by fusion, the SIMI-

LOR, OR MANHEIM GOLD; or by cementation with *calaminaris*, BRASS. 5. In a solution of *quicksilver*, it acquires a white surface from the precipitation of the quicksilver. 6. It easily unites with tin; on this depends the art of tinning. Fused with tin it forms BRONZE, OR BELL METAL. Dr. *Pearson* having examined some ancient metallic arms and utensils, was able to ascertain that they consisted of copper and tin, in the proportion of from six to twelve parts of copper to one of tin; according to the use for which they were intended. 7. With *iron*, it contracts very little union. 8. Alloyed with *silver*, it is rendered more fusible; these two metals are combined to form solder. 9. Added to *gold*, the gold is hardened, and its colour heightened. It precipitates *silver* from its solution in the nitric acid. This method is used to separate the silver after the operation of parting.

To separate silver from copper, *Napioné*, knowing sulphur to have a greater affinity for copper than for silver, recommends reducing the alloy into scoriæ by combining it with sulphur, to obtain the silver concentrated in a portion of the copper, which might be refined immediately by cupellation.

The hyperoxygenized muriate of pot-ash burns and inflames copper by a blow, if a piece of kindled charcoal be brought in contact with it.

It is employed for various domestic uses. Its oxide is employed to colour glass of a beautiful green.

IRON, when fresh broken, is of a pale, blueish grey colour. Sp. gr. of cast iron, from 7,2 to 7,6: of bar iron, from 7,6 to 7,8: of steel, from 7,78, to 7,84. When only ignited it becomes very malleable, but it requires for its fusion a heat equal to 130° *Wedgwood*, and at a few degrees of heat higher it burns. It is obedient to the magnet, and is the only metal capable of combustion, on collision with silex. When slowly cooled after fusion it crystallises in octahedra almost always implanted in one another. Its hardness, elasticity, and ductility are very considerable.

It is the most generally diffused metal in nature: almost every mineral substance deriving a colour from it, from a blue to the deepest red. Animal substances contain it, and it exists in the vegetable kingdom; even in vegetables apparently supported merely by air and water.

It attracts *oxygen* by mere exposure to the air; absorbing also the *carbonic acid* of the atmosphere, and forming a CARBONATED OXIDE OF IRON.

On being heated in a furnace for some time, the surface is oxidized, and separates in the form of black scales. This oxide is still attracted by the magnet, and contains from 0,25 to 0,27 oxygen; but if the heat be longer continued, and a free exposure to the atmospheric air be obtained, the oxide becomes a powder of a brown colour, and then contains full 0,40 of oxygen. The first portion of oxygen of 0,25 which *Fourcroy* terms the oxidulating portion adheres more firmly than the latter portion of 0,15, which he distinguishes as the oxidizing portion. The red oxide is therefore decomposed by hydrogen gas, but the black is not. The *brown oxide* was formerly called the *astringent saffron of Mars*. The *black oxide* is also formed of iron more rapidly burnt, as when small particles of iron are thrown into a taper, or a brisk fire, or separated by collision against substances possessing a great degree of hardness. It is also formed by burning iron wire in oxygen gas; when the particles which are detached shine with great brilliance.

Iron in filings, being constantly agitated in water, a black powder is deposited, being black oxide of iron, also called the *martial æthiops of Lemery*. The oxidizement is effected by the air contained in the water; but more especially by the decomposition of the water itself, hydrogen gas being evolved during the process. With heat this process is rapidly performed, and much hydrogen gas is separated. After oxidizement it is less attractible by the magnet, and less soluble in nitric acid: possessing these properties, inversely, as to the quantity of oxygen it contains. The oxide thus obtained is always black if made in close vessels; but if the experiment be made in the air, more oxygen is absorbed, and the oxide is of a brown colour. It is oxidized in a slight proportion, by being digested in a solution of the *fixed* or *volatile alkalies*, falling down in the form of an æthiops. It also deprives most of the other metallic oxides of their oxygen, and burns with a flame when heated with red oxide of mercury.

Though it does not enter into any known combination with *hydrogen*, yet it appears that in some cases it is dissolved in *hydrogen gas*, carrying with it a small quantity of carbon. The *hydrogen gas* also, by substracting oxygen from red oxide of iron, is capable of changing it to the black.

Carbon unites easily with iron. When charcoal, or carbonaceous matters, are burnt in large heaps, with melting iron; and when organic matters, which contain a slight portion of iron; are burnt in close vessels, the iron is absorbed in a small quantity by the *charcoal*, which is rendered less combustible, and acquires a metallic lustre, being an *artificial hypercarburet of iron.*

Such is Anthracolite, or incombustible pit-coal, which has a metallic lustre, gives a slight mark, is soft and brittle. Sp. gr. 1,468. It contains 0,90 carbon, 0,04 alumine, 0,03 silex, 0,03 iron.

Such also is Plumbago, also called *Graphite*, and *Black-lead.* It is that shining substance of a blackish blue colour, which is used to make the pencils called *black-lead pencils*; it has a greasy feel, exhibits a tuberculated fracture, soils the hands, and leaves a black trace upon paper. It is indestructible by heat, without the presence of air; but with the concurrence of air, it burns, and leaves but a small residue.

One part of plumbago, and two of caustic dry alkali, being heated in a retort, the alkali effervesces, hydrogen gas is formed, and the plumbago disappears. The small quantity of water, in the salt, is decomposed, whence the hydrogen gas; and its oxygen combining with the carbon of the plumbago, forms carbonic acid.

The *sulphuric acid* distilled from plumbago, passes to sulphureous acid, carbonic acid being yielded, and an oxide of iron left in the retort.

The *nitric acid* has no action upon plumbago, if pure.

The *muriatic acid* has no action upon plumbago; but, as it dissolves the iron and clay, which contaminate it, it is used for its purification.

The *oxygenized muriatic acid* dissolves it; a true combustion being effected by the oxygen of the acid, and the carbon of the plumbago.

If thrown by little at a time, on fusing *nitrate of pot-ash*, the salt will deflagrate, and the plumbago be decomposed; the residue being a strongly carburetted alkali, and a small portion of martial ochre.

All these facts prove that plumbago is a peculiar combustible substance, a true charcoal combined with a martial basis. It is more common than is imagined. The brilliant charcoal of certain vegetable substances, especially when formed in close vessels, possesses all the characters of plumbago. The charcoal of animal substances possesses characters still more resembling it: being difficult to incinerate, leaving the same stain, containing iron, and becoming converted into carbonic acid by combustion. During the distillation of animal substances by a strong fire, a fine powder attaches itself to the neck of the retort, which may be made into excellent pencils.—*Chaptal.*

Carbon may be formed in the earth by the decomposition of wood, together with pyrites; but the origin of plumbago seems to be principally owing to the ligneous, and truly indecomposable part of the wood, which resisting the destructive action of water, in its decomposition of vegetable substances, is disengaged from the other principles, and forms peculiar depositions, and strata.—*Chaptal.*

In the dominions of the king of Naples, there are wells dug expressly for the purpose of collecting an acidulous water, at the bottom of which, a quantity of plumbago is collected every six months.—*Fabroni.*

The same gentleman supposes the black mud found beneath the pavement of Paris, is plumbago formed in the humid way.

Plumbago is used for pencils, for lubricating the surfaces, and thereby lessening the effect of friction of certain parts of machines, for defending iron from rust, for polishing, &c.

The nature of *plumbago* has received considerable illustration, from the late experiments and observations on the DIAMOND; which thereby appears to be an oxide of carbon in the first degree.

From the experiments of *Guyton* on the carbonic nature of the diamond, *Clouet* was induced to propose the conclusive experiment of making *soft iron* pass to the state of *steel*, by *cementation with the diamond.* He therefore secured a diamond with some filings of iron, in a cavity bored in a block of soft iron, filling up the cavity with a stopper of iron. The whole properly inclosed in a crucible was exposed to the heat of a blast furnace, by which the diamond disappeared, and the metal was fused, and converted into a button of cast steel.

Mr. *Mushet*, from an experiment he made, concluded that the diamond did not contribute the carbon, for, on leaving out the diamond, the conversion took place as he thinks, from carbon dissolved in caloric penetrating through the crucible, and the rest of the apparatus.—*Phil. Mag.*

Sir *George Mackenzie* suspects, either that the carbon was derived, in Mr. *Mushet's* experiment, from the sand, or other materials he employed; or else that what he obtained was only a combination of iron with earths, somewhat resembling steel, Sir *George* repeating *Guyton's* experiment with complete success.—*Nicholson's Journal, June*, 1800.

Steel is also the result of the union of *iron* and *carbon;* but as in the former combination, the carbon is very superabundant, so in this, the iron is much more prevalent. If in the first fusion of iron the carbonaceous matter is kept supplied, during its escape with the oxygen, it becomes what is termed native steel. The common process is entirely to surround small bars of iron, with charcoal, in close vessels, and to expose them to a white heat, when the charcoal will appear unchanged, and the iron will have become factitious steel, *by cementation.*

Steel made in either of these modes possesses a larger and more brilliant grain than it did before; and wherever it is touched by a drop of nitric acid a dark spot is formed of carbonaceous matter. A similar carburet is deposited from its solutions in acids. It is capable of assuming a finer polish, its specific gravity is increased, and it is not so easily oxidated. It is ductile, whether cold or ignited; but being plunged in cold water, whilst ignited, it becomes harder, more brittle, and inflexible; but re-assumes its ductility by fresh ignition and gradual cooling. It may be rendered almost of any degree of hardness, this depending on the degree of heat employed in the process of tempering.

Tempering of steel has generally been regulated by the colour it exhibits. But Mr. *Stodart* has brought this operation to almost a degree of certainty, by placing the steel on a metallic bath formed of 8 parts of zinc, 5 of bismuth, and 3 of lead, and comparing the colours, and the temper produced, with the degree of heat, as marked by a thermometer immerged in the bath.

Mr. *Mushet* is of opinion that *crude iron* and *steel* only differ from each other in the proportions of carbon they contain, and concludes, that—

Iron, semi-steelified, is made with charcoal . .	1-150th part.
Soft cast steel, capable of welding	1-120th
Cast steel, for common purposes	1-100th
——— requiring more hardness	1-90th
Steel capable of standing a few blows, but unfit for drawing	1-50th
First approach to a steely granulated fracture, is from	1-40th to 1-30th
White cast iron	1-25th
Mottled cast iron	1-20th
Carburetted cast iron	1-15th
Super-carburetted crude iron	1-13th

or when any greater quantity is used.

Philos. Mag. July 1802.

The quantity of carbon necessary for making of steel is very small indeed, the quantity of *carbon* existing in steel seldom exceeding a 300th or 200th part, and, perhaps, never more than a 100th part; the remaining quantity of charcoal flying off at the time of cementation, perhaps, in the form of gaseous oxide of carbon. This, indeed, is rendered probable, by the appearance of a lambent blue flame during this process, and which much resembles that of the gaseous oxide of carbon. Steel is capable of being fused, and rendered what is called *cast steel*, which is employed for the finer articles of manufacture.

Ever since the invention of *cast steel*, it has been supposed to be impossible to *weld* it to either common steel or iron; but Sir *Thomas Frankland* says, the fact is, that cast steel in a *white heat*, and iron in a *welding heat*, unite completely.—*Philos. Trans.* 1795.

Dr. *Pearson*, by an ingenious investigation of the nature of a kind of steel, called WOOTZ, which is brought from Bombay, discovered that it contains oxygen, and concluded, from all the properties it possesses, that oxygen is the ingredient which distinguishes wootz from steel.—*Philos. Trans.*

The attraction of iron for carbon is such, that, at a very high temperature, it will even take it from oxygen, thus iron urged in a welding heat, with carbonate of lime and clay, is changed to steel. One-fifth of cast iron, converts bar iron into steel. The black oxide, with half its quantity of charcoal, which would serve for its reduction, affords a black iron of little tenacity. One-sixth of the oxide restores common steel to the state of iron.—*Annales de Chemie*, 1798.

Cast, or Crude Iron, contains *carbon* and *oxygen*. The presence of the former appears from its coating the utensils, employed in its fusion, with *plumbago*, a substance which contains nine-tenths of carbon: also from the acids which dissolve it always leaving a residue, which is purely carbonaceous. That crude iron contains oxygen, is rendered evident by the formation of carbonic acid, by urging the crude iron, in close vessels, in a violent heat.

Crude, cast, or pig iron, is eager and brittle, and contains iron, carbon, and oxygen, the carbon being in a concrete state separable by mechanical division.

1. When it contains a small proportion of carbon, and a superabundance of oxygen, it is called *white-iron, forge-pigs, ballast-iron, &c.*

2. When it contains equal quantities of carbon and oxygen, it is known by the name of *grey-iron.*

There are two other varieties. In the one carbon predominates with an extra privation of oxygen; the other approaches to plumbago.

Forged Iron, or Bar Iron, is distinguished into *soft iron*, and *eager or brittle iron*. *Soft* or *pure* iron is so ductile that it may be extended in wires of extreme fineness. A wire of 1-10th of an inch will support 450 pounds. In this state it possesses the aptitude for *welding*; but is almost incapable of fusion. In proportion to its softness and ductility it is free from carbon. It is divided into *red short iron*, and *cold short iron.*

Red Short Iron is malleable when cold, but brittle when ignited; it is supposed to derive these properties from arsenic, or from concrete carbon, not extirpated during the operation for rendering it malleable.

Cold Short Iron is brittle when cold, but not when ignited. Being dissolved in the sulphuric acid, it precipitates a *white powder*, supposed by Mr. *Bergman*, who discovered it, to be a peculiar metal; this precipitate he named siderite; but Mr. *Meyer*, of Stettin, has proved it to be a true phosphuret of iron. Every solution of iron is precipitated in the form of siderite, by the phosphoric acid.

Iron combines easily with *sulphur*, by fusion, forming a *true martial pyrites*, or sulphuret of iron. It also unites with *sulphur* simply by the addition of water, which is decomposed. The mixture swells, becomes heated, emits sulphuretted hydrogen, and frequently inflames spontaneously. By a similar natural process are native pyrites decomposed. By a mixture of large quantities of filings of iron and sulphur, moistened with water, and buried a little way under the surface, is formed the *artificial volcano of Lemery*.

The natural sulphurets of iron crystallize sometimes in cubes, and often in octahedra. The union of a number of octahedral pyramids, forms the GLOBULAR PYRITES.

From the decomposition of pyrites, the *sulphuric acid* is disengaged, which held the iron in solution.

We do not at present know the mode of formation, nor, perhaps, the exact composition of the natural pyrites. Since those formed by art cannot be made to imitate either their crystallization, brilliance, or colour.

The native sulphurets of iron, or martial pyrites, are thought to owe their origin to the decomposition of vegetables.

Guyton has shewn that the lapis lazuli is coloured by a *sea-blue sulphuret of iron*, which he obtained by dissolving sulphuret of iron in nitric acid, to which, well diluted with water, pot-ash being added, a light blue precipitate is obtained.—*Ann. de Chem.* 100.

By the addition of *glass*, though but a small quantity enters into the iron, its properties are much changed. Though soft to the file, yet if heated cherry red, it flies to pieces under the hammer. The cast ingot contracts in cooling. When by careful management it is made into bars, by hardening they acquire the grain of steel. By adding from 1-30th to 1-20th of charcoal, it may be forged at a red heat, and gains all the properties of cast steel; but by adding more, only a cast iron is obtained.

The mass of iron, weighing 1600 pounds, found in Siberia by *Pallas*, is supposed by Dr. *Chladni*, to have been a fire-ball or shooting star, and that iron is the principal matter employed in forming new planetary bodies.

The analysis of several bodies, which have fallen on the earth from some unknown region have been examined by Mr. *Howard*, and have been found to consist of silica, magnesia, oxide of iron, and of nickel. All these substances appear to be strikingly analogous to each other, and dissimilar to other mineral products. They appear to consist principally of substances of four kinds, besides the dark crust which surrounds them: the first of these substances is in the form of dark grains, of a conchoidal fracture, from the size of a pin's head to that of a pea; the second is a kind of pyrites; the third is a metallic iron; and the fourth a grey earthy substance, serving as a cement to the rest.—*Philos. Trans.* 1802.

Iron is the most capable of being oxidized, and of being united with *acids*, at the same time that its permanency of union and of dissolution is most limited of all the metals.

Concentrated *sulphuric acid* is decomposed by boiling on this metal, sulphureous acid gas being evolved.

If the acid be diluted with water, hydrogen gas will be separated, which will be purest from soft iron, most sparing from cast iron, and impregnated with carbon from steel. By this action of the water on the iron it becomes oxidized, and is then seized by the acid, which forms with it the sulphate of iron, the process going on until all the acid is saturated; but is suspended when the water is saturated with sulphate, the action being renewed by the addition of more water.

Sulphate of Iron, or *Salt of Steel*, or *Copperas*, thus formed, yields a sharp and astringent taste, and forms in transparent green rhomboidal crystals. The oxide which it contains is in the state of the black oxide, with from 0,25 to 0,29 of oxygen. It is formed also by the decomposition of the pyrites of iron.

Sulphate of iron contains half its weight of water, by which it at first liquifies on the application of heat, but on its evaporation it becomes a grey powder, *the sympathetic powder of Digby*. If the heat be increased to a very high degree, the sulphate is decomposed, the iron becoming separated from the acid, which escapes in a gaseous form, as sulphureous acid; having been deprived of a portion of its oxygen by the iron, which thereby becomes highly oxygenized, and of a fine red colour, being the substance known by the name of *colcothar*, and containing a portion of sulphate in a hyperoxygenized state.

If the sulphate be exposed in a retort to a very intense heat, after the coming over of a little water and sulphuric acid, strongly impregnated with sulphureous acid, an acid comes over of a white colour, and in a concrete form. A similar acid is described by *Bernhardt*, a German chemist, as forming in crusts, and resembling certain champignons, and yielding an acid vapour. These concrete acids *Fourcroy* has proved to be a sulphuric acid surcharged with the sulphureous acid.

The sulphate of iron, whether crystallized or in solution, attracts *oxygen* rapidly from the air and other substances with which it comes in contact, becoming yellow and opake as it becomes oxidized. It is decomposed, and is precipitated of a dark brown colour by the earths and the alkalies; it is also decomposed by most of the salts.

If melted nitrate of pot-ash and yellow sulphate of iron be distilled, two liquors come over, one of dark reddish brown, which swims on the other, which is heavier and of a lighter colour, and a white, concrete, caustic, deliquescent substance passes into the neck of the retort, being sulphuric acid rendered concrete by saturation with the nitrous vapour or nitrous oxide. The lighter of the two fluids just mentioned, being mixed with sulphuric acid, produced a violent effervescence, and even a dangerous explosion, the nitrous acid being reduced into vapour, and the sulphuric acid rendered concrete by absorption of nitrous gas during the explosion. The two liquors of different gravities are nitric acids, the lightest of which is the most charged with nitrous oxide.

The *green sulphate of iron*, containing oxide of iron with from 0,25 to 0,29 of oxygen, as has been before remarked, is greedy of oxygen, becoming thereby an oxygenized sulphate. This oxygen it seizes from the air, from carbonated water, nitric acid, and particularly from oxygenized muriatic acid, and passes directly to the state of hyperoxygenization.

Hyperoxygenized sulphate is of a red colour, it never crystallizes, but attracts moisture from the air; it is always with excess of acid; its iron is impregnated with 0,48 of oxygen. There exists, therefore, two sulphates of a certain impregnation with oxygen, and no intermediate state, their different shades of colour being the result of a mixture of the two sulphates, which may be separated by alcohol, the hyperoxygenized being dissolved whilst the other is untouched. The precipitates of the two sulphates are formed also, in the one case, with 0,73 of iron and 0,27 of oxygen; in the other, 0,52 of iron and 0,48 of oxygen.

Iron, mercury, zinc, tin, and other metals, by abstracting oxygen, occasion the oxygenized sulphate to retrograde to the state of simple muriate.

Proust has ascertained, that *galls* effect no change of colour in the simple sulphate; but that with the hyperoxygenized sulphates the galls form a bright black precipitate, and that the *alkaline prussiates* give with the simple sulphates a white precipitate, with 0,27 of oxygen, and with the oxygenized sulphate, a blue precipitate, or *Prussian blue*, with 0,48 of this principle: the white precipitate from the green sulphate acquires a blue colour by the accession of oxygen from the atmosphere, which it eagerly imbibes; this not being the case with those of the yellow sulphate, which are already saturated with oxygen. It is the black precipitate just described, which forms the basis of *ink* and of *black dyes*, and which acquires a brightness of colour by exposure to the air whilst wet, thereby securing a full saturation of oxygen.

Sulphureous acid is acted on immediately by iron filings, and acquires a deep fawn colour, which changes to a greenish hue. A few bubbles of hydrogen gas are disengaged, and a carburet of iron precipitates. Acids added to the solution produce a disengagement of sulphureous acid gas and a precipitation of sulphur; which with the sulphuric or muriatic is white, and with well smoking nitrous acid, yellow; the sulphur in both cases containing a small quantity of iron. A yellow precipitate, with crystals, are precipitated from this solution by mere exposure to the air, the crystals being a sulphuretted sulphite, but with a proportion of less sulphur than was held in the first solution. This second solution exposed to the air has its remaining sulphur deposited, and the sulphite becomes changed to a sulphate. The sulphuretted and the simple sulphite differ, in the former being permanent in the air, and the latter absorbing oxygen; the former depositing sulphur in the addition of acids, and the latter only giving out sulphureous acid; and in the former being soluble in alcohol, but the latter not. The simple sulphite may be also formed by the solution of oxide of iron in sulphureous acid. Neither of the sulphites gives a black precipitate with galls, or a blue one with prussiates.

Iron is rather oxidized than properly dissolved by the *nitric acid*, which at the same time is rapidly decomposed, nitrous and nitrogen being evolved, as well as hydrogen gas; hence ammonia is sometimes formed in this process. Nitrate of iron appears to hold the iron in its highly oxidized state of 0,48 of oxygen. To obtain the NITRATE OF IRON, the acid must be considerably diluted.

A pound of iron filings made into a paste with water, being mixed with from one to two ounces of nitric acid, very much diluted and stirred with a spatula, it effervesces and becomes a black oxide in less than half an hour, and if the vessel be closed and left till next day, the surface will be covered with a kind of champignons extremely white and several lines high, which are carbonate of ammonia, the vessel also now holding oxygenized nitrous gas. The water and nitric acid being deprived of their oxygen by the iron, their hydrogen and nitrogen combine whilst in a state of condensation, and compose the ammonia in this form.—*Fabroni, An. de Chem.* xxx.

It is attacked by the *diluted muriatic acid* with vehemence, hydrogen gas being disengaged from the water. By concentration, a *magma* containing thin, flatted, deliquescent crystals is formed, being a MURIATE OF IRON. This distilled, first yields an acid phlegm, then a non-deliquescent *muriated oxide* of iron, in very transparent crystals, in the form of razor blades, shewing prismatic colours; a deliquescent salt of a brilliant colour, and foliated appearance, like fine large talc, remaining at the bottom of the retort. This again by sublimation yields an opake, metallic substance, polished like steel, exhibiting sections of hexahedral prisms, being iron reduced.—*Chaptal.*

The solution of the sublimed muriate in ether loses its yellow colour on exposure to the sun, and recovers it in the shade.

Iron is precipitated from its solutions, by the *acid of galls*, this forming the BASIS OF INK.

It is dissolved by the *acetic acid* with facility. This holds the metals suspended in vegetables, it being precipitable from wine in the form of æthiops, by the means of pure alkalies. It is likewise dissolved by the *acidulous tartrite of pot-ash*, forming the SOLUBLE MARTIAL TARTAR, or *aperitive extract of mars.* In the *oxalic acid*, it yields prismatic, astringent, effervescent crystals, of a greenish yellow colour, soluble in water.

Phosphoric acid unites with it, but very slowly.

Carbonic acid forms with it, as in the chalybeate waters, the CARBONATE OF IRON.

Of the FLUATE OF IRON, and BORATE OF IRON, but little is known.

With the *Prussic acid* it forms, as has been already shewn, PRUSSIATE OF IRON, or *Prussian blue*. Prussiate of iron takes fire more easily than sulphur, and detonates strongly with the oxygenated muriate of pot-ash. Lime water saturated with the colouring principle by digestion on Prussian blue, is the most accurate means of ascertaining the presence of iron, precipitating it of a fine blue. With two parts of hyperoxygenized muriate of pot-ash it detonates strongly, and with a bright red flame, on being smartly struck or rubbed: the same mixture burns also rapidly on being ignited.

With the *salts* the iron enters into action according to the degree of attraction for the acids which enter into their composition.

"Iron," in filings, with an equal quantity of *nitrate of pot-ash*, thrown into a crucible strongly ignited, detonates, emitting numerous bright sparks, the residue, when washed, being a YELLOW OXIDE OF IRON, called *Zwelfer's saffron of mars*. Iron decomposes the *muriate of ammonia* very well, yielding the aëriform fluid, half alkaline, and half hydrogenized. Iron, in filings, sublimed with muriate of ammonia, in the proportion of an ounce to a pound, forms the MARTIAL FLOWERS, or *ens martis*, being a MURIATE OF AMMONIA COLOURED BY IRON.

Oxides of iron give a pale green glass, with *alkaline phosphates*, and also with *borax*, but so much the more inclining to yellow, as they are more oxygenized.

Iron unites with *arsenic* in the red short iron, and in the mineral called *mispickel*, which is a native arsenical iron. With *cobalt* it forms a very hard and brittle alloy. It enters into union also with *nickel*, *manganese*, *bismuth*, and *antimony*; but it enters into these alloys but sparingly, nor have they been found of any utility.

By immersing iron plates for twenty-four hours in water a little sharpened by an acid, and then repeatedly dipping them in melted *tin*, the plates called BLOCK TIN are formed. *Zinc*, according to *Malouin*, may also be sparingly united to the surface of iron. *Mercury* or *lead* does not enter into any union with iron.

LEAD is of a bluish white. Sp. gr. 11,352. It gives a black mark to paper, or the fingers; is the least sonorous, tenacious, and elastic of metals. It quickly tarnishes, its surface soon becoming oxidized or rather carbonated, and it may be classed among the most fusible of metals. It melts before it becomes red-hot at 540° F. In a very high temperature it sublimes: if suffered to cool slowly it forms in quadrangular pyramids.

It does not act immediately on *water*, but if exposed at the same time to the action of the air, it is rapidly oxidized: and although pure water will not dissolve the oxide, its solution takes place freely if any small portion of saline matter be held in the water.

Kept for some time in fusion, it becomes covered with a GREY imperfect OXIDE, which again exposed to a more violent heat, assumes a deep yellow, and is called *massicot*. This cooled by the affusion of water, ground and washed from the particles of lead, and again exposed to a moderate heat, becomes a more *perfect* and RED OXIDE OF LEAD, called *minium*, containing 0,10 of oxygen. If the fused lead is exposed to violent heat, and the wind of bellows directed on its surface, a scaly yellow oxide is formed, called *litharge*.

These oxides being fused with *coaly matter*, the metal is revived. Their reduction is also obtained by *hydrogen*. If acted on by a strong heat, oxygen gas is separated; and if urged by a very strong heat, they are converted into a YELLOW GLASS, or VITREOUS OXIDE; so fusible that it penetrates the best crucibles.

It combines very freely, in general, with the *acids*.

Sulphuric acid acts only on lead at a boiling heat, when much sulphureous gas arises, and an oxide of lead is formed, as well as a very caustic SULPHATE OF LEAD, which crystallizes in the octahedron and its several modifications. 142 parts of this salt = 100 of the metal.

Sulphureous acid does not dissolve lead, but unites readily with its oxide.

Concentrated *nitric acid* also converts it into a white oxide; but when the acid is weak, the lead is dissolved, and crystals of an opake white in three sided prisms with truncated angles, may be obtained, being the NITRATE OF LEAD. This salt decrepitates so loudly on burning coals, as to have been named by *Boerhaave, fulminating lead.*

The *muriatic acid*, assisted by heat, oxidizes lead, and dissolves a portion. This salt, the MURIATE OF LEAD, crystallizes in striated hexahedral prisms, which are slightly deliquescent.

The muriate of lead is also formed by adding the muriatic acid to a solution of a nitrate of lead, the oxide combining with the muriatic acid, and precipitating in a white powder. When exposed to a moderate heat, it melts into a transparent hornlike matter, called *plumbum corneum.*

Oxygenized muriatic acid gas being received in water containing either white, red, or yellow oxides, it is absorbed, and the oxide first is blackened and then dissolved, forming a HYPEROXYGENIZED MURIATE OF LEAD, from which may be obtained a BROWN OXIDE, possessing peculiar properties. It is reduced by the blow pipe on charcoal; it yields much oxygen, either by heat alone, or with sulphuric acid, like the oxide of manganese; and it inflames sulphur with a brilliant light, but without detonation, by mere friction.

With oxygenized muriate of pot-ash lead burns freely, on being ignited; and detonates loudly, with emission of light, on the percussion of three parts of the salt with one of lead.

The oxides of lead are all decomposable by the muriatic acid. It decomposes litharge of lead instantly, fifty or sixty degrees of heat being produced; the solution yielding fine opake, white, octahedral crystals, of a considerable weight, soluble in less than their weight of boiling water. They decrepitate on hot coals, and by an increased heat are converted into a mass of a beautiful yellow colour. By a somewhat similar combination is obtained the fine YELLOW PIGMENT, called PATENT YELLOW, which may be also produced by the fusion of litharge and common salt. Minium or litharge also decomposes the *muriate of ammonia*; and by thus decomposing *sea salt*, the separation of soda is obtained.

The *acetous acid* corrodes lead, and affords a WHITE OXIDE, known by the name of *white lead.* The *phosphoric* acid acts on it but very slowly.

All the oxides of lead are soluble in vinegar, forming the ACETATE OF LEAD, which crystallizes in efflorescent tetrahedral prisms, formerly called *salt of saturn*, or *sugar of lead*, which being kept for sometime in a crucible, in a moderate heat, becomes a pyrophorus.

The oxides of lead attract the *carbonic acid* of the atmosphere with great eagerness. They also unite with the *tungstic*, *arsenic*, *molybdenic* and *chromic* acids.

Alkalies dissolve the oxides of lead, which may be precipitated by acids: and, in a metallic form, by mere concentration; the alkali acquiring a peculiar faint taste. Pure alkalies being added to a solution of the muriate of lead, a magma is directly formed, occasioning a species of *miraculus mundi*.

The *alkaline carbonates* precipitate a carbonate of lead from the different saline solutions of this metal.

Sulphur combines readily with lead, forming a brilliant semi-crystallized mass, termed SULPHURET OF LEAD, which assumes the colour of the natural *galena*.

It unites with *phosphorus*, forming a white, brilliant PHOSPHURET OF LEAD, difficult of fusion, and soon tarnishing.

With *arsenic* it forms a brittle, black alloy; with *bismuth*, the alloy is harsh; with *antimony*, grey and brittle; with *mercury*, a crystallizable amalgama; with half its quantity of *tin*, a very useful solder; but with *zinc*, its union is very weak.

As lead has the property of being easily oxidized, and of destroying other base metals, it is employed in *refining* the nobler metals. This is done in a *cupel*, a vessel made of ashes, which the lead will not easily vitrify, and which being porous will absorb the litharge as it is formed, and leave the surface of the alloyed metal to be the better acted on by the fire. This process is termed *cupellation*.

Besides its other uses, lead, from its oxides promoting the vitrification of other metallic oxides and of earthy bodies, is employed to glaze pottery; and its oxides enter into the composition of glass, the fusion of which they assist, and render it fitter for brilliant ornaments. It is used in enamels, and also to form pigments. The oxides are also used to amend the appearance and taste of wines and brandies; and to harden oils, and render them more drying. Dissolved in oils, they serve as the basis of plasters.

As the alkalies, lime water, sulphuric and muriatic acids, decompose the acetate of lead, throwing down the oxide in a white powder, it is recommended as a re-agent to detect the presence of these substances.

To detect the admixture of lead in wine, equal parts of oyster-shells and crude sulphur may be kept in a white heat for fifteen minutes, and when cold, mixed with an equal quantity of acidulous tartrite of pot-ash, and put into a strong bottle with common water to boil for an hour; and then decanted into bottles holding an ounce each, with 20 drops of muriatic acid in each. This liquor precipitates the least quantities of lead, copper, &c. from wines in a very sensible black precipitate.—*M. Hankemann, Bibl. Phys. Econ.*

As iron might accidentally be contained in the wine, the muriatic acid is added to prevent its precipitation, and its being mistaken for the precipitate of lead.

By the property of precipitating the lead of a dark colour, the alkaline of sulphurets, and even the sulphuretted hydrogen gas, render the solutions of acetate of lead, a *sympathetic ink.*

TIN is of a silver greyish white, very soft. Sp. gr. of Cornish tin, melted and not hammered 7,291. hammered 7,299. It is exceedingly ductile, but inconsiderably tenacious. It is very flexible and soft, yielding a peculiar crackling whilst bending. It is the metal which dilates most by heat, and next to mercury is the most fusible, it fusing at 410°. During its fusion, the surface, exposed to the air, is soon covered with a pellicle of GREY, *imperfect* OXIDE, which by a greater heat becomes a *perfect* WHITE OXIDE, called *putty*, used to polish hard bodies, and convert glass to *enamel.* If thrown on the ground whilst in fusion it breaks into flaming globules, which roll about and sparkle in a beautiful manner. It takes fire with a violent heat, a white oxide subliming. Its attraction for *oxygen* is very strong, it yielding in this respect only to manganese and zinc. It does not however decompose *water* without the aid of some third substance. It acts very forcibly on all the *acids*, and is said actually to assume the character of an acid; but this is not proved.

After repeated fusions, an assemblage of prisms are obtained, united together sideways.

The *sulphuric acid* oxidizes it without dissolving it, but the *sulphureous acid* forms with it a SULPHITE, or SULPHURETTED SULPHITE OF TIN.—*Fourcroy*.

In pure *nitric acid* it is directly precipitated in a white oxide. The acid must therefore be considerably diluted, and no heat employed; thus the NITRATE OF TIN may be obtained.

This nitrate burns with a white and thick flame like that of phosphorus; and detonates when well heated in a crucible. On distillation it boils up, and fills the receiver with a white vapour, smelling like nitric acid.

Guyton perceived that on distilling one part of *nitric acid* with one and a half of tin no gas was evolved; but found the residue contained a twentieth part of ammonia, formed by the nitrogen of the acid with the hydrogen of the water, from which the tin had taken the oxygen.

Tin is dissolved by the *muriatic acid*, cold or heated, a fetid hydrogen gas being disengaged, the nature of which has not been yet enquired into. The solution is yellowish, and the MURIATE OF TIN crystallizes in needle like forms, and attracts humidity.

The oxide in this salt is imperfect, and eagerly takes up more oxygen if presented to it. This it does if brought in contact with oxygenized muriatic acid in an elastic state, also in the following process.

When amalgamated with one-fifth of mercury, and distilled with an equal quantity of the whole, of corrosive sublimate, an insipid liquor first comes over, and then white vapours, which condense into a transparent liquor, that emits a considerable quantity of vapours, by mere exposure to the air. This is the *smoking liquor of Libavius*; appearing to be a MURIATE OF TIN, in which the oxide is *hyperoxygenized*. The *simple muriate* precipitates *gold* of a purple colour, and attracts oxygen so strongly from the atmosphere as to become a tolerable eudiometer, but the oxygenized muriate, saturated with oxygen, possesses neither of these properties.

It is dissolved by the *oxygenized-muriatic acid* with vehemence, and when the acid is highly concentrated, a magma is obtained, resembling pitch, which hardens in time. The filings are immediately inflamed and oxydized on being thrown into oxygenized muriatic acid gas.

It is dissolved in the common *aqua fortis*, prepared with saltpetre of the first boiling, for the composition for scarlet dye, from *cochineille*. This solution often disappoints, from the variable proportions of the muriate of soda, and nitrate of pot-ash; when it contains too little muriate, a precipitate falls; and when the acid is in excess, it affords an obscure colour. The most accurate proportions for a good solvent of tin, are two parts of nitric, and one of muriatic acid.

Its action on *phosphoric*, *boracic*, and *fluoric* acids is very feeble. It is recommended by *Puymarin* as being proper to form vessels with for the separation of the latter acid by the sulphuric. *Carbonic acid* does not appear to act on it either in the gaseous or liquid state.

Tin and its oxides are dissolved, but the latter much more freely, by *alkalies*. It combines with the *earths* by fusion; and if aided by the *fixed alkalies*, it forms an opaque enamel.

Most of the *saline compounds* are decomposed by tin. *Nitrate of pot-ash* and *oxygenized muriate of pot-ash* are acted on with violence, if heat be applied. A mixture of the latter salt with tin, struck with a hammer, fulminates loudly; a large luminous halo being formed at the same time.

Charcoal renders it refractory, and with *phosphorus* it forms a brittle PHOSPHURET.

By combining with *sulphur*, it forms SULPHURET OF TIN, of a bluish grey colour, of a metallic splendour, and acicular texture. But if the combination is with the perfect oxide, as in the following process, then is formed SULPHURETTED OF HYDROGURETTED SULPHURETTED OXIDE OF TIN; the *aurum musivum*, or *mosaic gold*, used by artists in many varnished works. Eight ounces of tin and of mercury being amalgamated together, are put in a matrass with six ounces of sulphur and four of muriate of ammonia: the bottom of the matrass being ignited, the sulphuret sublimes; and if the heat be such as to make the mixture take fire, it is sublimed of a dazzling colour in large hexagonal scales. The tin, minutely divided by its amalgamation, is oxidized by the muriatic acid of the muriate of ammonia; and the hydrogen, disengaged from the water of crystallization of this salt, combining with sulphur and caloric, forms a sulphuretted hydrogen gas. Muriated oxide of tin and mercury, united with sulphur in the form of cinnabar, also rises; the remaining oxide of tin and sulphur forming the *aurum musivum*.

It may be prepared without either mercury or muriate of ammonia, from eight ounces of tin precipitated by the carbonate of soda, from its solution in the muriatic acid, mixed with four ounces of sulphur.

A precipitate from the nitrate of tin, by liquid sulphur of potash being dried, and put into a retort, with half its weight of sulphur, and a quarter of the muriate of ammonia, the sulphuret of tin will be formed at the bottom of the retort, and of a most brilliant appearance.—*Brugnatelli.*

Being amalgamated in the proportion of two ounces to a pound of *mercury*, and urged by a violent heat for five hours in a sand bath, no mercury was disengaged, but the tin was crystallized; the lower part of the amalgama being composed of grey brilliant crystals in square plates, thin towards their edges, leaving polygonal cavities between each. Every ounce of tin retaining in crystallization three of mercury.—*Sage.*

It may be combined with other metals in various proportions. The malleability of *gold* is impaired even by an exposure to its fumes. *Silver* also suffers a diminution of its malleability by being fused with it. When alloyed with *copper*, it forms BRONZE, or BELL-METAL; with a very small proportion of *iron* it becomes harder, and more sonorous.

Of similar mixtures the metallic *specula* for REFLECTING TELESCOPES are cast, such as 2 parts of copper, 1 of tin, and 1-16th of arsenic.

Three parts of *tin*, with five of *bismuth*, and two of lead, forms an alloy, which has been termed the SOFT SOLDER, it liquifies in boiling water.—*Lichtenburg.*

Darcet recommends, of *bismuth* eight, of *lead* five, and of *tin* three parts.

Two parts of tin with 1 of bismuth afford, according to *Wallerius*, the compound called TUTTENAG, an appellation which is given in the East Indies to zinc.

One part of tin and 1 of zinc being melted together, and mixed with 2 of mercury, then agitated in a box rubbed with chalk, forms an AMALGAM which wonderfully augments the power of ELECTRICAL MACHINES.—*Kienmayer.*

Its amalgamating with *quicksilver*, occasions its being employed in the formation of MIRRORS. 1 part of tin, 1 of lead, 1 of bismuth, and 2 of mercury, form an amalgam employed for covering CURVILINEAR GLASS MIRRORS.

When combined with *lead* and *antimony*, it forms a mixture called PEWTER, very generally employed in fabricating vessels for various domestic purposes.

It is also employed in the composition for printers *types*.

Tin is also employed in ENAMELLING. A mixture of lead and tin, 100 parts of lead to 15, 20, 30, or even 40 of tin, is to be first calcined, 100 parts of the above calx fused in a potter's furnace, with 100 of sand, containing nearly a third of talc, and 25 or 30 of muriate of soda, forms the composition for *earthen ware*.

For enamelling *on metal*, the sand is previously calcined with a fourth part of muriate of soda, and even of minium. *Fluxes for the colours* are generally similar compositions, except that lead tarnishes with some colours. For delicate colours therefore similar compositions to the following may be used. 3 parts of sand, 1 of chalk, and 3 of borax; or 3 of glass, 1 of borax, a 4th of nitre, and one of white oxide of antimony.

Painting on enamel may be performed either on the raw or on the baked enamel. The colours are produced by the metallic oxides. The oxide of gold forms purple: iron, by peculiar management, red; lead, antimony, and silver, yellow; copper, green; cobalt, blue; manganese, violet.

From the affinity of copper with tin, it admits of being *tinned*, or of having its surface covered with tin. For this purpose the copper is first scraped, or cleaned by an acid, then heated, some resinous substance being applied to prevent oxidizement, and the tin is rubbed over its surface.

If care be taken to prevent oxidizement, and a proper degree of heat be employed, the tin may be made to enter into combination with *iron*, and iron may thus have its surface tinned.

ZINC, is in colour between the silvery white, and lead grey. Sp. gr. 7,190. It yields to the hammer with a slight degree of elasticity; but possesses, however, a slight degree of tenacity. It does not evince any particular power of conducting *electricity;* but manifests very considerable effects in the production of electricity of the *galvanic* kind.

It melts as soon as ignited, when it inflames and sublimes in white flocks, which are called *philosophical wool, pompholix,* or *nihil album,* and is a true OXIDE OF ZINC. When laminated into thin leaves, it takes fire by the flame of a taper, burning with a bright flame of a blue colour, mixed with green. It is the most combustible of the metals.

From its strong attraction for *oxygen* it readily decomposes *water,* and, at a high temperature, the decomposition is accompanied with effervescence, and even detonation. It also effects the decomposition of water, and consequent evolution of hydrogen gas, even in the cold; but this in a much more eminent degree, if aided by the *galvanic* influence, called forth by contact with some other metal.

The hydrogen gas separated by zinc in general contains carbon; but as *carbon* is not known to unite with zinc, its production in this instance most probably depends on the carburet of iron, almost always contained in the zinc. No known union takes place between it and *nitrogen* or *hydrogen;* the latter, however, under certain circumstances, dissolves the zinc, and raises it in a gaseous form; it also, at a high temperature, reduces the oxide of zinc.

With *sulphur* no direct combination has been obtained. Sulphur will indeed unite with its oxide, and therefore BLEND is supposed to be formed by such a combination.

Of all known bodies, except manganese, zinc seems to unite most readily to *oxygen,* often inflaming at the moment it seizes it, as may be seen when filings of zinc and red oxide of mercury are heated together in a glass retort. It takes it from almost every other body, which renders it useful in detecting the smallest quantities of oxygen. Hence Zinc acts on all the *acids* with great rapidity.

Sulphuric acid, diluted, dissolves it in the cold, and produces much pure hydrogen gas; a black powder, a carburet of iron, is separated, and a salt is formed in compressed tetrahedral crystals, terminated by four sided pyramids. This is the SULPHATE OF ZINC, *vitriol of zinc*, *white vitriol*, or *white copperas*. This salt, by exposure to air, effloresces, and part of its acid escapes, by the action of heat.

From this sulphate an oxide may be precipitated, soluble in acids, and in the precipitating alkalies, if in excess.

Zinc dissolves freely in *sulphureous acid*, sulphuretted hydrogen being disengaged. By spontaneous evaporation this solution thickens, crystallizes, and becomes a white powder, which, heated by a blow pipe, yields a brilliant light, swells, and forms a beautiful aggregation of tubercles and of ramifications. By the addition of nitric acid, sulphureous gas is disengaged, and sulphur deposited.

The foregoing SULPHITE contains sulphur, and is therefore a sulphuretted sulphite of zinc; but if concentrated sulphureous acid be saturated with zinc, a *pure* SULPHITE OF ZINC will be formed.

In two pounds of saturated solution of sulphate of zinc put one ounce of nitric acid, then by the addition of pot-ash the excess of acid is saturated, and a white substance, soon becoming yellow, is precipitated; when white parts are discoverable in this yellow precipitate, it may be concluded no iron remains in the solution. If the zinc contain manganese, carbonate of pot-ash is to be added, but short of the total precipitation of zinc; leaving the fluid on the solution two or three days, that if any manganese have been precipitated, it may be redissolved by the acid, the zinc precipitating in its place. The sulphite of zinc thus purified will furnish the fine WHITE OXIDE OF ZINC so desirable by painters—*Ann. de Chem.* Cah. 103.

The *nitric acid* attracts zinc with vehemence, inflaming it when concentrated, and dissolves it even when diluted with water. The solution, by slow evaporation, yields crystals in compressed and striated tetrahedral prisms, terminated by four sided pyramids, being the NITRATE OF ZINC, which is deliquescent. This salt emits red vapours when heated; becoming soft, and preserving that softness for some time.

The *muriatic acid* attacks zinc, with effervescence; very pure hydrogen gas being produced. The solution thickens by evaporation, without crystallizing, a concentrated acid escapes, and the MURIATE OF ZINC will itself sublime by distillation.

It attracts the oxygen of *oxygenized muriatic acid gas* without effervescence; and thrown in powder into the oxygenized muriatic acid gas, it directly is inflamed and oxidized. It also unites with the *phosphoric* acid, and with *liquid carbonic acid.*

The *fixed alkalies*, boiled on zinc, obtain a yellow colour, and dissolve part of the metal; and an acid being added a white oxide is thrown down. It is also readily dissolved in *ammonia.*

It detonates strongly if mixed with *nitrate of pot-ash*, and thrown into an ignited crucible.

Three parts of nitrate of pot-ash and one of zinc being ignited inflame with excessive splendour, and throw out sparks which burst with the production of very brilliant stars. It is employed for the most admired fire works.

Gold, Silver, Platina, and *Nickel*, are rendered brittle by it.

Mercury amalgamates with it, being stirred into it before it hardens after fusion.

Neither *lead* nor *bismuth* enters into combination with zinc in fusion.

Fused with *antimony* it forms a hard and brittle alloy; with *tin* and *copper* it forms BRONZE; and with *copper alone*, it forms BRASS, or *yellow copper.* From similar combinations, but containing less zinc than enters into the composition of brass, are formed *tombac, prince's metal, similor*, and *Pinchbeck's metal.*

Lead is precipitated from acids by zinc; thus is formed *Ilsemann's* LEAD TREE, a small roll of zinc being suspended in a solution of acetate of lead, in the proportion of two drams to six ounces of water.

The *tinning of brass pins* is thus performed. A vessel is filled by layers of brass pins and plates of tin, one of these plates being uppermost and undermost. The vessel has then a solution of cream of tartar poured in, the acid dissolves the tin, which the zinc of the brass precipitates on them in a reguline state, by which, after five hours boiling, they are uniformly tinned.—*Translator of Gren's Principles.*

ANTIMONY is white, brilliant, volatile, and difficult of fusion. Sp. gr. 6,702. When melted, it emits a white fume, called *flowers of antimony*, being a SUBLIMED OXIDE OF ANTIMONY, in brilliant prismatic aciculæ, which are soluble in water, and which therefore must approach nearly to the nature of an acid. The metal whilst cooling slowing, crystallizes in octahedra, and generally assumes a stellular form, on its surface. It is very slightly changed by exposure to air. If thrown rapidly on the ground when in complete fusion, it breaks into globules which burn with a vivid flame, and throw out brilliant sparks, the surface of these particles becoming covered with a white oxide, so perfect as to approach to an acid nature. Its perfect oxidizement is manifested by its colour, it possessing according to *Thenars* 0,20 of oxygen; but on parting with a portion of its oxygen, by heat, it becomes yellow when it contains 0,19 of oxygen, afterward it becomes orange coloured, and contains 0,18, then brown, holding 0,16 and at last black, retaining only 0,02 of oxygen.

When combined with *sulphur*, it forms a SULPHURET OF ANTIMONY; this, when native, is an *ore of antimony*, commonly called *crude antimony*, or improperly, antimony, or *native sulphuret of antimony*.

NATIVE SULPHURET OF ANTIMONY, reduced to powder and exposed to heat in a shallow vessel, gradually loses its sulphur, and absorbs the oxygen of the atmosphere. The desulphuration of the antimony takes place nearly in the same proportion in which the oxydizement is produced, and is converted into the GREY OXIDE. This being urged by a more violent heat, becomes a reddish, and partly a transparent *glass of antimony*, the VITREOUS SULPHURETTED OXIDE OF ANTIMONY, the transparence of which depends on the presence of a very small proportion of sulphur; since if the desulphuration be carried on farther an opaque scoria only is produced. When corrected by being blended with wax, this sulphuretted oxide forms the CERATED GLASS OF ANTIMONY.

Tin, *copper*, *silver*, or *iron*, being fused with the sulphuret unites with the sulphur, and separates the antimony, which, according to the metal employed, was called *regulus of Mars*, *Venus*, *&c.* It is found at the bottom of the crucible, in a crystallized metalline form.

Antimony is separated also from the sulphuret or crude antimony, by detonating three parts of crude tartar, two of this sulphuret, and one of nitrate of pot-ash. After fusion, the antimony will be found in a reguline form at the bottom of the crucible covered with brown *scoriæ*, which contain the sulphuretted alkali, combined with imperfect antimonial oxide, and which, on being dissolved in water, lets falls an *hydroguretted sulphuretted oxide of antimony.* With *phosphorus*, antimony forms a brilliant metalliform phosphuret, and with *sulphur* it also readily unites.

Equal parts of *muriate of soda, nitrate of pot-ash,* and *sulphuret of antimony,* being melted together, a dense, vitreous, blackish, brown matter is obtained, insoluble in water, and not becoming moist in the air. It is a sulphuret, but holding less sulphur than the native sulphuret. It has been called *medicinal regulus of antimony, magnesia opalina, &c.*

Antimony is completely dissolved in the dry or wet way by alkaline sulphuret; thus equal parts of fixed alkali being melted with crude antimony, a sulphuret is formed containing antimony, being the ALKALINE SULPHURET OF ANTIMONY, commonly called *liver of antimony.* If equal parts of nitre and crude antimony be detonated and fused, another *combination of alkaline sulphuret with antimony* is obtained, formerly called *saffron of antimony.*

These alkaline sulphurets decompose water, its oxygen uniting with a portion of the antimony, whilst its hydrogen unites with the sulphur; so that an alkaline hydroguretted sulphuretted oxide of antimony is produced, which is kept in solution whilst the liquid is boiling, but which, on cooling, separates in two portions: one of which is deposited in the form of a reddish brown powder, whilst the other is still retained in solution, but may be precipitated of a golden colour by the addition of acids.

This separation arises from the cold alkaline solution not being capable of holding as much of the oxide as the hot, hence a portion of the hydrogenized sulphuretted oxide is precipitated, surcharged with the oxide; whilst that which is still held in solution having lost a portion of its oxide possesses a surcharge of sulphur. Each of these substances is hydroguretted sulphuretted oxide of antimony, only differing in the proportion of the oxide and of the sulphur which they contain. The first, in which, the oxide predominates, having been termed *Kermes mineral,* and the latter, in which sulphur prevails, is rather an HYDROGURETTED SULPHURET OF ANTIMONY: this is commonly called *the golden sulphur of antimony*. The latter may be obtained combined in different proportions with sulphur, by adding the acid gradually, and preserving each precipitate separate, since as the alkali is neutralized, its power of holding the oxide in solution is lessened; so that each precipitate contains more sulphur and less oxide than the former, and at last the precipitate is little more than mere sulphur.

Thenars has ascertained that the Kermes mineral contains 72,760 of brown oxide, 20,298 of sulphuretted hydrogen, and 4,156 of sulphur, there being 2,786 loss in water, &c. The golden sulphur he found contained 68,300 of orange coloured oxide, 17,877 of sulphuretted hydrogen and 11, to 12,000 of sulphur. He also discovered that they possess the property of attracting the oxygen from the air, and becoming paler in consequence of its addition.

Goëtling recommends the following process as yielding a product of constant similarity. Two parts of sulphuret of antimony and three of sulphur, to be dissolved in a ley of pot-ash, diluted with water, and precipitated by weak sulphuric acid. This is about the strength of the third precipitation of the mother water of the kermes, but the strength may be always according to the will of the physician, according to the quantity of sulphur which is added.

By using the sulphur of antimony, with three parts of the nitrate, the residue in the crucible, after detonation, is oxide of antimony, fixed alkali, a portion of nitrate not decomposed, and a small quantity of sulphate of pot-ash. This compound is called the *solvent of Rotrou*. Water deprives it of the salts, leaving only a white perfect oxide of antimony, which is called *washed diaphoretic antimony*. If to the water holding these salts in solution, a small quantity of acid be added, the small portion of oxide held in solution by the alkali is let fall. This precipitate has been called *ceruse of antimony*; or the *materia perlata of Kerkringius*.

The white oxide obtained by the nitrate of pot-ash is the most perfectly oxidized of any, and approaches the nearest to an acid, forming a crystallizable salt with pot-ash, which *Berthollet* therefore calls *antimonite of pot-ash*. By the experiments of *Thenars*, it appears that this oxide holds 0,32 of oxygen.

The scoriaceous matter formed by fusing soap or grease with oxide of antimony is pyrophoric, a portion being thrown out of the crucible into the air, burns, and throws out sparks like a firework.

Lime, or *lime water*, digested for some days, even without heat, on powdered antimony, yields a beautiful red sulphuretted oxide. *Ammonia* being distilled from crude antimony, a pulverulent *sublimate of a purple colour* is obtained, being a *sulphur of antimony*, with base of volatile alkali.

The *nitric acid* is rapidly decomposed by antimony, sometimes actual inflammation occurring. So eagerly does the antimony attract the oxygen, that the water in the acid is also decomposed, and its hydrogen uniting with the nitrogen of the nitric acid forms ammonia, which combining with nitric acid forms nitrate of ammonia, which has been supposed to have been nitrate of antimony held in solution.

The oxide formed and precipitated in this instance seems almost to pass to an acid state, containing 0,30 of oxygen. The sulphuret is acted on by this acid; but the oxide is not.

The *sulphuric acid* by boiling on antimony, is partly decomposed. Sulphureous gas is first separated, and sulphur itself sublimes, towards the end; an *oxide* is formed, and a small portion of oxide is suspended in the acid.

The *muriatic acid* acts on it only by a long digestion, and when by decomposition of the water in the acid the metal has become somewhat oxidized, the *nitro-muriatic acid* is its most convenient solvent. The solution has no colour.

The *oxygenized muriatic acid* possesses almost equal powers: thus, two parts of the corrosive muriate of mercury and one of antimony being distilled together, a slight degree of heat drives over what has been termed a butyraceous matter, the SUBLIMED MURIATE OF ANTIMONY, or *butter of antimony*.

Mr. *Chevenix* has ascertained the muriatic salts, formerly known by the strange name of *butters of the metals*, to be muriates and not hyperoxygenized muriates; and the extraordinary proportion of oxygen, to be combined, not in the acid, but in the metallic oxide.—*Phil. Trans.* 1802.

The sublimed muriate of antimony becomes fluid by a very gentle heat, and is thus easily poured from one vessel to another. Diluted with water, a white oxide of antimony falls, which has been called *powder of Algaroth*, or *mercurius vitæ*. Both the metal and the sulphuret inflame, and emit brilliant sparks on being dropt into the foregoing acid in the state of gas.

It also enters into combination with *phosphoric acid.*

Dr. James's Powder being analyzed by Dr. *Pearson*, he concluded it to be a ternary combination, or triple salt, composed of *phosphoric acid* and a *double basis of lime and antimony*, and proposes to form a similar substance by calcining together hartshorn shavings and crude antimony. But Mr. *Chevenix* considering the uncertainty of the medicine thus formed from part of the oxide being volatilized and part rendered insoluble, recommends the following process: equal parts of *white oxide of antimony*, obtained by precipitation, by water, from the common muriate of antimony, and of *phosphate of lime*, are to be dissolved, together or separate, in the smallest possible quantity of *muriatic acid;* and this solution is to be gradually poured into distilled water previously alkalizated by a sufficient quantity of *pure ammonia:* the precipitate well washed and dried is the substitute he proposes, which may be prepared always of the same strength, and is entirely soluble in every acid that can dissolve phosphate of lime or oxide of antimony separately.—*Philos. Trans.* 1801.

Wine and the *acetous acid* dissolve antimony.

The *acid of tartar* forms with the grey oxide the well-known salt, the ANTIMONIATED TARTRITE OF POT-ASH, *emetic tartar*, or *stibiated tartar*. *Chaptal* remarks that this preparation often varies in its strength, and wishing to establish an uniform process for its formation, proposes transparent glass of antimony to be boiled in water, with an equal weight of acidulous tartarite of pot-ash, until the salt is saturated: by filtration and slow evaporation crystals are obtained, in trihedral pyramids, of a sufficiently uniform degree of emeticity.

Most of the salts are capable of being acted on by antimony and its sulphuret. *Hyperoxygenized muriate of pot-ash*, mixed in the proportion of two parts to one of the metal or sulphuret inflames rapidly on contact with an ignited body, and detonates violently on being struck on an anvil.

The *gastric fluid* dissolves this semi-metal, as is proved by the famous perpetual pills. *Simple water* has also some action upon it, since it becomes purgative by remaining in contact with it.

Antimony and *mercury* unite with difficulty.

It combines with *gold, silver, platina, copper, iron,* and *zinc*, rendering them brittle, and from its volatility, may be driven off again by a sufficiently strong heat.

Lead and antimony afford a brittle alloy; a fourth part of antimony added to lead makes a compound fit for printer's types, either with or without *zinc* or *bismuth*.

Three parts of *white oxide of antimony*, 12 of *white oxide of lead*, 1 of *sulphite of alumine*, and 1 of *muriate of ammonia*, first heated weakly for some hours and then kept in a red heat forms the FINE METALLIC PIGMENT, *Naples yellow.—Translator of Gren's Principles.*

Tin is rendered by it more brittle, hard, and sonorous. 3 parts of *tin*, 2 of *lead*, and 1 of *antimony*, is said to be useful for making SHIP-NAILS.

An inspissated solution of glass of antimony in muriatic or tartareous acid assumes a gelatinous form, the jelly not being again soluble in water or by excess of acid. This *Vauquelin* has discovered to proceed from the existence of silica in the glass of antimony, he having found it in the proportion of 12 parts in the 100, being derived either from the crucible, or from the *gangue*, being strongly acted on by the oxide of antimony as well as by that of lead. To account for the solution of silica in a tartareous acid, he remarks, that although silica eludes, in its ordinary state, the action of the most powerful acids; yet, when joined with an alkali, another earth, or a metallic oxide, it may then be dissolved even by a weak acid.

Repeated crystallizations are not sufficient to separate the silica, but in making the emetic tartar he proposes the solution to be filtered hot, and evaporated to dryness, taking care not to burn it; and then redissolved and crystallized, as the silica will entirely separate towards the end of the evaporation.—*Ann. de Chem.* 1800.

BISMUTH, or *Tin-glass* is white, darkened by a shade of red, or yellowish red. It yields a little under the hammer, but is so brittle, that it may be thus reduced to powder. Sp. gr. 9,822. Next to tin and tellurium it is the most fusible of all metallic bodies. It tarnishes, but does not rust in the air.

If allowed to cool gradually after fusion, it crystallizes in parallelipepids, which with management may be made to exhibit a very pleasing appearance.

When exposed to a strong heat it burns with a blue flame, and sublimes in a yellowish smoke, which forms, when condensed, an OXIDE OF BISMUTH, or the *flowers of bismuth*. These flowers may be vitrified into a brownish glass. By a less heat it is calcined into a powder, which is a less *perfect oxide*.

It readily combines with *sulphur* by fusion, and forms a bluish grey artificial ore, or SULPHURET OF BISMUTH, which crystallizes in beautiful needle-formed crystals. Its combination with *carbon*, *nitrogen*, or *hydrogen*, is not known, and it unites with *phosphorus* most sparingly. Its attraction for *oxygen* being feeble, it is incapable of decomposing *water*.

Sulphuric acid being boiled on it, the bismuth is partly dissolved, forming the SULPHATE OF BISMUTH, which is very deliquescent.

Nitric acid is speedily decomposed by bismuth; nitrous gas is separated, whilst the oxygen combines with the metal, and a portion is dissolved which yields rhomboidal, tetrahedral prisms, terminating in tetrahedral pyramids with unequal faces, being the NITRATE OF BISMUTH, which effloresces in the air.

Muriatic acid does not act on it, but by the aid of heat and concentration; the MURIATE OF BISMUTH is deliquescent and difficult of crystallization. In oxygenized muriatic acid gas it immediately inflames, and throws out very brilliant sparks. A mixture of 1 part with 3 of oxygenized muriate of pot-ash burns rapidly in contact with an ignited body, and detonates loudly if struck with a hammer. The *acetous acid* does not take up the oxides of bismuth, as it does those of lead.

Water precipitates this semi-metal from all its solutions; the precipitate, when well washed, is employed as a white paint, for the complexion, and is known by the name of *magistery of bismuth*: but sulphureous hepatic vapours, and even the animal transpiration, blacken it, and reduce it to a metallic state. It is also employed in pomatums to blacken the hair. Its oxides are dissolved by *fat oils* into a tenacious mass resembling plasters. It also combines with *sulphur* by fusion. Its various solutions form pellucid sympathetic inks, which are curious from the facility with which they become black with alkaline sulphurets, or sulphurated hydrogen gas.

It renders *gold* brittle, and communicates to it its own colour; but it does not render *silver* so brittle as it does *gold*. It diminishes the red colour of *copper*; with *lead*, it forms an alloy of a dark grey colour; to *tin* it gives a greater degree of brilliancy and hardness; with *iron* it does not unite, but by a violent heat; and with *mercury*, it amalgamates and forms a fluid alloy.

It is used for *pewter*, *soft solder*, *printers types*, *&c.*

COBALT is white, inclining to a pink colour. Sp. gr. 7,700. When very pure it is malleable, in a small degree, in a red heat; but it is generally contaminated with arsenic. It is not volatile in close vessels, and when pure, is as difficultly fusible as iron, but is rendered more fusible, and of a brown colour, by the addition of arsenic. It burns with a red flame, and after fusion its surface frequently assumes a reticular form. It calcines with more difficulty, as it is more pure; its oxide is of so deep a blue, as to appear black.

This oxide gives a very deep blue colour to fifty parts of iron.—*Fourcroy.*

Whilst in its metallic state, it tinges no earthy substance; but in contact with fluxes it readily calcines, hence, being treated with *borax*, *soda*, *pot-ash*, *alkaline phosphates*, in a strong heat, it tinges them blue. In fusion, it will not mix with *bismuth*, *lead*, or *silver*, although it unites with *bismuth*, by the mediation of *nickel*: it does not amalgamate with *quicksilver*. With *arsenic* it burns with a bluish or white flame. It precipitates *copper* and *nickel* from their solutions in a metallic state.

With concentrated *sulphuric acid*, it unites and yields reddish crystals, tetrahedral columns, with dihedral summits, the SULPHATE OF COBALT.

It unites with the *nitric acid* readily, and with effervescence; the solution is reddish, and yields hexahedral crystals, the NITRATE OF COBALT: if *arsenic* predominates, the solution is first whitish, and then becomes red. Cobalt dissolved in nitro-muriatic acid, and mixed with 1½ as much of *nitrate of zinc*; and a lixivium of pot-ash being added, the precipitate ignited to whiteness forms a fine GREEN COLOUR FOR PAINTERS.—*Trans. of Gren's Principles.*

The *muriatic acid* dissolves it with difficulty, requiring heat; the solution, which is of a peach red, holding in solution the MURIATE OF COBALT.

If contaminated with much *nickel*, the above solutions are greenish. Its oxides yield to the *acetous acid* and to *ammonia*; the solutions with the former, are red and purple; with the latter, blue when hot. With the *nitro-muriatic acid*, the solution is red; if contaminated with *iron*, brown. One part of cobalt in 3 of diluted nitric acid, farther diluted with 24 of water, with the addition of 1 part of muriate of ammonia or of soda, makes *Hellot's sympathetic ink*, for though letters traced by it are invisible while cold, yet when very moderately heated they appear green, if the cobalt retains much iron; but blue, if free from iron.

By 1 part of oxide of cobalt, and 16 of distilled vinegar evaporated to an eighth, and 1-4th of the cobalt of muriate of soda, is formed *Ilsemann's blue sympathetic ink*, somewhat similar to the former.

Its solutions are not precipitable by *zinc*.

The alkalies produce a red precipitate, and, if in excess, give a bluish cast to the sediment.

The ores of cobalt are torrefied in Saxony in furnaces, the arsenical vapours attaching themselves to the sides, yield the arsenic of commerce. When the oxide of cobalt is cleared of arsenic, it is known by the name of ZAFFRE. The zaffre of commerce is mixed with 3-4ths of sand. This oxide fused with 3 parts of sand and 1 of pot-ash, forms a blue glass, which when pounded, sifted, &c. forms SMALT.

Brugnatelli, by dissolving the grey oxide of cobalt or zaffre in caustic liquid ammonia, obtained a combination, which he terms AMMONIURET OF COBALT. He also supposed he had obtained the *cobaltic acid*, but his experiments having been repeated without success, it is supposed that the acid he obtained must have been from arsenic, which had been combined with the cobalt he employed.

Cobalt, in powder, inflames if thrown into *oxygenized muriatic gas*; and detonates with a third part of *hyperoxygenized muriate of pot-ash*, if struck with a hammer.

Smalts are used in the preparation of cloths, laces, linens, muslins, threads, &c. When it is separated by water from the grosser particles, it is called AZURE. The azures mixed with starch form the BLUES used by laundresses. Besides being used for colouring glass, it is also used for blue paintings on porcelain. The most simple way of obtaining cobalt in its metallic state, is to reduce it from smalt, by fusing 1 part of smalt with 6 of soda.

NICKEL is a metallic substance, of a silvery white. It has been very generally supposed to be magnetic; but Mr. *Chevenix*, who by precipitation of the nickel with caustic ammonia from a solution in the nitric acid, obtained it pure, found its supposed magnetic property depended on the small portion of iron it must have contained. He also found its sp. gr. was 7,3806.

It is malleable in a considerable degree, and calcines slowly in a strong heat. If pure, the oxide is brown; if impure, greenish; rising in tuberous vegetations, proceeding from iron or arsenic. When pure, it requires as strong a heat as cast iron, the impure melts more easily. Fused with *sulphur*, it forms a hard low mineral; and with the sulphuret of pot-ash, a compound resembling the yellow copper ores. It does not amalgamate with *mercury*.

Nitrate of pot-ash detonates with nickel, but does not enter into such complete combustion with it as the hyperoxygenized muriate of pot-ash. Both the salts augment the hyacinthine colour, which the oxide of nickel gives to glass.

The *sulphuric acid* distilled on it, leaves a greyish residue, which, when dissolved in water, communicates a green colour. This is the SULPHATE OF NICKEL, which forms octahedra with truncated angles, but which effloresce in the air.

The *nitric acid*, with heat dissolves it, and yields the NITRATE OF NICKEL, in crystals of a beautiful green, in rhomboidal cubes. The *muriatic* dissolves it also, with heat, but more slowly; the MURIATE OF NICKEL forming in long rhomboidal octahedrons, of the most beautiful emerald green. The *acetous acid* acts only on its calces. The *fixed alkalies* precipitate the nickel in the foregoing solutions, greenish white. *Ammonia* also precipitates it, but in excess redissolves it, the solution being blue; even metallic nickel yields to ammonia.

The precipitate from galls is of a whitish grey. *Iron*, *zinc*, *tin*, *manganese*, and *cobalt* itself, precipitate nickel from its solutions in a metallic state.

Nitrate of pot-ash detonates with nickel, but does not enter into such complete combustion with it as the hyperoxygenized muriate of pot-ash. Both these salts augment the hyacinthine colour which the oxide of nickel gives to glass.

MANGANESE is of a greyish white, but soon darkens by exposure to the air; its surface becoming friable and dark, as it becomes oxidated, the more imperfect oxides being of a greyish colour, and the *perfect* OXIDE black, and will yield, merely by the application of heat, a prodigious quantity of oxygen gas, the oxide becoming of a lighter colour. But by absorbing oxygen from the air, it again becomes black, and capable again of yielding oxygen gas. It is in no degree malleable, and is very difficultly fused. Sp. gr. 7,000.—*Hielm.*

By heat it is converted into a black oxide, and, if strongly urged, it affords a glass of a yellowish brown. This metal is more difficultly fusible than crude iron, but unites by fusion with all the metals, except mercury. Kept in fusion, with *phosphate of soda*, upon charcoal, a transparent glass is formed, which curiously changes from a reddish purple colour to a colourless state, and again becomes coloured, according to the quantity of phosphate, and to its exposure to the interior or exterior part of the flame.

A globule of phosphate of ammonia, soda, and oxide of manganese, melted with a blowpipe, assumes a purple colour; but with more oxide changes to a red. By the addition of charcoal the colour disappears when exposed to the internal flame from the blowpipe, but is restored by the external white flame. Nitre restores it directly, but sulphur, sulphates, and the metals destroy it; the former act by contributing oxygen, the latter by substracting it. By mere fusion of a globule with access to the air, its colour may be restored, by absorption of oxygen. These experiments plainly evince its strong affinity for *oxygen*, by which it appears to be capable of decomposing *water*.

The habitudes of manganese with respect to acids are remarkable. Its *imperfect* oxide is dissolved by all the acids; its *perfect* oxide is dissolved by no acid, whose base or radical is fully saturated with oxygen, and thus incapable of taking up more of this principle. On the contrary, if the radical of any acid is capable of absorbing more oxygen from the perfect oxide of manganese, or if it be rendered thus capable of taking up more oxygen, by the addition of some sugar, gum, or the like, the oxide is then converted into an imperfect one, and as such will be dissolved by the acid. These solutions are colourless, and become brown, as the oxide approaches to perfect oxidizement or from particles of iron.—*Gren.*

On this principle the SULPHATE OF MANGANESE may be had from the black or perfect oxide; the NITRATE from *nitric acid* and *imperfect* oxide, or from *nitrous acid* and *perfect* oxide. *Muriatic* acid thus dissolves, even the perfect oxide, becoming oxygenized, but being volatile, the oxygen flies off and the muriatic acid continues to dissolve the oxide thus rendered imperfect. The metal is readily inflamed by oxygenized muriatic acid gas.

With the *fluoric acid*, a salt of sparing solubility is formed, so likewise with the *phosphoric acid.* The *acetous acid* acts but weakly on it: the *oxalic* dissolves the manganese, and the black oxide of manganese also. The *acidulous tartrite of pot-ash* dissolves the black oxide, even in the cold; and, added to any solution of manganese, precipitates a true TARTRITE OF MANGANESE. The *carbonic acid* attacks both manganese and its black oxide. *Muriate of ammonia* being distilled with the oxide, the oxygen of the latter unites with the hydrogen gas of the alkali, and forms water, nitrogen gas escaping. Manganese itself does not appear to combine with *sulphur*; but eight parts of oxide, with three parts of sulphur, form a mass of a greenish yellow colour, which acids attack with effervescence, and occasion an hepatic smell. Manganese is precipitated from its solutions by the *alkalies*, in the form of a gelatinous matter, which becomes black as it absorbs oxygen. From the rapidity with which this change takes place, it is well calculated to form an eudiometer, by being diffused on the internal surface of proper vessels, and marking, by the ascension of water in a graduated tube, the absorption of oxygen.

If one part of the native oxide of manganese, and three parts of nitrate of pot-ash, be melted in a crucible, till no more oxygen gas is disengaged, a greenish friable powder is obtained, termed *chamælion minerali*s, an ALKALINE OXIDE OF MANGANESE.

The solution of this is first blue, oxide of iron then separates, and from its yellow colour renders the solution green, this subsiding the blue re-appears; then from the oxygen it absorbs from the air, the manganesian oxide becomes reddish, brownish, and at last black, when it subsides, and leaves the fluid colourless.

Its affinity with oxygen exceeds that of any other metal, and its combustibility, compared with other metals, is like that of phosphorus compared with other combustible bodies.

Its combinations with other metals are at present but little known: but from its great affinity with *iron*, and from manganese being never obtained free from iron, it seems that they admit of an union.

Scheele has proved, that the ashes of vegetables contain manganese; and that it is to this mineral, that the blue colour of calcined pot-ash is owing. Of all metallic substances it is, after iron, the most generally, though minutely diffused through the earth.

To various species of uncoloured glass it gives various hues according to the quantity of oxide, and its degree of oxidizement.

If a very slight portion be used to glass discoloured by coaly particles or iron, it renders it colourless; it is hence called *glass-maker's soap*.

It is also employed to give a *black glazing to pottery-ware*.

URANIUM, or the metal of *uranochre*, the native oxide of uranium, of the *pitchblende*, the sulphuret of uranium, and of the *chalcolite*, or *green mica*, the native carbonate of uranium, discovered by *Klaproth*, in 1790, is of a dark steel or iron grey; internally browner. Sp. gr. 6,444.

It is soluble in nitric acid; but not in the other acids. It is infusible alone, but with phosphoric acid, or the alkaline phosphates, it becomes a grass green glass; and with soda or borax, a grey opake scoriaceous bead.

Its oxide is yellow, and is easily soluble in acids. With dilute *sulphuric* and the concentrated *acetous acid* it yields yellow crystals; with the *phosphoric*, an amorphous, white, difficultly soluble mass; and with the *nitric* and *nitro-muriatic acids*, greenish yellow crystals. The precipitate thrown down from these two last-mentioned solutions, by sulphuretted ammonia, is of a brownish yellow; by *tincture of galls*, the superfluous acid being saturated, of a chocolate brown; by *alkaline prussiates*, a brownish and red granular precipitate, diffused through the whole liquor: that of copper, by this alkali, being flaky; and that of molybdena, not so brown. By *carbonated fixed alkali*, the precipitate is of a whitish yellow; much of which is redissolved by the carbonic acid gas set loose; that of *pure ammonia* is a lemon yellow; that of *carbonated ammonia*, dark yellow. These solutions are precipitable neither by *iron* or *zinc*.

The oxide is insoluble in alkalies, either in the moist or dry way; which fully distinguishes it from tungstenic oxide, which it resembles in colour: it is, however, dissolved easily by the alkaline carbonates.

The oxide combines with, and differently colours, different fluxes. Sixteen of silica, 8 of pot-ash, and 1 of the oxide, gives a glass of a clear brown; and if soda be used instead of pot-ash, of a dark grey. Eight of silica, 8 of calcined borax, and 1 of the oxide, gives a glass resembling the smoky topaz. The same proportions, with phosphoric acid instead of borax, gives an apple-green; and 1 part of the oxide, with 16 of the vitreous phosphoric acid, a glass of the colour of the emerald.—*Fourcroy*.

TELLURIUM was undoubtedly discovered by *Klaproth*, although he modestly gives the honour of the discovery of it to *Muller*, and even to *Bergman*. He discovered it whilst analysing the aurum problematicum from *Fatzebay*, in Transylvania. It is also found in the graphic gold of Offenbaya; in the yellow, and in the grey foliated gold of Nagyag.

It is the most volatile and fusible of the metals, except quicksilver, and is of a dark grey colour, inclining to red, and of considerable metallic splendor. It is semi-ductile and semi-malleable. Before the blow-pipe it burns with a blue flame with a green edge. When broken by the hammer, whilst hot from recent reduction, it changes colour from purple to violet, and then to blue. Sp. gr.

6,115. It readily unites to *quicksilver* and *sulphur*. It is soluble in *nitric acid*, yielding crystals in the form of dendritic aggregation; and in *sulphuric acid*, in the cold, in 100 times its weight of concentrated acid, yielding a beautiful crimson solution, which loses its colour by heat, or dilution with water. It is also dissolved in the *nitro-muriatic acid*, and is precipitated from its solutions, in a metallic state, by *iron*, *zinc*, *tin*, and even by *muriate of tin*; also by *saline sulphurets*, yielding SULPHURETTED OXIDE OF TELLURIUM.

Its oxides are reduced by exposure to heat on a piece of charcoal, with a rapidity approaching to detonation. It amalgamates with mercury, and its precipitation by antimony shows it is not that metal disguised.

The order of affinities of the OXIDE are not well determined. Some foreign chemists have suspected this substance to be only the regulus of antimony.

TITANIUM, was first discovered to be a metallic substance by *Klaproth*, it having been before that considered as a red shorl. The same indefatigable chemist has discovered its existence in MANACHANITE, a substance first noticed by Mr. *M'Gregor*, in the valley of *Manachan*, in Cornwall, in small black grains resembling gunpowder. Mr. *Kirwan* pointed out the resemblance between this substance and Titanite. Mr. *Chevenix* has also ascertained its existence in sand brought from Providence Island.—*Phil. Trans.* 1801.

The oxide of this metal, which is of a whitish yellow, requires to be deoxidized to a certain degree to become soluble in acids. It is therefore treated with pot-ash, during which process it passes through various colours, red, blue, green, &c. according to the quantity of oxygen it retains; with which it even again supplies itself whilst drying, as is also the case with iron.—*Lowitz. Ann. de Chi.* XXXIV.

A slender stick of *tin* being placed in a solution of the MURIATE OF TITANITE, the solution becomes first rose, then ruby-red, and then of an amethystine hue. *Zinc* thus produces first a violet, and then a deep indigo-blue. The *prussiate of pot-ash* produces a green precipitate from the muriate of Titanium, and if an alkali be added whilst it remains with the same fluid, it passes through beautiful tints of purple and blue, becoming at the end white.

On the authority of *Lampadius*, the order of attraction is, gallic, phosphoric, arsenic, oxalic, sulphuric, muriatic, nitric, and acetous acids.—*Ann. de Chi.* XXVI.

CHROME is a metallic substance, very difficult of fusion, of a whitish grey, shining, and very brittle; it was first obtained by *Vauquelin* from the mineral, called *Siberian red lead*.

He obtained the CHROMIC ACID from this mineral by the following process:

By boiling 100 parts of this mineral with 300 of carbonated pot-ash, and 4000 of water, separating the lead and the alkali by weak nitric acid. Also by mixing 100 parts of muriatic acid, of *Siberian* red lead and of water, from which an insoluble muriate of lead separated; the remaining muriatic acid being engaged by an oxide of silver, and precipitated by lime or caustic alkali, in the form of horn silver, which leaves the acid. This crystallizes in small long prisms of a ruby-red colour; forming with *mercury*, a compound of a cinnabar red colour; with *silver*, a carmine-red compound; with *lead*, an orange-yellow mineral; and with *iron* or *tin*, the solution of the acid becomes green. It yields part of its oxygen to muriatic acid, by which it oxygenizes it, passing itself to a green oxide.—*Journal des Mines*, XXXIV. 1798.

Before the blow-pipe Chrome does not fuse, but becomes oxidized; but with borax it melts, and tinges that salt of an emerald green. *Nitric acid* acts on it only when boiled on it repeatedly, in a concentrated state, and in considerable quantities.

The ACID is of a ruby-red, and contains about two-thirds of its weight of oxygen, and on parting with a certain portion of oxygen, even to light, the OXIDE OF CHROME is formed, which is of a beautiful green—*Ann. de Chim.* XXV.

Vauquelin therefore concludes that the chromic is a true and distinct acid, and that the radical or base of this acid is a peculiar metallic substance.

The Siberian red lead ore may be considered as a CHROMATE OF LEAD. It also forms CHROMATES with the *earths* and *alkalies*. From 72 parts of the ore in a strong heat in a crucible with charcoal, he obtained 43 of grey metallic feathered crystals. From the beautiful emerald green it communicates to glasses and enamels, the acid might be a valuable addition to the *pigments of the enameller:* and the oxide, from the tints it produces in combination with other metals, might become an useful ingredient in *colours for painting:* it would also be an excellent reagent for the discovery of the least portions of lead, silver, and mercury. The durability of its pigment may be inferred, from the emerald of Peru not losing its colour, which it derives from this oxide, in the greatest heat. The *emerald* appears to be coloured by the *oxide*, and the *ruby* by the *acid.*

Tassaert has not only found the chromic acid united to lead, but also to iron.—*Ann. de Chim.* xxx.

ARSENIC.—Its natural colour is white, with a strong shade of blue, but it quickly tarnishes by exposure to the air, becoming a pale yellow, and at last greyish black. Sp. gr. 5,763. It is brittle. In close vessels, it sublimes without alteration, and crystallizes in regular tetrahedra, or octahedra, of a brilliance resembling steel. On burning coals, it gives a low bluish white flame, an alliaceous smell, and white smoke, which holds an *imperfect* OXIDE OF ARSENIC, or the *white arsenic of commerce.*

This substance, which in general is called *white arsenic*, is formed by the action of oxygen on the metallic arsenic, and may properly be termed the ARSENIOUS ACID. It is a very poisonous substance, exciting an acrid taste on the tongue. It has a glittering whiteness, and sometimes a vitreous appearance; and sublimes, at 283°; with the same smell and smoke as the arsenic itself. Its composition is said to be 93 parts of arsenic and 7 of oxygen. It may be reduced to the metallic state by treating it with oils, soaps, or charcoal, in close vessels.

The metal is soon oxidized in the air, on its surface. Its union with *nitrogen* and *carbon* is not known, but it is soluble in *hydrogen*, and readily unites with *phosphorus* and *sulphur*. It does not decompose *water*, but its oxide is decomposed by *hyrdogen*. It is often combined with *metals* in various ores, and is disengaged from them by calcination. It unites, by fusion, with most of the metals; those which were ductile, becoming thereby brittle; those which were difficult of fusion, flowing more easily; and those which were very fusible, becoming refractory. The yellow or red metals being also rendered white.

The oxide, or arsenious acid, is less volatile than the metal itself. If sublimed by a strong fire in closed vessels, it becomes transparent like glass. It requires for its solution eighty times its weight of water at 12°, and fifteen at boiling heat: and of alcohol seventy or eighty at boiling heat. Like the other metallic oxides, it is convertible into a metallic glass by a strong heat, and forms an opaque insoluble substance possessing metallic brilliancy; but unlike them, it is soluble in water, unites with metals, is volatile, and emits a strong odour. By its union with sulphur, either ORPIMENT, or REALGAR, is formed, the first being *yellow*, the latter being almost *red*. The difference of colour depending either on the degree of heat or the proportion of sulphur, employed in forming these SULPHURETS: both these substances being decomposed by lime and the alkalies, which disengage the oxide.

The vitrification of the *earths* is accelerated by the oxide of arsenic; but the glasses, thus formed, soon tarnish.

The *muriatic acid* attacks arsenic only if aided by heat; but equal parts of orpiment and *corrosive muriate of mercury*, being distilled by a gentle heat, a blackish corrosive liquor distils, which is the SUBLIMED MURIATE OF ARSENIC, or *butter of arsenic*.

The *nitric acid*, and the *oxygenated muriatic acid* distilled from the oxide of arsenic, are readily decomposed; from the former, nitrous gas passes over abundantly, and from the latter, ordinary muriatic acid; their superabundant oxyen being seized by the arsenical oxide, or arsenious acid, which is thereby changed to a more perfect acid, which may properly be called the ARSENIC ACID. This acid is said to be composed of 91 parts of arsenic and 9 of oxygen.

It yields a sour taste, and is of a white colour. It deliquesces in the air, fuses at a red heat, but is not volatile. It will, however, be decomposed by the access of hydrogen or of any other combustible substance. At 12° it requires only two-thirds of its weight of water to dissolve it; it may be then again concentrated, and brought to the state of a transparent glass. In consequence of its acting strongly on *alumine*, it pervades the ordinary crucibles.

This acid is also obtained from the residue of the distillation of equal parts of nitrate of pot-ash and oxide of arsenic, which produces a red, and almost incoercible nitric acid, and leaves an arseniate of pot-ash, which yields the arsenic acid in a strong heat, if mixed with half its quantity of sulphuric acid.

The nitrate of ammonia also, being distilled with the oxide of arsenic, the arseniate of ammonia remains, from which the alkali being driven by a fire long kept up, the residue is a vitreous, deliquescent mass, the arsenic acid.

This metal being thrown into *oxygenized muriatic gas*, immediately inflames, burns with a white flame, and is rendered the arsenious acid.

The *sulphuric acid* boiled on the oxide, dissolves it, but the oxide is precipitated on cooling. If the whole of the acid be dissipated by a strong heat, the arsenic acid remains.

Pure pot-ash boiled on the oxide of arsenic, becomes brown, gradually thickens, and at last forms a hard, brittle, but deliquescent mass; the ARSENITE OF POT-ASH.

Soda exhibits phenomena nearly similar with the oxide, forming the ARSENITE OF SODA.

Ammonia dissolves the oxide by heat, and yields crystals by spontaneous evaporation, which are the ARSENITE OF AMMONIA.

Baryt and *magnesia* appear to have a stronger affinity with this acid than the alkalies. *Lime* and *alumine* also decompose the alkaline arseniates.

Arsenic, besides being used in mixture with *metals*, is employed by *dyers*, and is also used as a *flux* in glass-houses. It is also a component part of some *glazes*.

Scheele's GREEN COLOUR for painters is prepared by precipitating sulphate of copper dissolved in water, by a solution of pot-ash and white arsenic.—*Gren.*

MOLYBDENUM.—This semi-metal was obtained by *M. Hielm*, from the sulphurated ore, which has a metallic lustre, and marks paper similar to plumbago. Sp. gr. 6,1. It is nearly infusible in our furnaces, calcining in a red heat, and, in a reguline state, it gives no colour to borax.

The molybdenic oxide may be obtained by exposing molybdena to intense heat in contact with oxygen. It is then white and volatile.

The MOLYBDENIC ACID is obtained from this oxide by means of the nitric acid, which attacks it with considerable violence, but ceases to act when the saturation is effected. Twenty times its weight of nitrous acid must be distilled over it in five successive portions, being then edulcorated, and dried, it is as white as chalk. However it still retains some sulphuric acid, from which it may be in a great measure purified by repeated fusion in close vessels, or perhaps by adding to its solution the solution of muriated baryt.

The molybdenic acid thus purified, is of the Sp. gr. 3,750, soluble in 570 times its weight of water at 60° Fahr.

The solution of the molybdenic acid forms MOLYBDENATES, by acting on the imperfect metals, as *tin*, *zinc*, &c. rendering them blue, particularly when heated, as they strip it of its oxygen. It precipitates the nitrated solutions of silver, mercury, and lead, the solutions of muriated lead, and of barytes in the nitrous or muriatic acids, but not those of the other earths. With the *earths* it forms difficultly soluble molybdates; and with the alkalies it unites and effervesces, but is not discoloured.

By detonation of 1 part of the metal with 4 of nitrate of pot-ash, a residue will be left, which contains the MOLYBDENATE OF POT-ASH.

Molybdena, when not in a metallic state, appears to suffer four degrees of oxygenizement; 1st. black oxide; 2d. blue oxide; 3d. green; which, as it is intermediate between an oxide and an acid, may be called, according to the distinction made by the new nomenclature, molybdenous acid; the last or 4th degree is the yellow acid, or that which is saturated with oxygen; heated in close vessels, it melts; in open, it sublimes; before the blow-pipe, on charcoal, it is speedily absorbed. With microcosmic salt it becomes green, with borax grey, and slowly also green.

Mr. *Hatchett* observes, whenever a solution of the molybdic acid becomes blue, or tending towards that colour, it is a sign that the molybdenic acid has suffered a diminution of oxygen.

The *nitric* and *oxy-muriatic* are the only acids which act on molybdena in the humid way.

Sulphuric acid does not act on the regulus, but diluted and digested with the oxide, it forms a green solution, which turns blue on cooling, and loses all its colour by dilution.—*Gren.*

Muriatic, *tartareous*, *oxalic*, and *acetic* acids, afford blue solutions of the oxide, the colour showing that the oxide is divested of part of its oxygen in the process.

The molybdenic acid, as well as the regulus, appears to be capable of combining with metals.

When the solution of muriate of tin, which holds this metal as imperfectly oxidized as possible, is precipitated by a solution of molybdenate of pot-ash, both solutions being well diluted, a beautiful blue precipitate is obtained, which *Richter* calls BLUE CARMINE.

TUNGSTEIN exists in the mineral called *tungstate*, or *ponderous earth*, in which it is united with calcareous earth: and in another mineral called *wolfram*, in which it is combined with iron and manganese.

This metal was obtained by Messrs. *Elluyarts*; and lately *Guyton* obtained a small and very brittle button of tungstein, by a heat of 185° Wedgwood in a three blast furnace. The central portion was, however, only agglutinated, and soon acquired a purple colour on exposure to the air. From the difficulty of obtaining it in a metallic form, its properties are not thoroughly ascertained. No other chemist has yet announced a similar success.

It is insoluble in the mineral acids, but convertible by the nitric, and nitro-muriatic into a yellow oxide. It likewise increases by heat 24 per cent. in weight.

The TUNGSTEINIC ACID is best obtained by fusing the tungsteinate of lime with carbonate of pot-ash, and then exposing it to the action of nitric acid. It is then a white powder, of a faintly acrid taste. Sp. gr. 3,6. It is soluble in 20 parts of boiling water, but is neither fusible nor volatile at any known temperature.

It evinces its acid nature by its union with the earths, the alkalies, and the metals.

Digested in the *sulphuric acid* it is converted into a blue, and in the *nitric* and *muriatic*, into the yellow oxide.

Its oxide may be combined with larger or smaller portions of oxygen. When imperfectly oxidized, it is bluish; and yellow when in the state of perfect oxide.—*Gren.*

It unites to *sulphur* in the dry way, and forms a bluish black, brittle, crystallized mass, the sulphuret of tungstein.

Guyton observes, that tungstein in the last degree of oxygenizement has a decided advantage over all the other metallic oxides, in forming *lakes* of great value to painters, which resist powerfully the greatest enemies to colours.—*La Decade Philos. &c.* 1798.

COLUMBIUM is a metal obtained by Mr. *Hatchett* from a mineral supposed to have come from the province of *Massachusetts*. The mineral is heavy, of a dark grey nearly black, and is acted on but very feebly by the *nitric*, *muriatic*, and *sulphuric acids*; the latter producing the greatest effect, and dissolving some iron. By alternate fusion with *pot-ash*, and digestion with *muriatic acid*, the acid takes up the iron, and the pot-ash becomes partially neutralized by a metallic acid, which is separable in a copious *white flocculent precipitate*, by adding *nitric acid* to the neutralized pot-ash. This precipitate, which is so abundant as to constitute three-fourths of the ore, is insoluble in boiling *nitric acid*, but boiling *muriatic* dissolves it when recently separated; so also does the *sulphuric*.

The acid solutions deposit with *alkalies* a white flocculent precipitate; *prussiate of pot-ash*, an olive green precipitate; *tincture of galls*, deep orange; *zinc*, white; and *water* precipitates a sulphate from the solution in sulphuric acid, which, as it dries, changes from white to blue, and lastly to grey. The white precipitate unites with *pot-ash* and *soda*, expelling carbonic acid, and with pot-ash forms a glittering scaly salt. *Ammonia* will not combine with it; and *hydro-sulphuret of ammonia*, added to the alkaline solutions, forms a chocolate coloured precipitate. The acid and alkaline solutions are colourless. The white precipitate will not combine with *sulphur* in the dry way. It forms a purplish blue glass with *phosphate of ammonia*; it reddens blue paper, and appears to be of extreme difficult reduction.

From these properties it appears to be an acidifiable metal, different from those already known.

STONES.

CALCAREOUS EARTHS are characterized by a dry, harsh and meagre feel, discoverable even in their mixtures with other earths, if they constitute nearly one-half of the mass. They are never hard enough to strike fire with steel, nor are those compounds, in which they constitute a third part.

Under the genus, calcareous stones, may be placed the vast varieties of LIME-STONE, MARBLE, CHALK, TUFA, CALCAREOUS SPAR, STALACTITE, STALAGMITE, FLOS FERRI, PISOLITHUS, HAMMITES, or ROE-STONE, with ALABASTER, SATTIN SPAR, and SWINE-STONE, resulting from the union of *lime* with the *carbonic acid*; here also may be placed the BARYTOCALCITES, formed by the union of *lime* with *baryt*; MURICALCITE, with *magnesia*; ARGENTINE, with *magnesia*, *alumine*, and *oxide of iron*: the ARGILLO-CALCITES, with *clay*, and the various MARLS and MARLITES proceeding from the same combination. By its union with *manganese* and *iron* is formed the SIDERO-CALCITE, or PEARL-SPAR; and with a notable proportion of *iron*, the FERRI-CALCITES; and when *supersaturated with carbonic acid*, the DOLOMITE or ELASTIC MARBLE. With the *sulphuric acid* it yields the various SELENITES or GYPSUMS; with the *fluoric acid*, the FLUOR SPAR, or FLUATE OF LIME; with the *phosphoric acid*, PHOSPHORITE; and with the *tungsteinic acid*, TUNGSTEIN.

By a mixture of *quick-lime, sand and water*, *MORTAR* is formed, which soon forms a very hard substance by the absorption of the water, and by undergoing a species of crystallization.

Baryt has its combinations generally marked by their great degree of gravity, if not concealed by their porous structure. *Fourcroy* ranks this earth among the alkalies on account of its taste, solubility, attractions, and other chemical powers.—*Tabl. Synopt.* 1800.

With *carbonic acid*, this earth forms the barolite, and with *sulphuric acid*, the baroselenite, or *ponderous spar*. It also constitutes the greatest portion of the liver-stone.

Magnesia distinguishes the stones, in which it makes about a fifth part, by a smooth and unctuous feel, unless opposed by the opposite characters of lime: they have also frequently a greenish cast, are inclined to a striated or slaty structure, and to a lustre of the silky kind.

Magnesia mixed with *silex* and *carbonate of lime*, forms the silici-murite; with *lime* and some *iron*, calci-murite, or magnesian spar; with *alumine* and *iron*, argillo-murite; and with a farther addition of *silex* and *lime*, chlorite; by its combination with *silex* and *alumine*, are formed the talcs, and by the addition of *oxide of iron*, and *carbonic acid*, the various steatites. The lapis ollaris contains a small portion also of the *fluoric acid*. The chrysolite and serpentines appear to result from its union with *silex* and *iron*; and by various intermixtures of *carbonate of lime*, are formed the asbestus, amianthus, and the suber-montanum, or corium-montanum. By somewhat similar combinations are produced also amianthinite, asbestinite, asbestoid, baikalite, with the shorlaceous, and glassy actinolyte and jade; in some of which is also contained the *fluoric acid*. By its union with the *boracic acid, alumine*, and *iron*, is formed the stone called boracite.

Alumine or argil gives the smooth, soft, and unctuous feel of clay in its mixtures with silex, when it exists in a tenth part; but with lime, not unless it exceeds the lime in quantity. Mixed with magnesia, and not exceeding a fifth part, it gives a disposition to a slaty or lamellar structure.

Native alumine has been discovered, in a state of purity, only at *Glaucha*, near *Halle*, on the river *Saale*.

From its admixture with *siliceous sand*, are formed the various CLAYS, FULLERS-EARTHS, LITHOMARGA, BOLES, MARLS, and COLORIFIC-EARTHS, which are coloured by various metallic, vegetable, or bituminous particles. From its union with *silex* and *iron*, proceeds the rough TRIPOLI, and the smooth CIMOLITE; from its union with phosphoric acid, PHOSPHOLITE; with *silex*, *iron*, *pot-ash*, and *manganese*, is formed LEPIDOLITE; and with the addition of *magnesia*, SAPPARE; and by combinations, in some respects similar, MICA, MICARELLE, and with the addition of *lime*, HORNBLENDE, SCHILLER SPAR, WACKEN, MULLEN-STONE, KRAG-STONE, TRAP, TOADSTONE, BASALT, CALP, ARGILLITE, SLATES, and NOVACULITE.

With *alumine* 74,50, *silex* 15,50, *magnesia* 8,25, *oxide of iron* 1,50, and *lime* 0,75, is formed the SPINELL.

The FLUATE OF ALUMINE, called the CHRYSOLITE OF GREENLAND, contains in 100 parts, according to *Klaproth*, 23,5 of *alumine*, 36,0 of *soda*, 40,5 *fluoric acid and water*. *Vauquelin* thinks the alumine contains 5 of *silex*.

The property of giving extreme hardness to stones, which alumine possesses, is very evident in the ADAMANTINE-SPAR, or CORUNDUM STONE, which in 100 contains, according to *Klaproth*, alumine 89,50, oxide of iron 1,25, silica 5,50 only. The dense and brilliant gem, the *blue perfect corundum*, or SAPPHIRE, is found to contain, in every 100 parts, 98,50 of alumine, 1 of oxide of iron, and 0,50 of lime. The *red perfect* corundum, or RUBY, contains alumine 90, silica 7, iron 1,2.

Lampadius has discovered that hornblende contains charcoal diffused through it, and Mr. *Kirwan* suspects that some pitch stones contain it. It is conjectured that it may exist in other fossils, and cause the peculiar earthy smell, which we perceive by breathing upon stones.

With the coloured and baser sorts of clays are made *TILES* and *BRICKS*, and with a finer sort the different kinds of *POTTERY*. With the more pure and fat clays are formed *TOBACCO-PIPES*, and those finer clays which, in strong fires, only undergo an incipient vitrification, are employed for the fine *PORCELAINS*.

SILEX when most pure, is termed ROCK CRYSTAL, and QUARTZ;

its crystals are the dodecaëdron with triangular faces, or double hexëdral pyramid with or without an intermediate prism. The *common white* OPAL chiefly consists of mere siliceous earth, 240 grains yielding 237 grains of silex, 0,25 of alumine, and 0,25 of oxide of iron. The *yellow* or *pitch* OPAL consists of 93,50 silex, oxide of iron 1, water 1.

One hundred parts of NOBLE OPAL appears to contain of *silex* 90, and *water* 10 parts. In 100 of SAXON HYDROPHANES are 93,125 of silex, 1,625 of alumine, and 5,250 of water and volatile matter.

From its mixtures with various proportions of *iron*, *lime*, and *alumine*, result the AMETHYST, TOPAZ, CHRYSOBERYL; and with *iron*, *lime*, and *magnesia*, OLIVIN. From its union with *shorlaceous actinolyte*, proceeds the PRASIUM; and with *alumine* and *iron*, OBSIDIAN; and *manganese* being added to these, the result is ORIENTAL RUBY and SHORL. *With alumine*, *lime*, and *iron*, it forms the TOURMALIN, VESUVIAN, and the PREHNITE; and with the addition of *manganese*, THUMERSTONE; and by the farther addition of *magnesia*, is formed the BOHEMIAN GARNET. Combined with *alumine*, *lime*, and *water*, it forms the ZEOLITES; and with *barytes* in the place of *lime*, the STAUROLITE; with *alumine*, *blue sulphuret of iron*, *sulphate and carbonate of lime*, LAPIS LAZULI; with *nickel*, *iron*, *alumine*, and *lime*, CHRYSOPRASE; with *alumine* only, SHORLITE; and with *alumine* and *pot-ash*, LEUCITE. If to the silex be added *oxide of iron* and *manganese*, RUBELLITE is the result; but if *iron* is added, SEMI-OPALS, and PITCH-STONE. From the addition of *lime* and *alumine*, to the combination just mentioned, proceeds HYALITE. From its various intermixtures with *alumine*, and a small portion of *iron*, also proceed CHALCEDONY with its varieties, CORNELIAN, ONYX, MOCHA, AGATE, CACHOLONG, and the SARDONYX; and by the farther addition of a small portion of *lime*, FLINT, HORN-STONE, PETRO-SILEX or CHERT, JASPER, EGYPTIAN PEBBLE, CATS-EYE, PORCELLANITE, HELIOTROPIUM, WOODSTONE, and ELASTIC QUARTZ are formed.

From the more compound mixtures of this species of earth with *alumine*, *magnesia*, *lime*, and *iron*, are formed the FELSPARS, and MOON-STONE, and with a small portion of *copper*, the LABRADORE STONE. Nearly allied to these are PETRILITE, FELSITE, RED-

STONE, and SILICEOUS SPAR. AGATES are composed of binary, ternary, or more numerous combinations of calcedony, jasper, quartz, hornstone, &c.

With *silex* 66,25, *alumine* 31,25, *oxide of iron* 0,50, is formed the EMERALD.

Silex combined with *oxide of iron* and a small quantity of water soon forms a hard and ponderous mass.

STRONTIA is ranked, as well as baryt, among the alkalies, by *Fourcroy.—Tabl. Synopt.* 1800.

It has been found in a state of CARBONATE, in a lead mine in Argyleshire, and near Boyra in Transylvania; and in a state of SULPHATE in Freyberg, Syria, Hungary, and near Bristol.

JARGONIA. The only stones of this genus are the stone called ZIRCON, or JARGON of Ceylon, which contains in 100 parts, *silex* 31,50, *oxide of iron* 0,50, *jargonia* 68; and the HYACINTH, which in 100 parts contains *jargonia* 70, *silex* 25, *oxide of iron* 0,50.

GLUCINE, the newly-discovered earth of *Vauquelin*, is found to exist in the *emerald of Peru*, in combination with *alumine, siliceous earth, lime*, and *oxide of chrome*. The BERYL, or AQUA MARINE, also contains this earth with *silex, alumine, lime*, and *oxide of iron.—Annales de Chimie*, xxvi.

YTTERBY, or GADOLINITE, is the stone which yields the earth called *yttria*. This stone is of a black colour, and of a vitreous fracture. Sp. gr. 4,097, and is magnetic. According to *Vauquelin* it contains *silex* 25, *oxide of iron* 25, *yttria* 35, *oxide of manganese* 2, *lime* 2, *carbonic acid* and *water* 11.

The RUBY appears, by the analysis of *Vauquelin*, to be a saline substance, composed of two bases, *alumine* and *magnesia*, with the *chromic acid*. The difference of colour between the ruby and the emerald, both of which, he supposes, owe their colour to this acid, he attributes to the different degree of oxidizement of their colouring matter; the red chromic acid, on parting with a portion of its oxygen, becoming green; hence he supposes it to exist in a ruby, in the state of an acid, and in the emerald, in the state of an oxide.—*Journal des Mines*, xxxviii.

By the analysis of *Vauquelin*, it also appears that the CHRYSOLITE, which possesses all the external appearances of a stone, is not truly of that class, but is a salt composed of the *phosphoric acid and lime.—Ann. de Chimie*, xxvi.

Klaproth having analysed the APATITE, found it also to be a saline substance; containing, in the proportion of 45 to 55 of *phosphoric acid and lime.*

Mr. *Chevenix* discovered that alumine has an affinity for magnesia, for lime, and for silica.—*Annales de Chim. t.* xxviii.

Guyton has since, without noticing Mr. *Chevenix's* experiments, given experiments in support of the opinion, that the earths do really possess a chemical affinity for each other.—*Annales de Chim. t.* xxxi.

Guyton had formed other opinions respecting baryt possessing an affinity for lime, magnesia, and alumine; and also respecting the affinity between strontia and alumine. But from the experiments of *Darracq* and Mr. *Chevenix*, it appears that his conclusions were too hastily formed.

The affinity of alumine for magnesia is by much the most powerful of all those which any of the earths have for each other.—*Chevenix, Phil. Trans.* 1802.

AGGREGATED STONES. By the intermixture of *quartz, felspar,* and *mica,* is formed GRANITE; and by the addition of *hornblende,* SIENITE; and by various triple combinations of these substances with *shorl, serpentine, steatites,* and *garnets,* GRANITINE; *quartz, mica,* and *garnet* compose the stone called NORKA OF MURKSTEIN. The duplicate aggregates Mr. *Kirwan* calls GRANITELL; that of *quartz* and *mica* the Swedes call STELL-STEIN. AVANTURINE may be considered as of this species; *hornblende* and *mica* form the GRUNSTEIN; *quartz* and *steatites,* the SAXUM MOLARE; and capillary shoots of *shorl* in *quartz* form the HAIR-STONE of the Germans. By GRANILITES are meant granites composed of more than three constituent parts. GNEISS is formed like granite, of *quartz, mica,* and *felspar,* but is of a thick slaty or fibrous texture, not granular. SCHISTOSE MICA is composed of *quartz* and *mica,* and is of a schistose or slaty texture, but contains more mica than gneiss. PORPHYRY is any stone which in a *siliceous, argillaceous, magnesian,* or *calcareous ground* contains scattered *spots of felspar,* visible to the naked eye. It may also contain quartz, hornblende, and mica. According to the ground it is named *siliceous porphyry, &c.* AMYGDALOID is a stone formed by elliptical masses of *quartz, lithomarga, steatites, hornblende,* &c. in a ground of *trapp, mullen, kragg, &c.* PUDDING-STONES are formed by siliceous pebbles cemented together by a substance of a similar nature, or by a ferruginous compound. SANDSTONES are formed by small grains of flint, quartz, &c. in a ground of calcareous, siliceous argillaceous, or ferruginous kind. When they contain mica, they are termed MICACEOUS SAND STONES. Stones that have round protuberances of a different substance from the common mass are called VARIOLITES. Stones not really porphyries, but approaching thereto, may be called PORPHYROIDS, and on the same principle is the term GRANITOID employed. Those are termed MIXED EARTHS, in which the different constituent parts are visible to the naked eye.

DERIVATIVES are earths or stones resulting from the coalition of stones and earths of different species, the different constituents not being distinct to the naked eye. LOAM is clay with a superabundance of sand. MOULD is loam mixed with the decayed remains of animals and vegetables.

Bergman relates, that in some of the mountains of Norway, which consist of an argillaceous pudding-stone, the siliceous pebbles it contains are observed to be compressed to the thickness of a fourth of an inch, in the lower part of the mountain, but to increase in size and roundness in proportion as their situation is higher.

VOLCANIC PRODUCTIONS.—The liquified matter issuing from volcanos is in general called LAVA. This is either *vitreous*, or *cellular*, or *compact*, or in the state of *enamel*. Besides the lava itself, *scoriæ*, *slaggs*, *ashes*, and *sand*, are produced by the eruptions of volcanos. POUZZOLANA, a substance composed of *silex*, *alumine*, *lime*, and *iron*; TERRASS consisting nearly of the same principles as the pouzzolana; PIPERINO, a concretion of volcanic ashes, a kind of breccia; and PUMICE STONE are also produced by volcanic fires. PSEUDO VOLCANOS emit smoke like volcanos, and sometimes flame, but never lava.

Widely different are the opinions of chemists, respecting the formation of various lapideous substances, and of the causes of the vast changes which have evidently taken place in this globe. Some, the *Plutonists*, contend that these are entirely the consequences of the action of fire, on the elementary substances of which our globe is composed; while, on the other hand, the *Neptunists* attribute the same effects entirely to the powerful action of water.

BASALTES are columnar masses of regular polygon stones, most commonly hexagonal, frequently pentagonal, discovered in various parts of the world, particularly in the island of Staffa, Icolmkill, &c. in the western part of Scotland, the opposite shores of Ireland, where they form a tract called the *Giant's Causeway*, Norway, Italy, &c.

Mr. *Kirwan*, who contends for the Neptunian origin of basalt, shorls, &c. observes that the heat communicated by volcanic fire scarcely ever equals 120°, and that not only shorls, which are fusible at 95°, and garnets, are rejected from volcanos, unfused; but even calcareous and fluor spars, with their transparency unimpaired. These, he supposes, undoubtedly to have pre-existed in the rocks or mother stones, before the eruption. In confirmation of his opinion respecting the aqueous origin of basalt, he remarks that this substance is converted by fire, into a most beautiful black glass, and that Mr. *Chaptal* has even converted certain kinds of lava into glass; which he employed in casting bottles.

Dr. *Beddoes* believes the origin of basaltes, from subterraneous fusion, to be thoroughly established by various authors, notwithstanding Mr. *Werner's* recent objections; he also believes there exists an affinity between granites and basaltes; that granite lavas are indeed granite rocks fused, and that they have cracked like the *basalte en tables.*—*Phil. Trans.* 1791.

Dr. *Hutton*, in his Theory of the Earth, differing from Mr. *Kirwan*, conceived that whinstone or basaltes, &c. attained their present position in a state of igneous fusion; but the conversion of whinstone, &c. by the heat of furnaces, into glass, was supposed to refute the doctor's hypothesis; since, his opponents said, if fire had been the agent, glass, and not whinstone, would have been formed.

Sir *James Hall*, believing that the mass might, by slow refrigeration in the bowels of the earth, have undergone a change similar to that of glass into Reaumur's porcelain; and have, by crystallization, lost the vitreous, and assumed the stony character, fused seven different species of whinstone, and by rapid cooling reduced them to a state of perfect glass. This glass he again fused, then reduced it to about 28° Wedgwood, in which temperature he kept it for some hours, and on allowing it to cool, the character of glass was lost, and by crystallization they had all assumed that of an original whinstone.—*Nicholson's Journal, Oct.* 1799.

Mr. *Kirwan* has, however, since offered some ingenious objections to the inferences drawn from these experiments, as to the high degrees of heat attributed to volcanos, acknowledging the discovery of the cause of the stony appearances which lavas exhibit after cooling to be a discovery of great importance to geology.—*Philos. Journal*, 1800.

Dr. *Samuel Mitchill*, of New York, observed in a stiff loam several bodies of a pentagonal figure, formed from a solid circular mass of argillaceous iron ore, of about two feet and five inches in breadth, and four inches in thickness. In the natural fracture of the stone, the fragments took upon themselves these regular forms, very much resembling basaltes; and like basaltes, though figured, they evidently, he says, are not crystallized, for they are as perfectly ferruginous and opaque as any argillaceous iron ore whatever. Do not these specimens, the doctor says, go very far towards deciding the dispute about the igneous or aqueous origin of basaltes? They support, he thinks, their Neptunian origin, and prove that argillaceous iron ore, which nobody has supposed to be a volcanic production, can take on a basaltic figure.—*Nicholson's Journal, Feb.* 1799.

Dr. *Garnet* accounted for the origin of BASALTES, by supposing that a quantity of pyrites very rich in iron, along with argillaceous and other earths, has been fused into a thin liquid mass by the fire of a volcano. On an eruption taking place, that part of the lava or liquid matter, which is thrown out by the expansive force of the vapours, or fire, and brought into contact with the air, cools too suddenly to admit of any regular form, but that which remains quiet within the bowels of the mountain, will cool very slowly, and be left without interruption to form crystals, or rather, by the gradual diminution of its bulk, to split into regular pillars, like starch when it is drying.—*Tour to the Western Islands of Scotland.*

Mr. *Baumé*, by a series of ingenious experiments, discovered that clays may be produced by the action of sulphuric acid on vitrified substances. Mr. *Ferber* applied this fact to the grand operations of nature on the matters ejected by volcanos; he discovered a fine white argillaceous matter in the hollow part of vitrified lava, evidently produced by the action of the sulphuric acid. Hence it appears that those substances which have, by the action of fire, been rendered otherwise intractable, again become, by the action of the sulphuric acid, subservient to vegetable life.—*Ferber's Letters.*

Spallanzani however observes, that although vitrified substances are thus changed by the action of sulphuric acid; the acid does not convert the vitrified substance to alumine, but merely disengages it.—*Voyage to the Two Sicilies.*

TO ascertain the component parts of *stony substances*, the following processes must be adopted:—1st. Reduction into very fine particles, by rubbing with water in a siliceous mortar. 2nd. Fusion with three times as much PURE POT-ASH, in a silver crucible.—3rd. Adding to this solution MURIATIC ACID, sufficient to redissolve the *silex*, *alumine*, and *other earths* which the alkali had sufficiently acted on, and which the first portions of the acid precipitates (that which remains requiring to be treated afresh with the alkali). 4th. Evaporating the solution almost to dryness, and adding a small portion of muriatic acid to supply what the alumine may have allowed to escape, and then distilled water, when the *silex* will fall to the bottom, and may be separated by filtre, and by exposure to a red heat in a silver crucible. 5th. The remaining earthy substances are then precipitated from the solution, by the addition of CARBONATE OF POT-ASH, then well washed and dried, and acted on by a solution of PURE POT-ASH, which will dissolve the alumine, from which the other earthy substances may be separated by the filtre. 6th. The alcaline solution may then be saturated with an acid, in a sufficient quantity to redissolve the alumine, which it at first precipitates; this may be again precipitated by the carbonated alkali, and then dried and weighed.

7th. The earthy matters which had resisted the action of the caustic alkali are to be treated with the muriatic acid; and magnesia, lime, and oxide of iron separated from the solution by means of pure pot-ash, and the *baryt* is to be precipitated in a sulphate of baryt, by the addition of SULPHURIC ACID to the remaining liquor. 8th. The precipitate containing the lime, magnesia, and oxide of iron, is to be redissolved in muriatic acid; the solution is to be evaporated to the consistence of a syrup, and the *lime* precipitated in a sulphate by the addition of concentrated SULPHURIC ACID. 9th. The *iron* may then be precipitated by an ALKALINE PRUSSIATE, and the *magnesia* by an ALKALI.

To separate ZIRCON from its combination with silex and oxide of iron in the jargon and hyacinth, the stones are powdered and fused with four times their weight of PURE ALKALI. After solution in water, and evaporation to dryness, the mass is to be dissolved in MURIATIC ACID, and again evaporated to a soft paste, when, by the addition of water, the muriate of zircon will be dissolved, and the *silex* precipitated. To free it certainly from the silex, the solution may be evaporated again to dryness, and water again added, by which any remaining portion of silex may be separated, and the *zircon* itself be obtained by precipitation with PURE ALKALI. The separation of the *iron* is most difficult; the best method is to expose the fine powder to the action of MURIATIC ACID for some days, by which the iron may be dissolved.

To separate *glucine* from its combination with silex, alumine, lime, and oxide of iron or of chrome, the *silex* is to be separated by the processes above described, and a precipitate is obtained from the muriated solution of the *alumine*, *glucine*, and *metallic oxide*, by a CARBONATED ALKALI, which precipitate is to be washed and dissolved in sulphuric acid, and a small quantity of SULPHURET OF POT-ASH is to be added to the solution, which is to be evaporated, by which the *alumine* will be obtained in octahedral alum. When, by repeated solutions and evaporations, all the alumine is thus separated, CARBONATE OF AMMONIA may be added to the mother water just beyond saturation; thus the glucine will be dissolved, and any fmall portion of *alumine* with the *metallic oxide* will be precipitated. The *glucine* is then separated from the ammonia by boiling, and from the carbonic acid by a red heat; whilst, by adding PURE POT-ASH to the precipitate, the alumine is dissolved, and the *oxide of iron* or of *chrome* is left pure.

The oxides of iron, chrome, and of manganese, may be all thus precipitated at once, if contained in the substance exposed to analysis. The precipitate might then be boiled in ACETIC ACID, which would dissolve the chrome and manganese, and leave the *iron*. To separate the *chrome* and *manganese*, CARBONATED ALKALI must be added to precipitate them, and the precipitate must be heated in an open vessel to oxidize the manganese. Then by boiling on them WEAK NITRIC ACID, the chrome will be dissolved and the *manganese* remain.

The presence of *pot-ash* is determined by a proper treatment with the SULPHURIC ACID, which will give a sulphate of pot-ash.

To ascertain the presence of *strontian*, the powdered stone is boiled with three times its weight of CARBONATE OF POT-ASH, MURIATIC ACID is then to be added to the powder, by which muriate of strontian is formed, which may be dissolved in water, evaporated, and then dissolved in alcohol, which will burn with a purple colour; from which the strontian may be separated by a carbonated alkali.

When well concentrated alkaline solutions of *silex and alumine* are mixed in equal quantities, a firm, gelatinous, opulescent mass results in a few minutes, which is perfectly insoluble in water, yet soluble in acids, even diluted, and even in distilled vinegar.—*Guyton.*

Mr. *Chevenix* found the SUB-BORATE OF SODA (borax) produce an easy fusion of even the *corundum stone*, so difficult of fusion, diminishing the attraction of aggregation of its particles first, by repeatedly heating the stone and immersing it in cold water.—*Phil. Trans.* 1802.

FOR accomplishing the analysis of *MINERAL WATERS*, various reagents are employed. Amongst these the first we shall notice are the ACIDS. The SULPHURIC demonstrates the presence of *baryt* by a heavy precipitate, and of *carbonic acid* and of *carbonates*, by an effervescence. The SULPHUREOUS shows the *sulphur* in a white precipitate, slow in falling, in waters containing sulphuretted hydrogen. The NITROUS does the same, destroying the fœtid odour, by separating the *sulphur*. The OXYGENIZED MURIATIC produces *similar effects;* but if in too large a quantity, it acts on the sulphur, and burns it as well as the hydrogen. From the EARTHS and ALKALIES are taken, for these purposes of analysis, LIME in solution (LIME WATER) to precipitate *carbonic acid* united with it and forming chalk; thus it decomposes the *carbonate of soda*, and by abstracting the acid throws down *magnesia* in slowly separating flocculæ. To ascertain how much of the carbonic acid was free, and how much was combined with the soda, exactly the same quantity of water is deprived of its free acid by boiling, and then its carbonate examined. POT-ASH is used to decompose the *sulphates, nitrates*, and *muriates of lime* and of *magnesia*, precipitating both their earths together; it precipitates the *carbonates of lime* and *of magnesia*, by attracting the carbonic acid which held them in solution. When highly concentrated it may disturb the solution of *alkaline salts*, by its attraction of the water; but in this case the turbidness is removed by adding more water. *Lime* and *magnesia*, it is to be remembered, unite with acids, without, but in the state of their *carbonates*, with, effervescence. The *metallic oxides*, precipitated by *pot-ash*, will be known by their peculiar characters. AMMONIA decomposes only the *magnesian* and the *aluminous salts*, precipitating only half their quantity, and forming triple salts with the rest. It also, by attracting carbonic acid, precipitates the *carbonates of lime, of magnesia*, and *of iron*. It also gives a blue colour, where the cuprous salts, and particularly the sulphate of copper, is present: but, except in the latter case, it is not equal to lime water. MURIATE OF BARYT detects the *sulphuric acid*, and points out its quantity, by that which the precipitated sulphate contains. The *muriate of lime* precipitates a sulphate of lime from the *alkaline sulphates*. The alkaline carbonates, formerly termed alkalies, cannot be depended on. The NITRATE OF MERCURY and OF SILVER discover the *sulphuric* and *muriatic acids*, by throwing down a sulphate or muriate of silver or mercury. TURNSOLE reddens even with *hydroguretted sulphurets* and *carbonic acid*, losing its colour from the latter by exposure to the air, which takes away the carbonic acid. INFUSION OF VIOLETS is turned green even by the *carbonates of soda, of lime*, and *of iron*. TURMERIC becomes of a violet colour by *alkaline* and even *earthy* solutions; and the reddish or bluish infusion of MALLOWS is changed green by the same substances. OXALIC ACID precipitates *lime* from any combination, in an indissoluble oxalate. GALLIC ACID detects the presence of *iron* by a reddish hue or a black precipitate. The ACETATE OF LEAD is darkened by *hydroguretted sulphurets*; with *sulphates* it produces a precipitate of white indissoluble grains, and a white heavy powder soluble in vinegar with *muriates*; it also produces a precipitate with the alkaline and earthy carbonates. VINEGAR and ALCOHOL are chiefly employed as solvents of certain principles.

To obtain their gaseous matters, heat must be employed, and the gas received on mercury; or their quantities may be ascertained by their union with reagents; *carbonic* acid with LIME WATER; *sulphuretted hydrogen* with OXIDE OF LEAD and NITROUS ACID; and *atmospheric air* with SULPHATE OF IRON.

To obtain a knowledge of the *salts* and *fixed matters*, a gentle evaporation must be employed. The residue is to be digested for some hours, with five or six times its weight of ALCOHOL, which will take up the muriate of lime and of magnesia, and, rarely, nitrates of the same bases, all these being deliquescent and soluble in alcohol. This solution may be evaporated, the salts redissolved in water, and the solution divided into three parts: the one will yield, with LIME WATER, its *magnesia*, and the other two may shew the quantity of *lime*, the one by the OXALIC ACID, the other by SULPHURIC ACID; the oxalate yielding the lime pure, by calcination. To ascertain the acid which is engaged with these bases, SULPHURIC ACID may be dropt on a small portion of the residue of the alcohol solution, when the disengaged vapour will show whether it be the *muriatic* or *nitric*. The residue is then to be subjected to eight or nine times its weight of cold water, which will take up the salts next in degree of solubility, *muriate* and *sulphate of soda*, *sulphate of magnesia*, *nitrate of pot-ash*, and *carbonate of soda*. These will be obtained, one after the other, by gentle evaporation, and will be known by their form, taste, &c. BOILING WATER is then to be poured on the residue to obtain *sulphate of lime*, which may be detected by the OXALIC acid which unites with the lime, or a SOLUTION OF BARYT, which attaches itself to the sulphuric acid.

The remainder can only contain the *earthy carbonates*, and perhaps *iron*; the latter being to be suspected if the mass is of a yellow colour. By moistening it, and exposing it to the sun and air for a few days, the *iron* is oxidized, and rendered insoluble in the ACETOUS ACID employed to dissolve the earthy carbonates. This solution being evaporated to dryness, and left in the air, the *acetite of lime* may be separated from the *sulphate of magnesia*, by the deliquescence of the latter. The *iron* and *alumine* may be dissolved by MURIATIC ACID and then separated, when *silica* only can remain, which may be fused with SODA by the blow-pipe.

VEGETABLE SUBSTANCES.

VEGETABLE LIFE is accompanied by so many chemical changes, that although we cannot regard it as a chemical process merely, we are still able, by examining chemically those changes, to advance considerably in the knowledge of the principles on which it depends.

Water, perhaps, conveys the greater part of the nourishment to plants. It not only becomes impregnated with air, during its descent as rain, but is the vehicle for conveying all it meets with in the earth, which is appropriate to vegetable nutrition. On its reception into the plant, it is reduced to its first principles, hydrogen and oxygen; the *hydrogen* becoming an essential principle of the vegetable, and constituting the greater proportion in the composition of resins, oils and mucilage. The *oxygen* is partly employed in producing sugar, vegetable acids, &c. and partly expelled by transpiration through the pores of the plant.

Oxygen appears to be necessary to the germination of seeds; forming sugar by its union with their mucilage, and thus, perhaps, forming the *stimulus* and proper *pabulum* of the germ. Hence the *oxygenized muriatic acid* appears to promote the evolution of the germ.

Air is necessary to vegetation, not only as a vehicle for water and caloric, but from its also yielding oxygen, which may either enter directly into the plant itself, and uniting with effete, carbonaceous matters be expelled, as carbonic acid gas, or it may enter the plant impregnated with carbon, which having deposited for the formation of the vegetable fibre, &c. it may be thrown off in a state of purity. The *nitrogen* it contains is, doubtlessly, highly beneficial.

Carbonic acid gas appears to be highly necessary to vegetation, and to be formed as well by the process of vegetable as of animal life. During the day, the carbonic acid seems to be decomposed as fast as it is formed, by the action of light on the plant; but during night, for the want of this decomposing power, as it seems, plants become surrounded with an atmosphere, containing an increased proportion of the carbonic acid.

Vegetables deprived of the carbonic acid they form are injured in their growth; but less so in oxygen gas, because they produce in that case more than is destroyed. M. *Saussure* has also observed the formation of carbonic acid gas, by the oxygen of the atmosphere uniting with carbon yielded by germinating seeds.—*Journal der Chemie*, *Jan.* 1800.

Nitrogen gas, so unfriendly to man, appears to be rapidly absorbed by vegetables; the vegetation of which is, therefore, much assisted by putrid vapours floating in the atmosphere.

Carburetted hydrogen gas is also favourable in a high degree to vegetation, properly diluted with the air of the atmosphere, although alone highly noxious.

Light is evidently necessary to the health of most vegetables; they appear even to seek it with greediness. If deprived of it, they become sickly, and the leaves they put out have not the usual green colour, but are nearly white, when they are said to be *etiolated.* It appears to act as a stimulus, and is a powerful agent in decomposing the various nutritive principles; and particularly in separating the oxygen gas from the water, carbonic acid gas, and other substances imbibed, whilst their bases become fixed in the plant.

Von Humboldt finding plants green which have grown in the dark, but in inflammable or mephitic gasses, attributes the verdure of plants to hydrogen and *nitrogen* in certain proportions.

The *heat* of vegetables sometimes exceeds that of the atmosphere. This heat is, undoubtedly, an effect of the fixation and concretion of those matters which form the food of plants.

Vegetables appear to be endued with digestive organs, and to possess the power of digesting and assimilating those substances which are taken up by their absorbents, and which are congenial to their nature. They also are capable, not only of throwing off those substances which cannot be assimilated by them, but even such of their principles as may exist in excess. Thus oxygen is emitted both from land and aquatic plants, in very considerable quantity, during their exposure to the action of light; and by this continual emission of vital air, is the loss repaired which is occasioned by respiration, combustion, fermentation, and putrefaction. Plants likewise emit a very considerable quantity of water in the form of vapour.

Dr. *Woodhouse* is, however, of opinion that growing plants do not actually emit oxygen gas; but that, whenever they appear to afford oxygen gas, it is by devouring the coal of carbonic acid for food, and leaving its oxygen in the form of pure air.

Vegetable substances yielding, in the last period of their analysis, *carbonic acid* and *water*, manifest that their constituent principles are *hydrogen*, *carbon* and *oxygen*; being, as it were, a species of oxides with binary radicals, the other principles being partly saturated with oxygen. From the difference of proportion of these three principles proceed the variety of vegetable substances.

It is a curious fact, that the combination of *hydrogen* and *carbon* does not admit of artificial union with *oxygen*, resembling that which exists in a vegetable substance, but directly as the oxygen is made to approach to these two principles alone, they separate, and each unites with a certain portion of the oxygen; and thus *water* and *carbonic acid* are the result of the last part of the analysis of vegetable matter.

Sap is that clear thin fluid which is directly formed by the elaboration of the various substances which are taken up as *pabula* by plants. It is the general humour of vegetables, as the blood is of animals, and from this are secreted the proper juices of different vegetables.

The saps of different trees appear to differ considerably in their composition; but in general they contain in much *water*, *gum*, *sugar*, *extractive matter*, *tannin*, *gallic acid*, *carbonic acid*, *acetous acid*, and *salts with basis of pot-ash*.

The expressed juices of plants have some analogy with the sap of trees, but in their chemical properties more nearly resemble the extractive matter.

MUCILAGE is a transparent, tasteless, inodorous, and viscous matter. It is soluble in *water*, but insoluble in *alcohol*, which precipitates it from water in a pure state, and still soluble in water. It is also coagulable by *acids* and by *metallic solutions*. It exists in most seeds and young plants, in so great a quantity, that they are almost resolvable into it. It also forms the basis of the proper juices of the plants: and sometimes, as in *euphorbium, celandine*, &c. it is combined with matters insoluble in water, which it keeps suspended in the form of an emulsion. It is sometimes found almost entirely alone, as in mallows, linseed, &c. Sometimes it is united with sugar, and at other times with oil, forming the fat oils. It sometimes constitutes the permanent state of the plant, as in the conferva, lichens, champignons, &c.

Mucilage consists chiefly of *carbon* and *hydrogen*, with *some oxygen*, and perhaps *a small portion of nitrogen*. Its products being *water, hydro-carbonate*, and *carbonic acid*, but less of the latter than is separated from sugar, shows plainly that it holds less oxygen.

The characters of mucilage are:—1. Insipidity. 2. Solubility in water. 3. Insolubility in alcohol. 4. Coagulation by the action of weak acids and metallic solutions. 5. The emission of carbonic acid, when exposed to the action of the fire, and being converted into a coal without exhibiting any flame. It likewise, when diluted with water, readily passes to the acid fermentation; and by distillation yields acetic acid.

Its formation seems almost independent of light.

Lord *Dundonald* has discovered that a gum, resembling gum senegal in its properties, may be extracted from *lichens*. 1801.

GUM is transparent, brittle, tasteless, and inodorous, it exudes from different parts, but, chiefly, from the trunks and branches of trees. It is generally supposed to be only inspissated mucilage, which, in its chemical properties, it exactly resembles.

Gum appears to consist of *oxygen, hydrogen, carbon, nitrogen*, and *lime*, with a little *phosphoric acid*, differing from sugar, not only in containing less oxygen, but also by its combination with nitrogen and lime.—*Cruickshank.*

One hundred parts of gum yield from 0,14 to 0,20 of mucous acid, and appear to be composed of 23,08 of carbon, 11,54 of hydrogen, and 65,38 of oxygen.—*Fourcroy.*

Fæcula of vegetables appears to be only a slight alteration of mucilage, it differing from that substance only in being insoluble in cold water, in which liquid it falls with wonderful quickness. If it be put into hot water, it forms a mucilage, and resumes all its characters. It seems that the fæcula is simply a mucilage, deprived of caloric. To extract the fæcula, the plant must be bruised or ground, and diffused in water; and the fæcula, which is at first suspended in that fluid, falls to the bottom. Thus are obtained *potatoe flour, cassava, sago,* &c. *Paper* is also a fæcula. In obtaining *starch,* the extractive and glutinous parts are destroyed by fermentation, the fæcula or starch precipitating purer and whiter. Nitric acid converts starch into oxalic and malic acids.

Coloured fæcula, as indigo, are employed in the art of dyeing.

Vegetable gluten. This has been called the *vegeto-animal substance,* from its properties resembling those of animal substances. To procure it, a paste is formed with flour and water, which is kneaded and wrought in the hands, under water, till it no longer communicates any colour to that fluid. The substance which then remains in the hand is tenacious, ductile, and contractile, becoming more and more adhesive as it dries. During the operation the fæcula falls to the bottom of the water, and the extractive matter remains in solution. If a large quantity of water be employed, the gluten does not form; perhaps from the too great separation of its particles.

The glutinous matter emits a very characteristic animal smell. Its taste is insipid; and, on being dried in a gentle heat, it resembles glue, and breaks short like that substance. If it be placed on burning coals, it curls up, and burns like an animal substance. By distillation it affords the carbonate of ammonia, and seems, in several instances, to shew a very decided animal character.

Fresh made gluten, exposed to the air, readily putrifies, and when it has retained a small quantity of starch, this last passes to the acid fermentation, and retards the putrefaction of the gluten; in this way it passes into a state resembling that of cheese.

Water does not dissolve the vegetable gluten; but if it be boiled with this fluid, it loses its extensibility and its adhesive quality: it also loses its elasticity and glutinous quality by drying. *Alkalies* dissolve it, by the assistance of a boiling heat; and it is precipitated by *acids*, but deprived of its elasticity. It is insoluble in *alcohol*.

The *nitric acid* dissolves it with activity, emitting at first nitrogen gas, as when an animal substance is employed. This is followed by an emission of nitrous gas, and the residue affords, by evaporation, the malic and oxalic acid, yellow oily flocculæ being also formed.

The *sulphuric* and *muriatic acids* likewise dissolve it, and salts with base of ammonia may be obtained from the combinations; acetous acid, and an inflammable gas, in consequence of the separation of hydrogen, being produced.

Dissolved repeatedly in *vegetable acids*, and precipitated by alkalies, it is brought to the state of fæcula; and if vinegar be distilled from it, it is reduced to the state of mucilage.

This gluten becomes soluble in *alcohol*, when it has undergone acid fermentation, and thus furnishes a varnish, which may be employed in the arts.—*Darracq*.

It is to this gluten, that wheat owes its property of making a good paste with water, and the facility with which it rises to form *bread*. Thus gluten is sometimes destroyed by the fermentation of flour, by which change it is rendered incapable of rising and forming good bread.

It exists in much less quantity in the flour of other corn, but is supposed to be formed in some other plants, particularly in the *fungi*. It has also been supposed to have been separated during the process of *paper making*. Its principles appear to be carbon, hydrogen, nitrogen, and oxygen.

Farina, or flour, therefore, is composed of three principles, the *amylaceous*, or *starch*, or *fæcula*, the *animal* or *glutinous* principle, and the *saccharine principle*.

Extractive matter of plants, obtained by evaporation of their juices, varies in colour, taste, &c. from the admixture of other principles. *Acetic acid*, with the *acetites of pot-ash, lime*, and *of ammonia*, are constantly found in it.

It differs from all other vegetable matters by its strong attraction for oxygen, and the indissolubility and brown colour it thereby acquires. Thus alum and oxy-muriatic acid, if added to a solution of any vegetable extract, unite with the extractive matter, and is precipitated of a brownish colour, of which it has deprived the fluid which held it.

It appears to be an oxide with a triple radical, being a compound of *carbon*, *hydrogen*, and *nitrogen*, with a portion of *oxygen not sufficient for its saturation*; and is therefore capable of absorbing much more than it originally holds. It appears to differ only in the proportion of its primitive principles from the *colouring matter*.

Sugar is a true salt, of a peculiar nature, yielding a sweet taste; it may be extracted from a number of plants, as the maple, birch, carrot, wheat, corn, beet, parsnips, grapes, &c. by digesting in alcohol. This fluid dissolves the sugar, and leaves the extractive matter untouched, which falls to the bottom.

The sugar generally used, proceeds from the sugar-cane, *arundo saccharifera*. The juice of the cane is obtained by expression, and boiled repeatedly with wood-ashes, and lime, to part the acid, which prevents the sugar from coagulating, until it acquires a syrupy consistence. It is then farther concentrated by boiling with alum and lime, and the thinner syrup, or melasses, or treacle, allowed to separate from the sugar, which in this state is called clayed sugar. This sugar suffers then a farther refinement, by boiling with lime and with bullock's blood, the albumen of the latter coagulating by heat, involves and separates most of the foreign matters the fluid contains; thus producing its clarification. It is then put into reversed earthen cones, through openings at the small end of which, the water trickles away, carrying with it also a portion of the colouring matter. It is then called refined or loaf sugar. If allowed to crystallize, it will form tetrahedral flattened prisms, the smaller lateral surfaces being sometimes composed of two, joining in an obtuse angle; the summits dihedral, truncated on two sides: it is then called *sugar candy*. It is easily fused, and when cooled, forms the substance called *barley sugar*.

Manna, which is sugar under another form, is secreted by, and exudes from, several vegetables; from the pine, the fir, the maple, the oak, the juniper, the fig, the willow, the olive, &c. but the ash, the larch, and the *alhagi*, afford it in the largest quantities.

Sugar is a non-conductor of electricity. Two pieces of sugar being rubbed together, light is evolved, and the peculiar smell of electricity is yielded. Powdered sugar also very readily emits a phosphoric light, if heated below ignition or fusion.

It is very soluble in *water*, and is also dissolved in six times its weight of *alcohol*.

It is combustible, and is decomposable either by distillation or combustion. Its products are *water, carburetted hydrogen, carbonic acid*, and *charcoal*, manifesting it to be, according to Mr. *Cruickshank's* valuable experiments, a *true vegetable oxide*, containing *carbon, hydrogen*, and *oxygen*.

By fermentation it forms alcohol and acetous acid; but if deprived of its oxygen, it bears a resemblance to gum, and, like pure mucilage, is not susceptible of the vinous fermentation.

It differs from sugar of milk in containing less oxygen, and much more carbon; and from gum, in containing more oxygen, and in not holding any nitrogen, which it is probable gum does.

Oxalic acid is obtained from it by the *nitric* and *oxygenized-muriatic acids*. It is also obtained by the addition of *sulphuric acid*, sulphureous acid gas being thus freely separated, evincing the substraction of oxygen during the process.

That sugar contains the same principles as mucilage, but more oxygen, is beautifully evinced by an experiment of Mr. *Cruickshank*. Phosphuret of lime being added to a solution of sugar, mucilage is found in the place of the sugar. During the formation and separation of the phosphuretted hydrogen, the oxygen of the sugar has quitted it to unite with the phosphorus and form phosphoric acid, the sugar being thus changed into mucilage. Oxygenized muriatic acid being added to mucilage, another proof offers itself: oxalic acid is thus formed, and with it a substance possessing the sweetness of sugar.

Sugar inflames and detonates strongly with the hyper oxygenized muriate of pot-ash, by percussion.—*Rollo*.

ALBUMINOUS matter of vegetables is obtained by filtering the expressed juice of cresses, white cabbage, &c. and placing it in a phial in boiling water, when it deposits in a flocculent form. It is also obtained from the water in which flour has been washed to obtain the vegetable gluten. This matter resembles the white of eggs; it is soluble in cold water, and coagulates with heat or spirit of wine, the coagulum being insoluble. Alkalies dissolve it, particularly *ammonia.* It putrefies without passing through the acid state; and with *nitric acid* it forms nitrogen gas, before it yields the oxalic acid.

OILS are inflammable substances, immiscible with water, and generally of less specific gravity than that fluid. They are obtained by expression or distillation from various animal or vegetable substances. Oils are composed of *hydrogen, oxygen*, and *carbon*; the VOLATILE containing *most hydrogen*, and the FIXED most *carbon.* They may be decompounded by being passed through ignited tubes; *charcoal, carburetted hydrogen*, and *carbonic acid*, being the result.

The oily principle appears to be the same in all oils; but is combined with *mucilage* in FIXED, and *aroma* in the VOLATILE.

1. *Fixed*, or *fat oils*, are obtained from seeds or kernels, by expression in proper sacks between metallic plates. The separation is aided, generally, by heat, and when heat is not employed the oil is said to be *cold drawn.* They are insoluble in alcohol or water, and are generally mild. They all congeal at certain low temperatures, and are volatilized at a degree of heat beyond that of boiling water; and, when volatilized, take fire by the contact of an ignited body.

Oil easily combines with oxygen. This combination is either slow or rapid. In the first case, *rancidity* is the consequence, and combustion in the latter. It seems, more strictly speaking, that when the oxygen combines with the mucilage in the oil, it forms RANCID OIL, but that when it unites with the oil itself, DRYING OIL is formed. The rancidity of oils appears to be an effect analogous to the oxidizement of metals; and the proof of its being produced by a change in the mucilage is derived from this circumstance, that if the mucilage be separated from the oil, by strong agitation in water, the oil may be preserved for a long time without any change.

Fourcroy supposes that rancidity is the consequence of the formation of sebacic acid; and that the drying of oil by absorption of oxygen is a *cerification* of the oil.

The process by which oil is rendered drying shews its dependence on the combination of oxygen with the oil itself, since nothing more is required than to boil oil with metallic oxides; during which process a substance is disengaged, which swims at the top, and appears to be simple mucilage.

The oxides of lead, bismuth, and mercury, thus combining readily with oils, become the basis of certain PLASTERS and OINTMENTS. But *Deyeux* observes, that plasters made with linseed oil are most soft and pliant. This difference he supposes to arise from the mucilaginous matter in the linseed oil; observing also, that olive oil, boiled with fænugreek or linseed, acquires the properties of linseed oil, it being his opinion, that it is the mucilage which renders certain oils drying.—*Annales de Chim.* 1800.

If the product of the combustion of oil be collected, much water is obtained; the hydrogen and the oxygen, which the oil contained, uniting and forming that fluid. According to *Chaptal*, a pound of oil of olives contains 12 oz. 5 dwts. 5 grains of carbon, and 3 oz. 2 dwts, and 67 grains of hydrogen.

If oil is burnt without a sufficient access of oxygen, a soot is formed, called *lamp-black*.

The fixed oils unite with *sugar*, also with the *acids*. They may by certain *media* be intimately mingled with water, when they form a milky white fluid called an *emulsion*. With the *sulphuric acid* they form a mass soluble in alcohol and water. With the *nitric* they turn black, and such as are drying inflame at the time of combination. Their inflammation is more certainly effected by a mixture of the concentrated nitric and sulphuric acids. The *muriatic* forms a saponaceous mass with them, and the *oxy-muriatic* thickens and whitens them. These masses have been called *acid soaps*.

Linseed oil, by long digesting on the oxides of lead, affords a pellicle of considerable firmness, transparent, wonderful elastic and extensible, and burning like elastic gum. A pound of this oil, sprèad on a stone, and exposed to the air for six or seven months, acquired almost all the properties of elastic gum.—*Chaptal*.

The *alkalies* also combine with the fixed oils, and form SOAPS, by which oils are rendered miscible with water. Soda is chiefly used for this purpose.

The *soaps* generally made in England are: 1. *White soap*, from tallow and a ley of soda. 2. *Mottled soap*, from tallow, kitchen-stuff, and soda. 3. *Yellow hard soap*, with tallow, rosin, and soda. 4. *Soft soap*, from whale or fish oil with pot-ash, the ley of which is not drawn off; and when it is combined, a small quantity of tallow is added, which forms the white spots.

By mixing a solution of soap with a solution of the sulphate of magnesia, lime, alumine, or of the muriate of baryt, an EARTHY SOAP, either *magnesian*, *aluminous*, *barytic*, &c. is precipitated.

A similar effect is produced by the addition of metallic solutions; a *metallic soap* is precipitated.

Ammonia forms a saponaceous fluid with oils, but its action is much less feeble than that of the fixed alkalies.

The fat oils perfectly dissolve *sulphur*, and form a reddish balsam, of a disagreeable odour, called BALSAM OF SULPHUR. They also dissolve *phosphorus*, and then become luminous at the surface.

2. *Volatile* or *essential oils* are contained in all the different parts of plants.

They vary in their colour, consistence, odour, &c. and are obtained chiefly by distillation. They absorb oxygen with greater facility than fixed oils, acquiring colour and consistence, and passing to the state of resin; depositing at the same time needle-formed crystals, which have by some been supposed to be camphor. They are soluble in alcohol.

Water actually dissolves a part of the essential oils, receiving both taste and smell on being distilled from the plant, as appears in the DISTILLED WATERS.

The *nitric*, *sulphuric*, and *oxygenized muriatic* acids, decompose them more readily than they do the fixed oils.

If 2 parts of oil of turpentine, and 1 of strong sulphuric acid, be quickly stirred together with a glass rod, and a little concentrated nitric acid be added, a sudden inflammation takes place. With *alkalies* the ethereal oils form a soap called *essential oily soaps*. They also dissolve *phosphorus* and *sulphur*.

CAMPHOR is a white, concrete, crystalline, and very combustible substance. Though chiefly obtained from the roots of the *laurus camphoratus*, it is said to exist in all odoriferous vegetables. It has a strong smell and taste, is soluble in *alcohol*, in *essential oils*, and in *acids*, without decomposition. With a gentle heat it rises unaltered; if ignited, it burns with a white flame, leaving no residue. It is very slightly soluble in *water*, but communicates its smell to that fluid. *Alkalies* do not unite with it, but *sulphur* does by fusion in a gentle heat, or by the alkaline sulphuret.

The mixture of camphor and sulphur is more fusible than either of the substances by themselves. It burns in oxygen gas with a vivid white and blue flame, which is projected from the centre in a beautiful manner.

It is dissolved by the *mineral acids*, from which it may be precipitated by the addition of water.

By the *nitric acid*, the peculiar acid termed *CAMPHORIC ACID* is obtained.

Camphor is capable of crystallization either by sublimation or precipitation; it forming in hexagonal plates. It appears to be a volatile oil, rendered concrete by carbon.

If passed through a heated porcelain tube it is decomposed into *charcoal* and *carburetted hydrogen*. If burnt in oxygen gas, camphoric and carbonic acid is formed, and charcoal deposited.

Romieu and others have observed that small pieces of camphor obtain a rotatory motion, when placed on water, in a glass, the motion ceasing if the water be touched by a conductor of electricity, but continuing if touched by an electric *per se*. It does not turn upon hot water.—*Bergen*.

Resins appear to be oils rendered concrete by their combination with oxygen. They appear to be volatile oils oxygenized and in part dishydrogenized.—*Fourcroy*.

They are inflammable, and yield much soot, during their combustion; their products being chiefly water. By distillation they yield *carbonic acid*, *carburetted hydrogen* and *charcoal*. They are soluble in *alcohol* and in *oils*, but not in *water*. They are generally less sweet than the balsams, and afford more volatile oil by distillation. They unite by fusion with *sulphur*, but difficultly with *phosphorus*. But they enter into union neither with the *metals*, nor with their oxides; nor do the *alkalies* or *acids* have any effect on them. Among the resins may be placed *mastich*, *sandarach*, &c.

Tar is separated from pine, and Scotch firs, in *tar-furnaces*, and when inspissated becomes black pitch. The turpentines appear to be resins containing volatile oil.

Gum resins appear to be a natural mixture of mucilage and resin. They are partly soluble in water, and partly in alcohol, and render water turbid in which they are boiled. Under this head may be placed *scammony, gum gutta, assafetida, aloes, gum ammoniac*, &c. They flow in a milky form on breaking the plants which contain them.

They yield by distillation, besides *volatile oils, ammonia* combined with an acid, and a considerable portion of *carbonic acid gas*; and leave a bulky saline coal.

Sulphuric acid renders them a coal, the *nitric* converts them, in part, into oxalic acid, and the weaker acids dissolve them. The *alkalies* have also some power in dissolving them.

Some gum resins are cleared by art of their extractive principle, for the purpose of applying them to various uses. Such is the intention, in the process for making *bird lime*. Resins dissolved in fixed oils form the fat or *oily varnish*; in volatile oils the *essential varnish*; and in alcohol the *spirit varnish*.

Caoutchouc, called the *elastic gum*, may also be placed here. It exudes from the *hevœa*, the *urceola*, and the *jatropa elastica*. When pure it is white, the dark colour being derived from the fires employed in drying it. It is a non-conductor of electricity. It excites so high a degree of electricity, by rubbing on paper, that sparks may be obtained, and even a phial charged by it. Its elements appear to be *nitrogen, hydrogen, oxygen*, and *carbon*.

The *nitric ether* dissolves this gum, first softened by boiling in water. If placed in contact with a volatile oil, such as that of turpentine, it swells, softens, and becomes very pasty, and may, in this state, be applied as a varnish.

Hermstadt is of opinion that it is contained in misletoe.

Balsams are substances containing a principle which does not exist in resins, and which, combining with oxygen, forms an acid, the *benzoic acid*; while the oil, saturated also with oxygen, forms the resinous part, which is therefore found united with a concrete acid salt. In this class may be placed *benzoin, balsam of Tolu*, &c.

Tannin, or that substance which acts as a *tanning principle*, combining with the gelatinous parts of animals, and thereby preventing their decay, it is generally found to accompany the gallic acid in the bark, ligneous part, &c. of vegetables.

It is readily obtained from a strong cold infusion of *oak bark*, &c. by adding to it a solution of *muriate of tin*, when a precipitate is thrown down containing pure tannin and oxide of tin. This precipitate is then to be diffused in water, and *sulphuretted hydrogen* is to be added, which unites with the tin and leaves the pure tannin free.

As some of the tannin may be held in solution by the muriatic acid, *Proust* recommends its precipitation by a careful addition of *alkali*.

Tannin may be obtained by adding lime water to an infusion of tan, and dissolving the precipitate in an acid, as the nitric, which unites with the lime and separates the tannin in a powder.—*Guillot*.

It may be had in a pulverulent form, of a light brown colour, which, when diffused in water, becomes of a darker colour. Its solution in water is also of a dark brown, but in alcohol, which will take up a sixth of its weight, its solution is lighter. Its taste is bitter and rather aromatic. It combines with *alkalies*, and has a strong affinity for many of the *metallic oxides*. Acetate of lead being added to a solution of tannin, the oxide and tannin fall in a precipitate. The red oxide of iron also unites with it and forms a brown, and almost black precipitate.

It combines with the *gelatin* of animal substances, forming an insoluble *magma*, resembling leather. This immediately takes place if a solution of tannin be added to a solution of glue, which is inspissated gelatine.

Mr. *Chevenix* found a peculiar principle in *raw coffee*, totally different from all other vegetable principles. But as roasted coffee possesses tannin, and as *Seguin*, *Davy*, &c. suppose that heat developes the tannin principle in many vegetables, Mr. *Chevenix* doubts whether this principle may not be converted into *tannin*, whilst in the vegetable, by heat.—*Nicholson's Journal*, 1802.

The bark of several trees, the poplar, the willow, the chesnut, the hazel, the ash, and many other trees, contains this principle; but the oak bark appears to contain the largest quantity. It abounds in the bark in proportion as it is nearer to the woody fibre. Tannin exists in tea and in red port, but in no substance has it been found so abundant as in the *terra japonica*, or *extract of catechu*, produced from a species of the *mimosa*, in the East Indies. This was suspected by Sir *Joseph Banks*, from the strong taste resembling tannin, which he thought was yielded by this substance; and by the examination of Mr. *Davy*, it appeared that at least two-thirds of this principle enters into its composition.

VEGETABLE ACIDS have all a compound basis. Every one have *carbon* and *hydrogen*. The variety in their habitudes and properties proceed from the different proportion of these principles, and of *oxygen*, in each particular acid.

FIRST, *Vegetable acids ready formed, and obtained by very simple processes.*

1. The CITRIC ACID, or the *acid of lemons*. This is obtained in a concrete state, by saturating the juice of lemons with powdered chalk; with which it forms a difficultly soluble salt, CITRATE OF LIME, which is to be washed with warm water, and then a sufficient quantity, previously ascertained, of sulphuric acid, to fully saturate the chalk employed, is to be added, then boiled for some minutes, with ten parts of water, and then filtered. The sulphate of lime remains on the filtre, and the fluid, by evaporation, will yield the CRYSTALLIZED CITRIC ACID, which will be obtained in a state of purity, and in fine crystals, by repeated crystallizations. Its crystals are octahedral prisms, truncated on their solid angles.

By exposing the juice of lemons to a freezing cold, the water it contains will be frozen, and the acid remain in a liquid state, highly concentrated. But this process does not destroy the mucilage, nor the extract; the juice will therefore run into fermentation in warm situations.

M. Brugnatelli obtained citric acid pure, by well straining it through linen cloth, then mixing it with spirits of wine, and, after standing some days, filtering it through paper; the pure citric acid passing through, and the slimy matter being left on the paper.—*Ann. de Chim.* xxii.

Proust observes, that by this process the extractive part is left and that *Scheele's* process, above described, can only be depended on.

It seems to be one of the strongest of the vegetable acids, and of course the least decomposable. *Scheele* thought it was not changed by the *nitric acid*; but *Fourcroy* and *Vauquelin* find, by long continued action it is converted to acetic acid, with a small portion of oxalic. It is also changed into acetic acid by the *sulphuric acid*.

Distilled in a retort it yields *acetic acid*, *carbonic acid gas*, and a small portion of *carburetted hydrogen*, a light coal remaining. Its affinities are in the following order: baryt, lime, pot-ash, soda, strontian, magnesia, ammonia, and alumine.—*Vauquelin*.

It acts on several metallic substances by the aid of water, and forms CITRATES with the *alkalies* and *earths*.

2. The MALIC ACID may be extracted from the juice of many unripe fruits, particularly of apples, by saturating the juice with pot-ash, and adding a solution of acetate of lead; the acetic acid combining with the alkali, and the lead with the malic acid, forming a MALATE OF LEAD, which is precipitated. This precipitate being washed, and diluted sulphuric acid added to it, sulphate of lead is formed, and the malic acid left.

Besides various fruits, many of which yield both it and the citric acid, sugar also yields it, when treated with nitric acid.

Vauquelin has also discovered the malate of lime in the *sedum album*, *acre*, *et telephium*, in many species of *crassula*, in all the cotyledons he examined, in many of the *mesembryanthema*, and in common parsley. He observes, when the juice of a plant furnishes an abundant precipitate with an oxalate of ammonia, and also a light flocky precipitate, with acetate of lead, which is easily soluble in vinegar, it assuredly holds a malate of lime.—*Ann. de Chim. c.* 104.

With the *alkalies* it forms deliquescent salts; with the *earths* it also forms MALATES, that of alumine being difficultly soluble. The MALATE OF IRON does not crystallize, but that of *zinc* forms in fine crystals. It precipitates the *nitrates of lead*, of *silver*, or of *gold*, in the metallic state. It is readily destroyed by fire, or converted into the carbonic acid. The *nitric* acid changes it into the oxalic acid. *Vauquelin* says, perhaps, by being oxygenized by degrees, it at least contributes, in some plants, to form the oxalic acid.

3. The GALLIC ACID is chiefly obtained from nut-galls; it is also yielded by many barks, roots, fruits, &c. To procure it, one

pound of powder of nut galls may be infused in two pints and three-quarters of water for four days, shaking the mixture frequently, and then filtered and left in a vessel covered merely with blotting paper. The liquid will then become covered with a thick pellicle of mouldiness, and a precipitate fall down in proportion as the infusion evaporates. These precipitates being collected, and dissolved in boiling water, form a liquor of a brown yellow colour, which, on evaporation by a gentle heat, deposits the acid in a precipitate like fine sand and crystals of a yellowish grey, it not being possible to obtain it white. It may also be obtained in lamellated crystals by sublimation, if care be taken that heat be very slowly applied.

M. Fiedler adds *alumine* to a strong infusion of nut galls, which precipitates with the extractive matter and the tannin, leaving a clear solution of the gallic acid, yielding fine acicular crystals.

It gives an acid astringent taste, effervesces with chalk, and reddens turnsole. Half an ounce of this salt is soluble in an ounce and a half of boiling water, or in twelve ounces of cold water. Boiling spirit of wine dissolves its own weight of this acid; but cold spirit only one-fourth. It is inflammable, it also melts and leaves a coal of difficult incineration. By distillation it gives out an acid phlegm, and a sublimate nearly of the smell and taste of acid of benzoin.

It contains the greatest quantity of carbon of any of the vegetable acids.

Dejeux thinks its radical is simply carbon, and that it differs from carbonic acid only in the quantity of carbon. But *Gren* thinks that, as it is, like the acids just spoken of, convertible into oxalic acid by nitric acid, its basis is composed of hydrogen and carbon.

It precipitates the several metals in different colours. *Gold*, of a *brown colour*; *silver*, of a *grey*; *mercury*, of an *orange*; *copper*, of a *brown*; *lead*, of a *white*; and *bismuth*, of a *citron yellow*. With the red oxide of iron it forms a black precipitate; but with the grey oxide a green precipitate. On the surface of the fluid, from which gold and silver is thus precipitated, a pellicle of the reduced metal is formed. Platina, zinc, tin, cobalt, and manganese, are not precipitated by the gallic acid, it appearing that these are the metals most tenacious of the quantity of oxygen necessary to their saturation, and which seldom stop at any lower degrees of oxidizement; whilst those metals which are precipitable by this acid are susceptible of various degrees of oxidizement, are but little retentive of the last portions of oxygen with which they are saturated, and form an union with this acid best when they are at their *maximum* of oxidizement.

Thus *Proust* observes, that it is only the red oxide of iron (oxidized *ad maximum*) that forms the ink with the galls; but which ever sulphate is employed, when the ink is spread on paper it blackens, from the oxygen it absorbs.

Boil four ounces of logwood near an hour in six quarts, beer measure, of water, supplying the waste during boiling, and afterwards adding water to make up five quarts; to this liquor strained whilst hot, add when cold 20 ounces of galls coarsely bruised, 4 ounces of sulphate of iron calcined to whiteness, 3 ounces of coarse brown sugar, and 6 ounces of gum arabic or senegal. This makes a good black ink, but for ordinary purposes, half the quantity of the two latter ingredients may suffice.

Mr. *Desormeaux* adds to the foregoing half an ounce of acetate of copper, first moistened and pounded into a paste.

Sulphuretted hydrogen gas passed through ink makes its colour disappear, but on being used, the oxygen it absorbs presently blackens it; at first the oxide of the sulphate is oxidated *ad minimum*, and then becomes oxidated *ad maximum*.—*Ann. de Chim.* c. 103.

Writing in common ink may be effaced by diluted oxymuriatic acid, and may be again restored by dipping the paper in a very weak solution of sulphuret of ammonia, or of the prussiate of potash, to which a few drops of the sulphuric acid have been added. Old writings may be revived by a similar employment of these substances.

To prepare inks which will not be effaced by the oxy-muriatic acid, indigo and the oxide of manganese may be added.

The BENZOIC ACID is obtained by boiling 4 parts of benzoin with 1 of lime, and 30 of water, stirring them together over a gentle fire for half an hour, by which, the acid uniting with the lime, the BENZOATE OF LIME is formed. After settling, the clear liquor is poured off, and the process twice repeated with fresh lime-water. The liquors should be then filtered, and muriatic acid added as long as any precipitate, which is the ACID OF BENZOIN, falls. To have its crystals, which are compressed prisms, it must be dissolved, filtered, and gently evaporated. It may be also obtained by *sublimation*, in the form of *flowers of Benjamin*.

It acts very powerfully on the tongue, reddens the infusion of violets, effervesces with the alkaline carbonates, and unites with earths and alkalies, forming BENZOATES. It does not act on the metals, but unites with their oxides, on the benzoate of pot-ash being added to the metallic oxides in solution.

A similar acid is obtained from *balsam of Tolu* and *storax*, from the urine of children, and even of adults, and of some quadrupeds which live on hay, as the horse, the camel, and the cow. It is also found in the water of dunghills. The effects produced on it by the *nitric acid* are not thoroughly known.

It differs, however, from the other vegetable acids, and retains an essential oil, which gives it smell, volatility, combustibility, and solubility in alcohol.

The two vegetable acids next to be considered, are those which naturally combine with a portion of pot-ash to a state of demisaturation, and are called *vegetable acidules*. They are two in number, the *oxalic* and the *tartareous*.

ACID OF TARTAR is obtained from TARTAR, more properly named the TARTAREOUS ACIDULE, or the ACIDULOUS TARTRITE OF POT-ASH; it being a combination of acid of tartar with a less portion of pot-ash than is required for its saturation.

Tartar is formed on the sides of casks during the insensible fermentation of wine. It may be also obtained from must or unfermented wine, and from several fruits and vegetables. Exposed to heat it yields oil, an acid phlegm, and a prodigious quantity of gas, three-fourths of which is carbonic acid gas, and the remainder carburetted hydrogen; and leaves, in its ashes, a considerable quantity of vegetable alkali.

Ammonia is said also to be yielded by it; but farther enquiries seem necessary to determine whether this substance exists as a principle in the tartar.

So strong is the attraction of the tartareous acid for the portion of pot-ash which it holds, when in the form of an acidule, that it only yields it to the strongest acids, in consequence of undergoing, by their action, an actual decomposition; the muriatic and sulphuric forming with it the acetic acid; and the nitric, the oxalic.

The tendency of the tartareous acid to unite with a certain portion of pot-ash, to form tartar, is so great as to produce a seeming exception from the general laws of affinities. Even such acids, the acetic for instance, as are not so strongly attracted by pot-ash as is the tartareous, decompose the neutral tartrite of pot-ash, and separate from it, not the tartareous acid, but the acidulous tartrite, the consequence of the tartareous acid retaining this certain quantity of alkali. A similar circumstance is observable also with the following (the oxalic) acid, a sufficient quantity of alkali being left to form the acidule.

Lime, strontian, and *baryt*, unite with the tartareous acid in a precipitate, and leave the pot-ash of the acidule free; but *alumine* and *magnesia* only unite with the acidule, and form triple salts.

Purified acidulous tartrite of pot-ash, or *crystals*, or *cream of tartar*, is obtained by solution of the above, and by subsequent filtration and evaporation. It crystallizes in tetrahedral prisms, cut off slantwise, and requires for its solution 160 parts of cold, and 28 of hot water.

The acid of tartar may be obtained by dissolving two pounds of crystals of tartar in water, and throwing in *chalk*, or, according to *Fourcroy*, *lime*, by degrees, until the liquid is saturated. A precipitate forms which is a true tartrite of lime, tasteless, and crackling between the teeth. By adding sulphuric acid, diluted with water to this tartrite, and digesting them together for twelve hours, the tartareous acid is set at liberty, and may be cleared from the sulphate of lime by means of cold water. This acid yields tabular and spear-like crystals, which become black when exposed to the fire, yielding hydrocarbonate, and carbonic acid gas, an acid phlegm and some oil, and leaving a spongy coal behind. Its radical, therefore, consists of hydrogen and carbon, which, with oxygen, form this acid. One hundred parts contain 70,5 of oxygen, 19 of carbon, and 10,5 of hydrogen: it only requiring the subtraction of 6 parts of carbon, and the addition of as much oxygen, to form the oxalic acid.

This is one of the strongest vegetable acids, yielding only to the oxalic. It has no action on *platina*, *gold*, or *silver*, and scarcely any sensible action on *copper*, *lead*, *antimony*, and *tin*;

but it dissolves their *oxides*. It acts on *iron* with a considerable degree of effervescence.

By a neutralization of the acidulous tartrite by a farther addition of pot-ash, the TARTRITE* OF POT-ASH, or, as it was improperly called, *soluble tartar*, is formed.

The saturation with *soda* of the *acidule* forms the TARTRITE OF SODA and POT-ASH, formerly called *sal rochelle*, or *sel de seignette*, which crystallizes in tetrahedral, rhomboidal prisms; a tartrite of lime proceeding from the wine, being precipitated.

This triple salt contains, according to *Vauquelin*, 0,54 of tartrite of pot-ash, and 0,46 of tartrite of soda.

The TARTRITE OF AMMONIA forms crystals of tetrahedral prisms with obliquely truncated summits.—*Gren.*

Thenard has proved that most of the tartrites can combine with each other, and form triple salts, which have particular properties. Some, in fact, have for their basis two alkalies; others an alkali and an earth; others an alkali and a metal; and others an earth and a metal. It is remarkable, that most of these bases, which are separated by the alkalies from their simple combinations with the tartareous acid, are not separated when in the state of triple salt.—*Ann. de Chim.* xxxviii. 1801.

The crystals of tartar are rendered more soluble by the addition of *boracic acid.*

The OXALIC ACID is obtained chiefly from the salt of sorrel, of which we will therefore first speak.

OXALIC ACIDULE, or *salt of sorrel*, consisting of oxalic acid and oxalate of pot-ash, is obtained, by evaporation, from the expressed and clarified juice of the *oxalis acetosella* and of the *rumex acetosa.* It forms small white needle-like crystals, of a penetrating austere taste, and, as the acid unites with other bases, without quitting its own, like the acidulous tartrite of pot-ash, it forms triple salts with the alkalies, earths, and some of the metals.

Dejeux has discovered the pure acid, not in the state of acidule, passing out of the stalks and pods of the grey pea *(cicer arietinum)*.

The OXALIC ACID may be obtained from the oxalic acidule, by saturating it with *pot-ash* or *ammonia*, then pouring a solution of this salt into a solution of nitrate of baryt; the oxalate of baryt thus formed, insoluble in cold water, is then to be well washed, and sulphuric acid added; sulphate of baryt then forms, which precipitates, leaving the oxalic acid in the liquor above it, which may be freed from any sulphuric acid by adding a boiling solution of oxalate of baryt, and may be crystallized by a due evaporation.

It has a penetrating sour taste, it effervesces in the air, is soluble in twice its weight of cold, and half its weight of hot water. It contains more oxygen than tartareous acid, and is so strong that it will affect turnsole when diluted with 3600 parts of water, and cannot be made to pass into a higher degree of acidification. The attempt being made, and the oxygen increased out of proportion to the carbon and hydrogen, the vegetable composition is destroyed, and it is reduced to its last term of analysis, yielding only water and carbonic acid, with a very small portion of coal: this being the result of an analysis of the oxalic acid; the acidule of course leaving a residuum of pot-ash.

It forms OXALATES with the *alkalies*, making, with *pot-ash*, in small quantity, the oxalic acidule, or it may combine with it to saturation. It combines more readily with *metallic oxides*, than with the *metals* themselves. With *arsenic* it forms very fusible volatile crystals; with *cobalt*, a light rose-coloured pulverulent salt; with *nickel*, a greenish yellow salt; with *calx of bismuth*, a salt in powder; with *calx of antimony*, in crystalline grains; with *manganese*, a powder becoming black by heat; with *zinc*, a white pulverulent salt; with *tin*, if the solution be slowly evaporated, it forms *prismatic crystals*; if quickly, a *transparent mass* like horn; with *lead* it forms white, with *iron* greenish, and with *copper* light blue crystals. An OXALATED SILVER is obtained by adding this acid to the nitrate of silver in solution: it also dissolves the precipitate of *platina*, by soda; but has scarcely any action on the *calx of gold*.

By readily dissolving the *black oxide* and the *gallate of iron*, this acid becomes useful in the removal of the spots of ink.

It combines with *alumine*, *magnesia*, and *baryt*. Its affinity with *lime* is such that it takes it from every other substance, forming an almost indecomposable OXALATE OF LIME. It is therefore employed to discover this earth in combination or solution. The *oxalate of ammonia* is preferable for this purpose, and is particularly useful in separating the phosphorus from the phosphate of lime, precipitating an oxalate of lime, and forming a phosphate of ammonia.

Brugnatelli says, that the oxalic acid cannot be depended on as a reagent on lime, since he discovered that, in several instances, the presence of lime was ascertained by other known reagents, when the oxalic failed.—*Ann. de Chim.* No. 86.

It is more highly oxygenized than the other vegetable acids, and most of the other vegetable acids are changed to oxalic by a further degree of oxygenizement.

It may also be obtained from sugar and other vegetable oxides, by the action of nitric acid.

Acidulous tartrite of pot-ash, and *acidulous oxalate of pot-ash*, being heated till no fumes or flame appear, and then wetted with a few drops of water, ammonia is produced: the ammonia may be thus produced, as long as any carbonaceous matter remains, by merely heating it, and then wetting it with a few drops of water. Charcoal mechanically joined to pot-ash does not produce the effect.—*Lampadius*. 1801.

VEGETABLE ACIDS *obtained by the use of* NITRIC ACID.

SUGAR, MUCILAGES, MILD OILS, FLOUR, and even a great number of *animal substances* afford, when heated with the *nitric acid*, an acid perfectly similar to the acid last described. These substances contain, therefore, the *oxalic radical*, to which oxygen only is wanted to be added, to convert it into oxalic acid; this acid, like other vegetable acids, being probably a compound of *hydrogen*, *carbon*, and *oxygen*. *Berthollet* obtained from *wool* more acid than half the weight of it. Since several vegetable acids, and in particular that of *tartar*, pass to the state of oxalic by distillation with weakened nitric acid, we may conclude these vegetable acids have the same radical, and differ only in the proportion of oxygen.

By concentrated nitric, or sulphuric acid, and stronger heat, both the tartareous and the oxalic are converted into the acetic acid.—*Gren.*

MUCIC ACID is obtained by nitric acid from any mucilaginous substance; and from it having been chiefly procured from the sugar of milk, it has generally been termed *saccho-lactic acid*.

It is sourish to the taste, and reddens litmus. It yields, by destructive distillation, a brown acid salt, smelling like the flowers of Benjamin, or acid of amber. It is easily soluble in spirit, but not in water, and burns in the fire with a flame. It forms MUCATES with the *alkalies* and *earths*; those with the earths being almost insoluble, and that with *ammonia* soon loses its base by heat. On the *metals* it acts very feebly, and with their calces it forms salts of very difficult solubility.

This acid is precipitated in the form of a white powder, by gently heating two parts of nitric acid with one of gum. The fluid in which this is held also contains another acid, called, by *Scheele*, the *malic acid*, and by *Fourcroy*, the *oxalous acid*, since it only requires the continued, or the augmented, action of the nitric acid to oxygenize it farther, to render it the oxalic acid; which acid is always formed at the end of the process, if the action of the nitric acid is not interrupted. By fire, and by the action of the muriatic and sulphuric acid, it is converted into the acetic acid.

CAMPHORIC ACID, which is obtained by means of the nitric acid, seems to differ in some respects from the oxalic. It yields crystals resembling the muriate of ammonia, which are very sparingly soluble in water. With *pot-ash* it forms crystals in regular hexagons; with *soda*, irregular crystals; with *ammonia*, it forms needle-formed crystals; with *magnesia*, a white pulverulent salt. It dissolves *copper*, *iron*, *bismuth*, *zinc*, *arsenic*, and *cobalt*; the solution of *iron* yielding a yellowish white, insoluble powder. With *manganese* it forms crystals, the figures of which, in some respects, resemble basaltes.

It burns without leaving any residue, forming gaseous compounds. It does not precipitate lime from lime-water; nor does it produce any change in the sulphuric solution of indigo. Its salts exhibit a blue flame with the blow-pipe.—*Bouillon la Grange.*

Doerffurd has proved that this pretended acid is the same with the benzoic acid. Nor is this an educt obtained or separated from the camphor by the process, but a product at that time generated.—*Gren. Principles of Modern Chemistry.*

SUBERIC ACID is obtained, as its name imports, from *cork*. During the action of nitric acid on cork, carbonic acid and carburetted hydrogen gas are separated, a greasy or resinous matter being at the same time also separated, which floats on the liquid. The suberic acid is bitter, pungently acid, and deliquescent, becoming brown by exposure to solar light. Its elective attractions are first to *baryt*, then to *pot-ash*, *soda*, *lime*, *ammonia*, *magnesia*, and *alumine*. It differs from the gallic acid in its yellow precipitation; from the malic in its solid form; and from the acid of tartar, in not burning or smoking on hot coals. It gives a green hue to a solution of the nitrate of copper, without occasioning any precipitate; and has a weaker attraction for lime than the oxalic acid. Unlike the camphoric, it turns the sulphuric solution of indigo green.—*Bouillon la Grange*.

The empyreumatic vegetable acids resulting from dry distillation, and which have been termed, from the substances from which they have been obtained, PYRO-TARTAREOUS, PYRO-MUCILAGINOUS, and PYROLIGNEOUS acids, are no longer considered as distinct acids; they appearing to be only the acetic acid impregnated with different empyreumatic oils, of which it appears to be an actual dissolvent.

FERMENTATION OF VEGETABLE SUBSTANCES.

FERMENTATION takes place, accompanied by a decomposition, in the various parts of vegetables, when the action of water, is favoured by the combined aid of air and heat.

The first agent of fermentation appears to be oxygen gas, which is afforded either by the atmosphere, or by the decomposition of the water; oxygen gas being absorbed, and caloric separated during the process.

Fermentation appears to be the natural process for reducing vegetable substances to a simpler state of combination; thus carbonic acid, a binary compound, is one of its results.

The SACCHARINE FERMENTATION is considered by *Fourcroy* as the first chemical change a vegetable undergoes; the conversion of the insipid matter of seeds into a saccharine substance, on the imbibing of moisture, being an immediate effect of germination. It is by this change that different seeds are converted to *malt*, by the process called *malting*, which is thus performed. Barley, which is generally chosen for this purpose, is softened by soaking in water, and then piled up until the grain has germinated two-thirds of its length; the farther germination is then stopped by drying in a kiln, when it is called *kiln-malt;* or in airy lofts, when it is called *air dried malt.* It will now be found that the insipid matter of the seed has become a real saccharine substance. This also gives the sweetness of fruits, which they gain by keeping.

VINOUS FERMENTATION cannot take place unless sacch matter is present, with which water must be conjoi water and sugar, alone, in a state of purity, do not pass fermentation, but require the presence of some other ma haps to divide the saccharine matter.

This fermentation is employed for making *wine, ci perry,* &c. Thus the *juice of grapes,* at about 70° becomes turbid, and agitated through its whole mass, se carbonic acid gas, and a frothy substance called *must.* T cess ceasing, the liquor becomes clear and bright, and o vinous odour and taste, with certain intoxicating powers; *of the wine* settling to the bottom. Even after this an *imper fermentation* goes on, which occasions the difference betwe and *old* WINE.—During this fermentation *tartar* is deposi the sides of the vessels. If the fermentation be impeded, at its height, by the exclusion of air, as in bottling, the wi the first opportunity lets the imprisoned gas, formed after it clusion from the air, escape rapidly, as in the sparkling *champ wines, cider, perry,* &c.

An *acid* exists in all wines, which is the *malic acid,* and w by acetification, is converted into acetic acid. Alcohol, the p duct of the decomposition of sugar, is more or less abundant in wines.

Flour is likewise disposed to fermentation, especially if the gr be first *malted.*

BEER is made from malt by infusing ground malt in boili water in a *mash-tub,* it being then called *mash,* and the infusio drained off is called *sweet-wort.* To give it a pleasant flavour, is then boiled with *hops,* then the decoction is speedily cooled t prevent the acescent fermentation, and removed to the *fermenting vat,* where, by the addition of a little recent yeast, fermentation is soon excited. Then, lastly, when fermentation has thus continued a proper time, it is preserved from the air in casks or bottles, and is then called *casked or bottled* BEER. When it derives a colour from the malt having been *high dried in the kiln*, it is called BROWN BEER; and when the malt has been but slightly heated, or dried in the air, it is then called PALE BEER.

These fermented liquors yield, by distillation, an ardent and inflammable spirit, possessing an aromatic and resinous smell, a penetrating and hot taste, and an inebriating quality.

Such is RHENISH BRANDY, distilled from *wine-lees;* FRENCH BRANDY, from the *husks* and *stalks of grapes;* RUM, from the juice of the *sugar-cane;* MELASSES SPIRITS, from the *refuse of sugar:* and MALT SPIRITS, from *grain.* Even *animal milk*, from the sugar it contains, is capable of the vinous fermentation, and of affording a spirit; such is the KOUMISS, made from mare's milk, by the Tartars.

ALCOHOL, or SPIRIT OF WINE, is the produce of a redistillation or *rectification* of these spirits; it may also be obtained by the addition of pure fixed alkalies, which, attracting the water which the spirit contains, becomes dissolved in it, the alcohol swimming above and containing a small portion of the alkali, from which it may be freed by rectification.

When purest, its Sp. gr. is 829. It is composed, like the carburetted hydrogen, of hydrogen, carbon, and oxygen; but the two latter principles in a larger quantity than in those gases, it being decompounded into heavy carburetted hydrogen and charcoal, by being passed through a tube heated red. It assumes a gaseous form at 176°. By combustion it is resolved into water and carbonic acid gas.

Alcohol is employed for lamps, in preference to oil, owing to its not clogging the wick so much, by the deposition of charcoal. But where heat is required as well as light, another mode is to be adopted. In the ordinary lamp, a portion of the heat is lost in raising into a state of gas that part of the alcohol which is next to be consumed. To compensate for this loss, the following plan is proposed:—Instead of a wick, a small opening is to be left at the top of the vessel for the passage of the gas, which is to be liberated by the application of the lighted wick of another lamp at the bottom of the vessel; the gas inflaming at its exit from the small opening, immediately on the approach of any flaming body. If a number of very minute orifices be used, the flame will be formed in as many beautiful jets, making a pleasing firework.

So ardent is the heat of the flame which is thus obtained, that Prof. *Pictet* has applied it ingeniously to the formation of a most powerful and useful blow-pipe. For this purpose the gas is made to pass out in an horizontal direction through the flame of another lamp, properly disposed before it; thus constantly and regularly impelling a flame so ardent that glass and most of the metals yield to it immediately.

Alcohol dissolves *sugar*, but in less quantity than water, and as it coagulates mucilaginous matters, it serves to clear the saccharine matter from mucilaginous particles. It dissolves the *resins, the alkalies, acids, many saline substances, phosphorus, essential oils*, and *soaps*, but does not dissolve *fat oils, animal fat, sulphur*, or *Prussian blue*.

The mixture of a portion of water and of alcohol has been observed to fill a less space, than would be filled by the sum of their several volumes.

Although alcohol is a product of the vinous fermentation of saccharine matter, it does not exist, perhaps, completely formed in wine. *Lavoisier* having found 100 parts of sugar to contain 0,64 of oxygen, 0,28 of carbon, and 0,08 of hydrogen, he subjected it to the vinous fermentation, and then found that its products, alcohol, carbonic acid, and acetous acid, contained the precise quantity, nearly of the principles he had found existing in the sugar. The change of fermentation he supposes to consist in a new combination of the original constituent principles, by which two new substances are formed, one of which is oxygenized at the expence of the other, and becomes carbonic acid, whilst that which has been deprived of its portion of oxygen becomes alcohol.

Sage obtained 1 ounce, 1 drachm, and 24 grains of concrete oxalic acid, from 16 ounces of spirits of wine.—1800.

Cadet obtained crystals of oxalic acid from a mixture of alcohol and sulphuric acid, intended to form sulphuric ether.—1801.

ETHER, or *naphtha*, the lighest of all fluids, is formed by distilling *sulphuric, nitric*, or *muriatic* acids, and alcohol.

Ether is a clear liquid, exceedingly volatile, evaporating rapidly at the common temperature of the atmosphere, and boiling if poured on the surface of warm water. The cold produced by its rapid evaporation is so great as to freeze water. Air, rendered inflammable by holding ether in solution, is employed for the cannon of *Volta*, and is not changed by passing through water. It has a peculiar taste and smell; is sparingly soluble in water, and burns freely with a bright flame, even on the approach of an inflamed body. Sp. gr. 739.

It may be obtained with the *phosphoric* and *acetic* acids. That obtained from the nitric is the lightest, and that from the acetic the heaviest. The sulphuric is the most free from colour. The colour seems to depend on the presence of some matters, not essential to the existence of ether, which perhaps in every process is the same fluid.

On mixing equal parts of *sulphuric acid* and *alcohol*, ether is formed at 78°. After this, water, acetic acid, and the fluid called the sweet oil of wine, which is heavier and less volatile than ether, comes over: this is accompanied by an inflammable gas smelling like ether, and which actually forms an oil on being mixed with oxygenized muriatic acid; and is therefore called the *olefiant*, or the *carbonated oily hydrogen gas*. When this ceases, water, sulphureous acid, and carbonic acid gas come over, leaving sulphuric acid thickened by charcoal in the retort.

Alcohol alone boils alone at 64°, but is so fixed by the sulphuric acid, that it does not boil until it has attained 78°; the constituent principles are, however, volatilised according to their affinity for caloric, and carry with them a small portion of the more fixed elements; so that whilst the acid is strongly attached to the alcohol and to the water, the ether combines with caloric, and is volatilised. When the greatest part of the alcohol has been thus changed into ether, the attraction of the acid for the remainder of the alcohol is increased with the increase of heat, and the principles of the acid are separated; so that on the one hand its oxygen uniting with the hydrogen of the alcohol, forms water: whilst on the other, ether, volatilising with it, a large portion of carbon forms the sweet oil of wine, which may be considered as ether loaded with carbon.

If *nitric acid* be employed, ether may be obtained without any other heat than that evolved during the process. Ether is the first product, then an inflammable gas composed of heavy carburetted hydrogen and nitrous gas, and lastly pure nitrous gas. If the acid is not diluted, the evolution will be so rapid as to occasion considerable inconvenience.

Ether is obtained by the *muriatic acid*, only when it is in its oxygenized state, particularly when applied in its nascent state to the alcohol, as when the oxymuriate of tin is employed.

The *muriatic ether* has an aluminous taste, and whilst burning yields an odour like the acid of sulphur. This proceeds most probably from the presence of some extraneous matters, since perhaps ether is always the same identical matter.

Former chemists, endeavouring to obtain *ether* by the *oxygenized muriatic acid*, had obtained rather a vinous oil than real ether. This olefication of ether *Van Mons* observes is an effect of the oxygenizing action of the acid, continued after the ether is formed; similar to the action exercised by the air of the atmosphere on natural oils. Agreeable to this opinion, when the excess of oxygenized gas was considerable, he has seen the ethereous oil converted into a real white grease, opake, and of the consistence of half melted tallow. These effects depend on withdrawing a portion of hydrogen; so that ether is oil, *plus* a certain portion of hydrogen; oil is grease, *plus* that proportion, &c.

The following process he therefore recommends, as fitter to remove every difficulty in this preparation:—Put 1,00 of any weight of the muriate of soda, perfectly dry, into the retort of *Wolfe's* apparatus improved by *Lavoisier*, and distribute in the receiver and bottles, of which only two should be employed, the same weight of good alcohol. The joinings being luted, and the tube of safety fixed, 0,50 of concentrated sulphuric acid is to be poured on the salt, and after proceeding in the cold for five or six hours, fire is to be gradually applied. Thus a muriatic alcohol is obtained, which is to be poured into the retort, from which the salt has been removed, and 0,20 of the oxide of manganese been put in, a certain quantity of a solution of caustic pot-ash is to be put in the bottles, which enchains the oxygenated acid, which is in excess at the formation of the ether, and prevents the action which olefies this liquid.

Ether seems to differ from alcohol in containing more oxygen and hydrogen.

The proportion of carbon to hydrogen in ether appears to be nearly as 3 to 1, and in alcohol 4 to 1.—*Cruickshank.*

Like alcohol it may be decomposed by being passed through a tube heated red.

Like alcohol its flame may be used for the blow-pipe, and for pleasing illuminations.

By simply mixing the sulphuric and muriatic ethers, instantaneous evaporation takes place, and the absorption of caloric is so rapid as, it is said, immediately to congeal quicksilver.

Hoffman's anodyne liquor is a solution of ether in alcohol, and is made by uniting two ounces of spirit of wine with two ounces of ether and twelve drops of sweet oil of wine.

Messrs. *Bondt, Dieman, Van Troostwyk,* and *Lawrenberg* discovered that by the distillation of ether, or of a mixture of sulphuric acid with alcohol or ether; or by causing the vapours of alcohol and ether to pass through a tube of clay ignited, or through the component parts (alumine and silex) of such a tube, a gas is obtained, which they called the *carbonated oily hydrogenous gas,* which, on being mixed with oxygenized muriatic acid gas, manifested the extraordinary property of forming an oil. But if the distillation be made through a glass tube, or if this gas be made to pass through a glass tube, the property of forming oil is lost, carbon being deposited.—*Ann. de Chim.* xxi.

Two parts of *muriate of soda,* one of *magnesian oxide,* three of *alcohol,* and one of *sulphuric acid,* being distilled with a gentle heat, a dulcified oxy-muriatic acid first rises, and at last a little oily fluid of a pleasant odour and aromatic taste, which sinks in water, comes over. This has been called *oil of salt;* perhaps it resembles the *oil of wine* in its mode of production.—*Gren.*

Acetous fermentation appears to depend, as has been just remarked, on the mucilaginous principle. Vegetables or their juices containing this principle, being exposed to the air, become heated, and the liquid parts turbid; a lively smell is emitted, and much air is absorbed. After some time, a considerable quantity of lees settle, leaving above them a clear acid liquor.

If wine be allowed to continue too long fermenting, or if exposed to too great a heat, it runs into the acetous fermentation and forms *wine vinegar.* Beer, in the same manner, produces *common vinegar,* or *alegar.*

The *growing sour of milk* is a true acetous fermentation, and both the *oxalic* and *tartareous* acids, may, without addition, be changed to the acetic acid, by fermentation.

VINEGAR formed during the acetous fermentation, is pleasantly acid, and becomes aeriform by heat. It is decomposable by heat, showing that it is composed of oxygen, hydrogen, and carbon. It has no action on *hydrogen*, *phosphorus*, *carbon*, or *sulphur*.

VINEGAR may be concentrated by distillation, or by freezing, when it forms the ACETOUS ACID, which united with *pot-ash*, forms what is termed the ACETITE OF POT-ASH, also called improperly *terra foliata tartari*; with *soda*, the ACETITE OF SODA; and with *ammonia*, the AMMONIACAL ACETITE, generally known by the name of *Mindererus's spirit*.

It should be however observed, that the term *acetous*, is hardly admissable, since it does not distinguish the real difference existing between the two states of the acid; since this depends on the presence or absence of carbon, rather than on a difference in the quantity of oxygen.

ACETIC ACID is procured by combining distilled vinegar with some of the metallic oxides, and exposing them to distillation, when the higher acid is obtained. Or half its weight of *sulphuric acid* may be mixed with *acetite of soda* and distilled. A few drops of sulphuric acid added to a phial of the acetite of pot-ash, makes a strong smelling bottle, by the evolution of the acetic acid.

Acetic acid, as it is termed, is very acrid and volatile, emitting, when heated, an inflammable vapour, and forming with alkalies and earths, salts which are distinguished by the term ACETATES. It will also form ether with alcohol.

Gren thinks the acetous and acetic acids differ only in the degree of their concentration, and not in the proportion of their principles. *Adet* is of the same opinion.

But *Chaptal* contends that there is an actual difference, and that the *acetous acid* passes to the state of *acetic acid* by *decarbonization*. *Dabit* believes, that it depends on the different proportions of oxygen.—*Ann. de Chim.* No. 212.

Y. Peres believes that radical vinegar is nothing but acetous acid deprived of carbon. He obtains it merely by distillation from one part of sulphuric acid and two of vinegar. He thinks this acid is placed too high in the tables of attractions, since it only displaces the carbonic, acetous, and other weak acids.—*Mag. Encycl.* 1802.

Darracq has shewn that there exists no difference between the constituent parts of acetic and acetous acids, except the latter containing mucilaginous or extractive matter, and more water. There is therefore only one acid of vinegar, which being at its maximum of oxygenizement ought to be called *acetic acid*, and its salts *acetates.*

Fourcroy and *Vauquelin* observe that, the greater part of the products of vegetable life, and among those of animal life, the animal jelly, cheesy matter, and *urée*, the peculiar matter of urine, are susceptible of acetification.

This formation of acetic acid may take place, entirely independent of fermentation: gums, mucilages, tartrites, and woods being acetified merely by the action of fire. Acetification indeed appears to depend on four different circumstances. 1st. The decomposing action of fire by distillation, by which the constituent parts of the substance ar[illegible] combined as to form the acetous acid; water and carbonic [illegible] gas being also formed at the same time, with charcoal, which is precipitated. 2dly. The action of strong mineral acids on vegetable matters. Thus the *sulphuric acid*, by its strong affinity for water, attracts a part of the oxygen and hydrogen under that form, whilst part of the carbon is precipitated, and darkens the mixture, and another portion of these principles of the vegetable combine afresh, and form the acetic acid, which is separable by distillation. The *nitric, muriatic*, and *oxygenized muriatic acid* also produce acetous acid, by their action on vegetable substances, and on alcohol. Acetification appears to be the last step of vegetable acidification; since if the decomposing action of the mineral acids be employed to the acetous acid, it destroys its acid nature, and reduces it to carbonic acid and water, as is the case with every vegetable decomposition pushed to its *maximum.* 3dly. The acetous fermentation, in which there is neither precipitation of charcoal, nor disengagement of carbonic acid. In this process the oxygen of the atmosphere is absorbed, and the pre-existence of a vinous state is supposed. 4thly. A species of fermentation not requiring the presence of wine, and has some connexion, perhaps, with the putrid decomposition. It takes place in many vegetable substances, and in some animal fluids, particularly in urine.—*Ann. de Chim.* Cah. 104.

The process by which BREAD is formed, and by which the *colouring matter of vegetables* is evolved, seems to be the commencement of a spontaneous decomposition, which, if not checked in its commencement, would terminate in the putrefaction and total dissolution of the vegetable matters acted on.

In the making of *bread*, the flour kneaded into *dough* with water passes into a state of fermentation; having acquired this state, is called *leaven*, and if added to more dough it hastens its fermentation. If baked before sourness is discoverable good bread is formed. Yeast is used to promote the rising of dough.

Cit. Chautran has obtained an *acid* from the MILDEW of corn. This acid differs from phosphoric acid, forming an insoluble salt with lime and ammonia, and crystallized salt with pot-ash. The mildew itself, he thinks, is of an animal nature.—*Soc. Philom.* 1800.

TANNIN, or that substance which acts as a *tanning principle*, combining with the gelatinous parts of animals, and thereby preventing their decay, is generally found to accompany the gallic acid in the bark, ligneous part, &c. of vegetables.

The bark of several trees, the poplar, the willow, the chesnut, the hazel, the ash, and many other trees, contains this principle: but the oak bark appears to contain the largest quantity. It abounds in the bark in proportion as it is nearer to the woody fibre. Tannin exists in tea and in red port; but in no substance has it been found so abundant as in the *terra japonica*, or *extract of catechu*, produced from a species of the *mimosa*, in the East Indies. This was suspected by Sir *Joseph Banks*, from the strong taste resembling tannin, which he thought was yielded by this substance; and by the examination of Mr. *Davy* it appeared, that at least two-thirds of this principle enters into its composition.

Tannin may be obtained by adding lime water to an infusion of tan, and dissolving the precipitate in an acid, as the nitric, which unites with the lime, and separates the tannin in a powder.—*Guillot.*

As some of the tannin may be held in solution by the muriatic acid, *Proust* recommends its precipitation by a careful addition of *alkali*.

It is readily obtained from a strong cold infusion of *oak bark*, &c. by adding to it a solution of *muriate of tin*, when a precipitate is thrown down, containing pure tannin and oxide of tin. This precipitate is then to be diffused in water, and *sulphuretted hydrogen* is to be added, which unites with the tin, and leaves the pure tannin free.

It may be had in a pulverulent form, of a light brown, which, when diffused in water, becomes of a darker colour. Its solution in water is also of a dark brown, but in alcohol, which will take up a sixth of its weight, its solution is lighter.—*Davy*.

Its taste is bitter, and rather aromatic. It combines with *alkalies*, and has a strong affinity for many of the *metallic oxides*. *Acetate of lead* being added to a solution of tannin, the oxide and tannin fall in a precipitate. The *red oxide of iron* also unites with it and forms a brown, and almost black precipitate.

It combines with the *gelatin* of animal substances, forming an insoluble *magma* resembling leather. This immediately takes place if a solution of tannin be added to a solution of glue, which is inspissated gelatine.

Mr. *Chevenix* found a peculiar principle in *raw coffee*, totally different from all other vegetable principles. But as roasted coffee possesses tannin, and as *Seguin, Davy*, &c. suppose that heat developes the tannin principle in many vegetables, Mr. *Chevenix* doubts whether this principle may not be converted into *tannin*, whilst in the vegetable, by heat.—*Nicholson's Journal*, 1802.

Alkalies exist in plants, combined with oils, acids, &c. and sometimes very slightly engaged. They are generally obtained by destroying all the other principles of the plant by fire. The alkali, in general, obtained from vegetables, is *pot-ash*. Marine plants yield *soda*. Plants also are found to contain *ammonia*. Such are onions, mustard-seed, tobacco, the *fungi*, &c. Plants also yield neutral salts formed by the combination of the acids with the alkalies.

Whilst considering the alkalies thus discovered in plants, we are however not to omit to reckon on the considerable effects attributable to the combinations which ensue, in consequence of combustion. The atmospheric air, during this process, will unite with some of the vegetable principles, and produce certain results: and perhaps the nitrogen may, by its union with certain principles, form alkalies, or at least augment or actuate those which existed in the plant.

The alkali thus obtained contains carbonic acid; which, as is the case with the boracic acid, in borax, is chemically, not merely mechanically, super-saturated with its alkaline basis.—*Crell's Journal*, 1800.

Vauquelin observes, that the pot-ash is found in the sap of trees, in the state of *acetite*.

The COLOURING PRINCIPLE is found in vegetables in four states of combination:—

1. With the extractive principle, as in logwood, cochineal, &c.
2. ——— resinous principle.
3. ——— fæcula, as archil, indigo, &c.
4. ——— gummy principle.

The ART OF DYEING, consists in transferring the colouring principle of one body to another, so that it shall be durably fixed; and depends on the exertion of particular affinities between the colouring matters and the substances to which they are applied.

Colours are all formed from the solar light; the various tinges of colours resulting from the absorption of some of the rays of light, and the reflection of others. By the art of dyeing, a substance possessing the property of reflecting particular coloured rays, is transferred to the surface of another body.

The *pigments* or colouring matters employed in dyeing are, according to Dr. *Bancroft*, either *substantive*, such as are taken up by stuffs not previously prepared; or *adjective*, which are not absorbed by the stuff unless it has been macerated in some substance called a *mordant*, or, more properly, a *base*, which, either by imparting oxygen or otherways, alters its substance, or by an intermediate affinity, becomes a bond of union between the colouring matter and the stuff; or acting on the colouring principle gives to it the desired tint, or, by coagulating it, renders it fixed, since being no longer soluble in water, it is not removable by washing.

The MORDANTS chiefly employed are the *sulphate of alumine*, or the *acetate of alumine*, made by the addition of alum to a solution of acetate of lead, when by a double decomposition, sulphate of lead is formed and precipitated, and the acetate of alumine is also formed and remains in solutions. The *nitro-muriate*, the *acetate*, and the *tartrite of tin*; the *red acetate*, and the *red sulphate of iron*. The colour may be considered as a simple property of the triple compound; the dye, the cloth, and the mordant.

When the colouring principle is held in a substance of the nature of extracts, water dissolves the whole of it as in logwood, madder, &c. Into an infusion of this colouring substance the stuff to be dyed is therefore plunged, being first, if necessary, steeped in its mordant.

Haussman has discovered, that the brightness of colour from maddering is secured by correcting any acid in the water or madder, by adding chalk to the water.

Some resinous colouring matters are only soluble in spirit of wine, and are therefore only used in the smaller articles, such as ribbons, &c. Other colouring matters are combined with *fæcula*, which water alone does not dissolve, such are *archill*, *indigo*, &c. The colouring matters of this class are, however, all soluble in alkali, or lime; these substances are therefore used to dissolve them in water, that they may be precipitated upon stuffs; this may be done by the addition of an acid. Acids may be used instead of alkalies, in fixing some of these colours upon stuffs, thus may indigo be dissolved in the acid of vitriol, instead of in lime. Some colouring principles are fixed by a *resin*; but which, by the assistance of *extractive matter*, may be suspended by water. Stuffs being boiled in this solution, the resinous part applies itself and adheres, so as not to be liable to be again carried off by water. The chief substances of this kind are *sumach*, *santal*, *the husks of walnuts*, &c. The colouring matter of some vegetables are only extracted by *oils*, such is the *alkanet root*.

The simple colours of the dyes are four; blue, red, yellow, and black.

Blue is obtained from indigo, which is a fæcula obtained from the Indigo plant, *Indigofera tinctoria*, by steeping it in water and allowing its fermentation, the coloured fæcula falling in a blue flocculent sediment. Woad (*isatis tinctoria*) affords a similar fæcula. The leaves are bruised, and formed into roundish lumps, in which form they are sold by the name of *woad*. The leaves in this state undergo a slight fermentation, by which the colouring matter is in a great measure set free.

In indigo, besides carbon and hydrogen, with some nitrogen and oxygen, there is, according to *Berthollet*, 1-30th part of iron.

Brugnatelli, obtained, by distilling the nitric acid from indigo, a peculiar resin, of a deep yellow colour, and of half the quantity of indigo employed.—*Ann. de Chim.* lxxxvii.

Indigo combines with the substances usually dyed with it, without the aid of a mordant. It is employed either in its deoxygenized state with lime, when it gives a green colour, which changes blue by attracting oxygen from the atmosphere, or in an oxygenized state with sulphuric acid, when it yields a blue at once.

Red is yielded by *cochineal, archil, madder*, and *Brazil wood*. These require the intervention of mordants, which precipitate their solutions upon cloths; those generally used are sulphate of alumine and nitro-muriate of tin. The red colouring matter of *carthamus* is dissolved by the aid of carbonate of pot-ash; and its tints are heightened by acids.

Yellow dyes are given by infusions of *weld, fustic*, and *quercitron bark*, and fixed by alumine. Nankin yellow is obtained by a solution of the *red sulphate of iron*, which is combined with the cloth by carbonate of pot-ash.

Black is produced by the tannogallate of iron combining with the cloths, at the moment of its formation during the decomposition of the red sulphate of iron by a decoction of gall-nuts. The colour is much deepened by the addition of logwood.

The juice of aloes produces a lively violet, highly proper for works in miniature, and which may serve, either cold or warm, for dyeing silk, from the lightest to the darkest shade.—*Fabroni. Ann. de Chim.* xxv.

Turnsol has been discovered to be made by finely powdered *lichen, archil*, or even the greater moss of the oaks, first mixed with an alkali, and kept moist with human urine; it becoming red and then blue, when it is mixed with one-third of pot-ash, by remaining with which it acquires a dark blue colour. It is then made into cakes, by a mixture with chalk, to increase the profit.—*Journal de Commerce.*

Sap colours are either inspissated juices of plants or extracts from them.

Lake colours are formed by precipitating alumine with the colouring matter, by adding fixed alkalies to a decoction of the plant, or its parts, in alum and water.

By combining the fundamental colours, on the stuffs, rarely in the bath, the various compound colours are formed.

The stuff, preparatory to the application of the colouring matter, must be cleared of all glutinous matter which belongs to it in its natural state; it must also be bleached, and impregnated, when that is necessary, with the mordant.

The removal of the glutinous matter from the fibres of the stuff, which would prevent the reception of the colour, is accomplished by washing in a solution of soap, of alkali, and particularly of soda.

The operation of bleaching, or whitening, which will much contribute to the brilliancy of the subsequent colour, depends on the action of oxygen, which combines with the colouring principle which stains the cloth, and destroys it. The most common mode is that of boiling the pieces in an alkaline lixivium, and exposing them afterwards to the air, to render the whiteness more perfect. But the oxygenized muriatic acid produces the effect with so much facility, that all former processes must yield to it.

The oxygenized muriate of pot-ash is also employed for this purpose. Mr. *Higgins* recommends alternate immersions in a solution of this salt, and in a solution of the sulphuret of lime.

The piece being prepared so far by these processes, it is then impregnated with the mordant or principle which is to receive the colour, and render it incapable of extraction. The stuff thus impregnated, is then passed through the colouring liquid, and by the decomposition or change of principles between the mordant and the principle which holds the colour in solution, the colour is precipitated on the base of the mordant, and adheres to it.

Some vegetable substances are likewise disposed to take some colours by being animalised. In this way, cow's dung and bullock's blood are used in dyeing cotton.

Calico printing is effected by impressing the mordant in the desired forms on the cloth, which is afterwards subjected to the colouring matters; these becoming fixed where the mordants have acted, and being easily washed out from the other parts.

Guyton supposes the red colour of fruits to be owing to the reaction of their own acid on the colouring matter: and that tin, in restoring the colour of violets, attracts from it the acid which had turned it red: lead, bismuth, zinc, antimony, and particularly iron, doing the same. The metallic oxides are not equally powerful; but the oxide of tungstein, he thinks, is superior to all others, in forming cakes for painters.—*La Decade Philos.* 1798.

POLLEN, or the fecundating powder of the stamina of vegetables, is generally of a resinous nature, soluble in alkalies and alcohol. Like resin it is inflammable. The *aura* round certain vegetables, may, it is said, at the time of fecundation, be set on fire.

WAX appears to exist in the very texture of some parts of various vegetables; a matter analogous to wax covers and polishes the surface of some leaves, as those of the laurel. Other trees form a fatty matter around their fruits, or on the surface of their leaves.

It appears that wax and the pollen have for their basis, a *fat oil*, which passes to the state of resin by its combination with oxygen. If the *nitric* or *muriatic acid* be digested on fixed oils for several months, it passes to a state resembling wax.

Wax, by repeated distillations, affords an oil possessing all the properties of volatile oils. It is reduced into water and carbonic acid by combustion.

Alkalies dissolve wax, and render it soluble in water. It is this saponaceous solution which forms the *punic wax*, which may be used as the basis of several colours, and may be made into an excellent paste for washing the hands. It is likewise used with a brush, as a varnish, on several bodies; but it would be highly advantageous if it could be deprived of its solvent, which constantly acts, and is the cause why it cannot be applied to several uses, in which otherwise it might be found advantageous.

Ammonia likewise dissolves it; and as this solvent is evaporable, it ought to be preferred when it is proposed to use the wax as a varnish.—*Chaptal.*

HONEY, or the nectar of flowers, is contained chiefly in the nectaria of flowers, from which it is collected by bees. It appears to be a solution of sugar in mucilage; but resembles more the sugar of figs than common sugar.

The LIGNEOUS part of the vegetable forms the vegetable fibre; and not only constitutes the basis of the vegetable, but also the husk of seeds, lanuginous coverings, &c. It is the most insoluble and unchangeable of all vegetable substances; even the concurrence of air and water alters it very difficultly, and it is said so absolutely to resist every kind of fermentation, as to be almost indestructible, but by insects. It contains the greatest quantity of carbon of any vegetable substance.

Wood boiled long in water, until deprived of taste and colour, is reduced to a light fibrous substance, which may be called the ligneous principle. This substance yields by heat, water, acetous acid impregnated with empyreumatic oil, oil in a concrete state, carbonic acid, and hydro-carbonate gas, and a portion of ammonia combined with the acid, proving that it holds nitrogen, and, according to the observations of *Fourcroy*, it contains 100 parts of its weight. The coal which remains constantly retains the form of the wood, and yields pot-ash, sulphate of pot-ash and of lime, and phosphate of lime. With nitric acid it yields nitrogen gas, and malic, and oxalic acid, and the latter in a greater quantity than most other vegetable substances.

Extract is obtained by evaporating the decoctions of different vegetables. This substance is said to be obtained, nearly pure, by the evaporation of an infusion of saffron in water. It is very soluble both in alcohol and water. By heat it is decomposed into water, carbonic and acetous acid; it possessing different proportions of the same elements which constitute the greater part of vegetable matters.

Aroma, the odorant principle in vegetables, which from its fineness, invisibility, &c. has been said to be of the nature of gas, perhaps should only be considered as the odour of the volatile oil.

Charcoal is an *oxide of carbon*, obtained from wood by the process termed *charring*, which is performed by burning it, whilst the air is excluded as far as possible, and yet to allow the combustion to proceed. It is a solid, black, friable and infusible substance, still exhibiting the fibrous structure of the vegetable from which it has been produced.

Its habitudes with other substances have been described when speaking of *carbon*, and its combinations.

Charcoal possesses the property of clarifying various turbid fluids, which, according to Mr. *Lowitz*, it appears to do by chemically combining with, and thereby separating the discolouring particles.—*Crell's Journal*, 1800.

Besides those already mentioned, various other principles have been found in the vegetable kingdom. *Sulphur*, in substance, is said to be found in the dried scum which rises from the herb *patience*, whilst boiling in water. *Phosphorus* has been found by *Margraaf* in seeds of mustard, by distillation. *Iron*, *manganese*, and, according to *Becher* and *Kunckell*, *gold*, have been found in the ashes of plants; and, it is said, that particles of *native iron* have been found in strawberries. *Lime*, *alumine*, *magnesia*, and *silica*, are also found in plants. *Flint* has been found within the joints of the bamboo.

Bonnet cane, and all cane of this kind, when briskly rubbed together, produce sparks of white light; and when violently struck together, sparks, nearly as vivid as those from a gun-lock, are perceived, and a strong smell at the same time produced. Similar effects follow when the cane is sharply struck by steel or any siliceous stone. These phenomena appear to proceed from the epidermis of the cane containing silex; 22 grains of epidermis yielding about 9 grains of silex. From 240 grains of the internal part of the cane, about 2 grains, apparently silex, were obtained. Other canes yielded much less silex; but it was found in the English reeds and grasses, in wheat, oats, barley, &c. Possessing also carbonate of pot-ash with the silex, they yield glass by the blow-pipe, a straw being thus converted into a fine pellucid globule of glass.—Mr. *H. Davy*. *Nicholson's Journal*, *May*, 1799.

The epidermis of the *equisetum hyemale*, or Dutch rush, appears to be almost wholly composed of silex. Mr. *Notcutt* obtained a globule of glass from it by the blow-pipe.—*Phil. Jour.*

Vegetables being exposed to the joint action of heat and air, the oxygen combines with the inflammable principles of the plant, and combustion takes place with the production of smoke, and the disengagement of heat and light.

The SMOKE is a mixture of water, oil, volatile salts, and all the gaseous products which result from the combination of caloric and hydrogen, with oxygen and the several principles of the vegetable, and hence carbonic acid and carbonated hydrogen gases, are also formed, and the empyreumatic acids. With the smoke arises *soot*, partly composed of the carbon of substances imperfectly burned, having escaped the action of the oxygen. Hence the soot may be again burned; and hence it is, that where, as in the lamps of Argand, and in violent furnaces, where the combustion is more perfect, there is no perceptible smoke.

Soot, by analysis, yields an oil, a resin soluble in alcohol, an acid formed by the decomposition of mucilage, also volatile salts, such as carbonate of ammonia and other neutral salts. The fixed principles remaining after the combustion, form the *ashes*, containing salts, earths, and metals already treated of. By this process are obtained the *fixed alkalies* already spoken of. *Sulphate of pot-ash* is also sometimes found in these ashes. The sulphuric acid, here, in the opinion of *Gren*, is derived from the sulphur, which he considers as one of the constituent parts of wood, combining with oxygen, during combustion.

The putrid fermentation takes place when vegetables are heaped together, and softened with the humidity with which they are impregnated, and by their own effused juices. Their colours change, the mass becomes of a dark brown, swells, becomes heated, and is reduced to a magma. Their constituent principles enter into new combinations; the *hydrogen* unites with the *oxygen*, and is volatilised in *water*, or is separated in a gaseous form, carrying with it a portion of carbon; a third part of this principle unites with *nitrogen* in those plants which contain it; and a fourth portion remains in the putrid mass, supplying it with colour and smell. The *carbon* is partly united with the *hydrogen*, and partly with *oxygen*, forming with the latter *carbonic acid*, whilst another portion is left in the magma. The *oxygen* is employed in forming the combinations already mentioned with the other two principles. The whole is at last resolved into a brown mass, which for the most part forms vegetable mould, being a mixture of all the primitive earths, and of the metals which are found in vegetables as well as the oil, salts, &c. This process of vegetable decomposition may be considered as the great agent and means, by which nature returns to the earth those principles of which it had been deprived for the support of vegetable life.

It is by this fermentation, carried only to a certain length, that the fibrous texture of *hemp* and other vegetables are separated, for the purpose of forming *thread*, *linen*, &c.

If this decomposition s accomplished in a close place, a foul *musty* smell is perceived from the separation of the *hydrogen*.

When, as in marshes, a portion of animal matter is at the same time decomposed, *ignes fatui*, and such luminous appearances as accompany the disengagement of *hydrogen* and of *phosphorus* make their appearance.

Peat, or quick moss, appears to be vegetable matter which has undergone a particular change: during the process a black carbonaceous matter, called *peat earth*, separates, and this combining with oxygen, an acid is generated resembling the suberic acid. The peat in this state appears to be what Lord *Dundonald* calls oxygenated peat.—*Jameson's Mineralogy.*

Agriculture cannot but be improved by an attention to the daily discoveries in chemistry, these have taught us the food of plants, and the art of correcting the vices of a soil, so as to render it most fit for vegetation. The substances by which this is accomplished are termed manures, and which are, of course, varied, according to the nature of the soil on which they are employed.

For *clayey soils* the best manure is marl, that which is most calcareous is, with limestone-gravel, most useful. Marl and dung is still more advantageous. Where these cannot be had, coarse sand, lime, coals, ashes, chips of wood, burned clay, brick dust, gravel, or even pebbles are useful, for all these improve the texture, and some of them supply carbon.

For *chalky soils* the best manure is clayey or sandy loam, they wanting the argillaceous and sandy ingredients. For *sandy* soils the best manure is calcareous marl, and next to this clayey marl, and then clay mixed with lime, or calcareous or clayey loams.

For *gravelly loams*, marls, whether argillaceous or calcareous, are proper; and if the gravel be calcareous, clay may be employed. For *ferruginous loam or till, and vitriolic soils*, the calcareous ingredient is required to neutralise the acid.

Boggy soils generally are helped with limestone gravel, or lime mixed with coarse sand or gravel, especially when of a clayey nature; but if more sandy, lime or calcareous marl will answer well; in general they should first be burned, to liberate the carbonaceous principle.

Heathy soils should, for the same reason, be burned, and limestone gravel should be added when the soil is clayey, and lime when it is gravelly.

By *paring* and *burning* the old sickly roots are destroyed, and coal is formed, by which the carbonaceous principle is restored, which has been exhausted by too many crops. But it is to be recollected, that by this process much useful vegetable matter is dissipated in the atmosphere.

Gypsum from its accelerating putrefaction is a most excellent manure, especially for clayey lands, and such as are dry and naturally suit clover. It should be strewed on the surface in February, when it converts the old grass into coal, and nourishes the young growth.

Carbonate of lime promotes vegetation, being soluble in water, and may therefore be absorbed. *Red oxide of iron* also is beneficial by contributing a portion of oxygen.

Besides the manures already mentioned, *charcoal* itself has been successfully used, the charcoal being slowly converted by the action of water into carbonic acid and carburetted hydrogen gas. *Soap-boilers' waste* is also sometimes employed as a stimulating manure.

Lime has been found to be very serviceable as a manure, but Mr. *Tennant* discovered, that lime procured from *magnesian* limestone was injurious to vegetation.

The fertilizing powers of *dung* proceed from its resolution into *soil* or animal earth, and from its yielding carbon and hydrogen. Dr. *Ingenhouz* recommends as manures those substances yielding most carbon, which, taken up by the oxygen and caloric of the atmosphere, would form carbonic acid gas, the food of plants. Instead of *fallowing*, he therefore recommends impregnating the earth with sulphuric acid, as this, with the calcareous earth, would form gypsum, and with the magnesia, Epsom salt, from both which would carbonic acid gas be developed.

In situations where but little rain falls, the soil should be retentive of moisture, and should therefore contain much clay; but in wet situations, sandy and siliceous soils are preferable.

The oxygenized muriatic acid, mixed in the proportion of half a cubic inch of acid and three cubic inches of water, made into a paste with the black oxide of manganese, and seeds, produced the germination of seeds, which no efforts before could cause to vegetate. The application of oxygen, in a mode somewhat similar, to the roots of plants, appears also to promote vegetation.—*Humboldt. Journal de Physique*, 1798.

Von Humboldt, who, we observed, when speaking of the earths in general, attributes to them the power of absorbing oxygen from the air, especially when aided by heat and moisture, observes that the same property is possessed by every sort of CLAYS, and FRESH MOULD.

Saussure, junior, having made numerous experiments, denies that oxygen is absorbed by *pure* earth, either silica, lime, or alumine. In this he is confirmed by the experiments of *Berthollet*, and others. He asserts, however, that it is absorbed by mould formed of decomposed and decomposing organic substances.—*Ann. de Chim.* 1800.

From this property, which the mould possesses, of absorbing oxygen, results much of the advantage proceeding from TILLAGE, since by frequently changing the surface of the earth, the process must necessarily be accelerated. The tilled earth thus absorbing oxygen from the air, leaves the air at the surface in possession of more than its common proportion of nitrogen.—Hence, on the Alps the atmospheric air contains more oxygen than that of the warmer plains, the snow preventing the contact of the air with the earth, and of course this absorption of oxygen.

BITUMINOUS SUBSTANCES.

NAPHTHA is a white, or yellowish white substance, exceedingly light, and fluid as water. It feels greasy, has a penetrating odour, and burns with a light flame, leaving scarcely any residuum.

It is insoluble in *spirits of wine*, and passes over intirely in distillation; it is thickened, but not inflamed by *nitric acid*.

PETROL, or PETROLEUM, is a brown semi-transparent substance; being naphtha, thickened, and altered in colour and other respects by the air.

MINERAL TAR is petrol farther altered by the air, having become of the colour and consistency of tar.

ASPHALTUM, or MINERAL PITCH, is produced by a still further exsiccation. There are three varieties described of this substance, depending chiefly on the degree of solidity they possess. 1. *Cohæsive*, MINERAL PITCH. 2. *Semicompact*, MALTHA. 3. *Compact*, ASPHALT.—*Kirwan*.

JET is a substance of a full black, harder, and less brittle than asphalt; and, according to *Weidenman*, is a species of coal; but in the opinion of *Fourcroy*, it is indurated asphalt.

CANNELL-COAL appears to be next to jet, in gradation of purity, of the compound mineral bituminous substances.

MINERAL TALLOW is rarely met with, and imperfectly known. It much resembles tallow.

MINERAL CAOUTCHOUC is a substance much resembling in its elastic properties, the substance from which it takes its name.

The varieties which exist in the bitumens can hardly be conceived by any one, who has not seen those which have been collected by Mr. *Mawe*, and described by that gentleman in his *Mineralogy of Derbyshire*.

Mr. *Hatchett* observes, that we can only infer that animal substances have contributed to the formation of bitumen from the vestiges, and exuvia of animals, which so commonly accompany bituminous substances; but no doubt can be entertained in respect to vegetables; for it appears that bitumen is formed from them by long maceration, and by other processes at present unknown to us.

The elementary principles of bitumen are, carbon and hydrogen, sometimes nitrogen, and probably some oxygen, which, by its action on the other principles, tends to form the concrete bitumens; and also produces that portion of acid obtained by chemical operations. These same principles, carbon and hydrogen, constitute the vegetable oils and resins; and the same with some nitrogen, form the oils and grease of animals.

The quantity of carbon contained in these substances is ascertained by repeated projections on melted nitrate of pot-ash, until no farther inflammation is produced; and then calculating from the result, 12,709 parts of carbon being required to alcalise 100 parts of nitric. The proportion of bitumen may be learnt by distillation.—*Kirwan*.

Organized bodies, buried and subjected to the action of mineral bodies, under certain favourable circumstances, may form, Mr.

Hatchett thinks, with some small change, perhaps, in the respective proportions of their principles, a new combination which we call bitumen.—*Mr. Hatchett, Nicholson's Journal.*

Humbold relates, that he converted the *phallus esculentus* into a substance resembling tallow, by means of the sulphuric acid, and also made soap of it.—*Ann. de Chim.* t. xxii.

Mr. *Jameson* asks, may not the mineral tallow of peat-mosses be a species of fungus, altered by some natural operation similar to the one just mentioned?—*Mineralogy of Shetland Isles.*

Pit-coal, according to Mons. *Gensanne* and others, is an earth or stone, chiefly of the argillaceous genus, penetrated or impregnated with petrol, or asphalt. It has also been supposed to have been formed by vegetables growing in the sea, and by vast forests which have been buried by subsequent revolutions. M. *Arduino* supposes it to be of marine formation, deriving its existence from the fat and unctuosity of the numerous tribes of animals that inhabit the ocean.

Lord *Dundonald* thinks fossil coal is a substance formed of the remains of antediluvian vegetables, animal juices, and mineral substances.—*Treatise on Agriculture and Chemistry,* 1795.

As pit-coal affords ammonia by dry distillation, instead of its being an earth penetrated by asphaltum, there seems reason to suppose it of an origin rather more animal than vegetable. Its composition appears to be carbon, hydrogen, nitrogen, oxygen, alumine, and iron, in a variety of proportions, forming a bitumen of a peculiar kind.—*Gren's Principles.*

Mr. *Kirwan* objects to the above opinions. He supposes the carbonic substance and petrol, to have entered into the composition of various stones, of which many mountains have been composed: having been derived from the primordial chaotic fluid. He also thinks that coal-mines, or strata of coal, as well as the mountains or hills in which they are found, owe their origin to the disintegration and decomposition of primeval mountains, which contained, most probably, a far larger proportion of carbon and petrol, than those of the same denomination now contain, since the disintegration took place at so early a period.—*Geological Essays,* 1799.

Mr. *Kirwan* remarks that coals are not soluble in acids.—*Mineralogy,* vol. ii.

Mr. *Jameson*, however, observes, that they are all rendered completely soluble in water, by means of the nitrous acid, the carbonaceous basis appearing to be converted into an oxide.—*Mineralogy of Shetland Isles.*

Proust has ascertained that the following are the proportions of *charcoal*, or *oxide of carbon*, in certain sorts of wood, and in pit-coal:—

Green oak, from 100 parts gives	20
Wild ash	17
Willow	17
White ash	17
Pine	20
Heart of oak	19
Black ash,	25
Guaiacum wood	24
Pit-coal	70 to 80

Some sorts of pit-coal, which burn without either flame or smoke, shew no vestiges of hydrogen. Good pit-coal affords as small a proportion of ashes as the dried woods.

Besides the known products, pit-coal is thought by *Proust* to yield *succinic acid*. Thirty pounds of pit-coal yielded him a drachm of salt, the smell of which indicated the presence of that acid.—1800.

Proust, discovering that a coal containing no pyrites, and burning to white ashes, manifested the smell of sulphur in passing from the state of incandescence to incineration, concluded that it contained a peculiar carbure of sulphur, which is decomposed by combustion only, since no sulphur is yielded by it on distillation.

As phosphorus becomes much less combustible when combined with coal, as well as difficult to separate, in the same manner, he thinks, sulphur, combining with carbon, forms this carbure in animal charcoal. Wool and other animal matters contain sulphur, but none appears on distillation, it therefore passes, he thinks, in this peculiar form, into the carbonaceous residue.—*Journal de Physique*, 1800.

Coal, by dry distillation, yields the carbonate of ammonia, and an empyreumatic oil in the form of *tar*, which is called *COAL TAR*. If this be performed in a proper oven, the coal being piled in the manner of wood for charring, it also becomes charred and forms

COKE, which burning without smell, flame, or smoke, is employed in preference to coal itself in several processes. Like charcoal it emits much carbonic acid gas.

AMBER is a bitumen, generally of a yellow or brown colour. It is found either under the surface of the ground, among the clay, sand, and iron bog ore, when it is called *fossil amber*, or is thrown on the shore by the waters of the sea, and is then called *mineral amber*. It is tasteless, but when rubbed it yields a faint odour, and manifests electric powers. It is not soluble in water, and but lightly in spirits of wine, except by the addition of alkalies, when the solution is termed *tincture of amber*. It is soluble in expressed oils, and also in oil of turpentine, when it forms the *amber varnish*.

By distillation it yields an acid phlegm; a light, dark-coloured oil, which, from repeated distillations from water or clay, becomes limpid, and is then called *rectified oil of amber*; and a concrete *acid salt*, the *salt of amber*, or *succinic acid*.

The SUCCINIC ACID may also be obtained pure and white, by distilling diluted *nitric acid* with half the quantity of salt of amber, the nitrous gas coming over, and leaving the succinic acid in beautiful white, three-sided columnar crystals, whose points are truncated.—*Hermstaedt*.

SUCCINATES are formed by the union of the succinic acid with the alkalies and earths.

By mixing ten or twelve grains of soap, four ounces of alcohol, and one drachm of oil of amber, with a proper quantity of caustic solution of ammonia, a compound of a milky colour is formed, called EAU DE LUCE.

MELLILITHUS, or *honey-stone*, is found among the strata of *braunkohle*, in Saxony. It is formed in crystals, of a honey yellow colour, which are soft, brittle, and reducible to a greyish powder.

The primitive form of its crystals, according to *Haüy*, is the rectangular octahedron; they are frequently blunt octahedra, the terminating faces being curvilinear; and sometimes they are dodecahedra approaching to the rhomboid. He also remarks that it has a double refraction, unlike amber, and that its crystals, when insulated, easily acquire a strong electricity.

It was supposed by some to be a gypsum impregnated with petroleum; and by *Born* it was thought to be a kind of amber.

It appears to be a salt with a base of alumine and a peculiar vegetable acid, blended with a small proportion of lime and bitumen. It proceeds like amber from the subterraneous decomposition of trees.

This acid, which Mr. *Klaproth* calls the MELLILITHIC ACID, he thinks is not a simple mineral acid, but appears from its properties to be a peculiar modification of those elements which constitute vegetable acids, and is consequently a specific vegetable acid. It enters into combination with several mineral oxides, and its affinity to them is greater than that of acetic acid, though less so than that of mineral acids.

Like the oxalic acid it precipitates the watery solutions of lime, baryt, strontia, of muriate of baryt in crystals, with those of quicksilver, of lead, and silver, in the nitric acid. But added to a solution of sulphate of lime it precipitates transparent crystals, whilst the oxalic acid throws down a pulverulent and opaque precipitate. It produces a precipitate from a solution of the sulphate of alumine, which the oxalic acid does not.

UMBER appears to be a vegetable residue, and consists of oxide of iron and manganese, both at their maximum, with argil, sand, &c.—*Proust.*

Gren asserts, that bitumens must necessarily have had their origin from the decomposition of animal bodies.

OF ANIMAL SUBSTANCES.

THE compound constituents *(materiaux immediats—Fourcroy)* of animal bodies, consist of but a small number of simple principles; their various natures chiefly resulting from the different proportion in which these are combined. These principles appear to be *oxygen, nitrogen, carbon, hydrogen, phosphorus,* and *sulphur.*

I. GELATIN, or *animal jelly,* is a mucous, semiductile, and transparent substance, contained particularly in the tendons, cartilages, membranes, ligaments, and in the skin of animals. It is obtained merely by boiling any of the foregoing substances in water:

it has in general no smell, is insipid to the taste, and is very soluble in water, but not in alcohol. By distillation this jelly yields an insipid and inodorous phlegm, with carburetted hydrogen and carbonic acid gas. By a stronger heat it swells, becomes black, and emits a strong odour, with white acrid fumes: an empyreumatic oil, and a little carbonate of ammonia; a spongy coal remaining, which contains muriate of soda and phosphate of lime. During the putrefaction of gelatin, ammonia, hydrogen, and carbonic acid gas, are emitted, and water is formed, shewing that its principles are nitrogen, hydrogen, carbon, and oxygen.

It is dissolved by acids, but more readily by alkalies; and, with nitric acid, nitrogen gas is disengaged. It seems to differ from the vegetable jelly, chiefly in the lymph it contains, which is evidently much mose animalized than the other constituent parts of the jelly. If concentrated to such a degree as to give it the form of a cake, its disposition to putrefaction is stopped; on this principle dry or *portable soups* are formed. By a similar concentration of the jelly, made from the parings of leather, the skins of animals, with the ears of oxen, calves, sheep, &c. are the strongest *glues* made. With the clippings of gloves and of parchment is made *size*, used by plasterers, &c. *Gilder's size* is made by boiling eel-skin with a small quantity of lime in water, to which some whites of eggs are added: that which is employed to fortify *paper*, and repair its defects, is made of wheat flour diffused in boiling water. From the mucilaginous parts, chiefly the air bladders, of a large fish, in the Russian seas, is formed *fish-glue* or *isinglass*, which possesses very strong agglutinating power, and is useful in stiffening, and giving a lustre to gauzes, &c. Isinglass forms a strong glue, by solution, in either water or alcohol.

Gelatin, Mr. *Hatchett* observes, may exist in the different degrees of tenacity and viscidity which characterize *mucilage*, *size*, and *glue*, the different forms in which it appears. This difference is evidently an inherent quality, and not caused by mere inspissation, the glue made from certain parts of animals, such as the skin, being of a better quality than that which is made from the sinews, and the best and strongest glue is always made from the more aged animals. Gelatin, when completely dried, is affected by water, according to its original degree of viscidity, cold water dissolving dried mucilage in a short time, but only occasioning cake of glue, after steeping three or four days, to swell much, without being dissolved.

There is every reason to conclude that the substance which in very young animals was at first mucilage, becomes progressively more viscid, and assumes the character of gelatin, which, as animals increase in age, becomes more and more viscid.

Skins of animals yield gelatin proportioned to the degree of flexibility they possess. Thus the skin of the eel and the shark yields a large proportion. The skins of the hare, rabbit, calf, ox, and rhinoceros, yield similar results; that of the rhinoceros yielded the strongest and most viscid gelatin. The true skin or *cutis* is completely soluble by long boiling, and seems to be essentially formed of gelatin; but the *cuticle* is only softened, but not dissolved, and appears to contain gelatin only in a small proportion; it is however necessary to its flexibility, since it becomes quite brittle when deprived of it.

The cuticle is not even acted on by alcohol. It is however dissolved by alkaline lees and by lime, which is employed in the process of tanning for removing it, to allow the tanning matter to have access to the true skin.

The *cartilages* of the articulations are also completely soluble when long boiled with water; but this by no means happens when other cartilages are thus treated.

Hair imparts a small portion of gelatin to water, losing thereby its elasticity and flexibility, the softest and most flexible hair yielding most.

Feather, quill, human nail, ox's hoof, tortoise shell, and the *scale* of a *scorpion*, shewed no trace of gelatin by the test of the tanning principle, and but a faint white cloud with nitro-muriate of tin.

Horns, such as those of the *ox, ram, goat*, and *chamois*, yield small quantities of gelatin, and in proportion to their flexibility. But *stag's* or *buck's horn* differ from these, both in composition and construction; containing, like bone, much phosphate of lime, and like bone, a large quantity of gelatin: phosphate of lime generally being accompanied by gelatin as in stags horn, bone, ivory, &c. but when carbonate of lime is the hardening substance, as in shells, madrepores and millepores, no gelatin can be discovered.

The ink of the *cuttle fish* appears to be chiefly formed of gelatin, with much charcoal mechanically combined.

Horny scales of the *mantis*, of *lizards*, *serpents*, &c. yield but very slight traces of gelatin, seeming to consist of the membranaceous substance merely, appearing to be devoid of phosphate of lime, as an ossifying matter.

Gelatin is evidently the principal cause of flexibility and elasticity, and the putrescibility of various parts.—*Hatchett. Philos. Trans.* 1800.

Gelatin and tannin precipitate together in a glutinous elastic, and extensible mass, resembling leather. Gelatin thus tanned becomes, when dry, a hard, smooth substance, of a very close texture, and unchangeable by air, water, and most other reagents. This substance might undoubtedly be employed in the arts with great advantage, for making boxes, taking impressions, &c.—*Davy.*

The ART OF TANNING consists in impregnating the skins of animals with the *tanning principle*, which renders them tenacious, durable, and impermeable to water; in a word, converts them to *LEATHER*. The first step towards this process is clearing the skin of all unnecessary matter. The hair is removed by the depilatory power of incipient putrefaction, or of lime, by the action of which, on the albumen of the epidermis, their separation is rendered easy: the oily and other matters, insoluble in water, are then removed by an alkaline lixivium, and, in some instances, sulphuric acid is employed.

The skin thus cleansed and prepared is placed in a *pit*, containing a solution of tannin, to undergo the necessary impregnation with this principle. This part of the process is accelerated by employing strong solutions; beginning, however, with the weaker, and gradually augmenting their strength.

The SKIN is composed of—1. the *epidermis*, consisting chiefly of albumen, with a little gelatin;—2. the *mucous membrane*, formed of a gelatinous substance;—and, 3, the *cutis*, or true skin, the important part for this purpose constituted by a fibrous intertexture, the component parts of which are fibrine, albumen, and phosphate of lime, in very small proportion to the gelatin, of which it is chiefly composed; which matter becomes glue by evaporation, or leather by the action of tanning.

As the *gallic acid* corrugates the surface, and does not seem to combine with the matter of skin, Mr. *Biggin* thinks its presence in tanning is not only useless but detrimental.—*Phil. Trans.*

To render leather impenetrable by water, Mr. *Hildebrandt* recommends it to be soaked in oil in which minium is dissolved and boiled to a deep brown.—*Ann. de Chim. de Crell.* 1799.

II. ALBUMEN, or as it has been called, coagulable lymph, besides being the principal constituent of the serum of the blood, forms the cheese in milk, and makes up the greatest part of the white of eggs. It coagulates at about 150° Farenh. being transparent, when dry, like horn. It has but little taste, is dissolved by alkalies, is insoluble in water, oils, or ardent spirits; the latter as well as acids, and metallic solutions promoting its coagulation. When considerably diluted with water, it no longer coagulates with heat. It gives oxalic acid when treated with the nitric acid, and appears to contain carbon, hydrogen, nitrogen, oxygen, phosphorus, and lime.

It is, according to Mr. *Hatchett*, the predominant and essential part in the tissue or web of membrane, cartilage, sponge, the horny stems of *gorgonia*, horn, hair, feather, quill, hoof, nail, horny scale, crust, and tortoise shell, and although of similar chemical properties, yet it varies in consistency, from a tender jelly-like substance, to a completely formed membrane, or to an elastic, brittle, and hard body, like tortoise shell, manifesting a stratified arrangement. Moreover the chemical properties of these substances resemble, in every respect, those of pure *albumen*; so that it evidently appears to be the original substance from which tortoise-shell, hair, horn, muscular fibre, &c. have been derived and formed.*

Mr. *Hatchett* thinks there is also much reason to believe that gelatin, although it appears so different from albumen in many respects, is yet formed from it, and that albumen, or the coagulating lymph, is the primary animal substance from which the others are derived. Pure albumen, which has not been subjected to the effects of organization, appears to contain a considerable portion of saline matter, and very little of any earthy substance; but in such bodies, which (although derived from albumen) have suffered various changes by the action of the vital principle, the quantity of saline substances appears to be diminished, while that of the earthy matter is increased; and as lime, in the states of phosphate and carbonate, is so much more abundant in the muscle of beef than in that of veal, we may infer, that the earthy matter is more abundant in the coarse and rigid fibre of adult and aged animals, than in the tender fibre of those which are young.

There appears much reason, Mr. *Hatchett* says, to believe that the gelatinous substances and muscular fibre, differ from simple and unorganized albumen, by a diminution of the carbonic principle in the one, and by an excess of it in the other, the muscular fibre containing by much the greatest quantity: resembling, in that respect, the vegetable fibre.

In respect to economical purposes, Mr. *Hatchett* observes, that all animal substances whatever (exclusive of carbonate and phosphate of lime) may be converted into two substances of much utility, glue and soap; the gelatin yielding the one and the albumen the other.—*Phil. Trans.* 1800.

III. FIBRINE is that white fibrous substance which is left after freely washing the coagulum of the blood, and which also chiefly composes the muscular fibre. It is insoluble in water and alcohol, and is dissolved only by the alkalies when concentrated and aided by heat. It is soluble in many of the acids, and precipitated by alkalies. On heat being applied, it shrivels like parchment. It yields, by distillation in a retort, water containing carbonate of ammonia, zoonic acid, a thick fetid oil, carburetted hydrogen, and carbonic acid gas, with much concrete carbonate of ammonia; it hence appearing to be a substance highly nitrogenized. It is undoubtedly highly animalised, and constituting the muscular fibre, it performs most important offices. It is perhaps the seat of irritability, and the medium by which the vital energies are directed to the various organs.

The coal it leaves is compact, and difficult to incinerate; then leaving phosphate of lime, known so to be by its dissolving in nitric acid, and being precipitated by ammonia.

IV. The MUSCULAR OR FLESHY PARTS afford, by distillation, water, empyreumatic oil, nitrogen gas, carbonate of ammonia, and a coal which yields a small quantity of fixed alkali. *Thouvenel* found, in flesh, a *mucous extractive substance*, soluble in water and in alcohol; and when concentrated, possessing an acrid and bitter taste. On hot coals it swells, liquifies, and emits a smell like that of burnt sugar: all its characters, indeed, show a resemblance between it and the saccharine matter of vegetables. *Thouvenel* also obtained, by a slow evaporation of the decoction of flesh, salt, in the form of down, and in crystals of an indeterminable figure: this salt appeared to him to be a phosphate of pot-ash in frugivorous, and a muriate of pot-ash in carnivorous, animals. *Fourcroy* thinks these salts may be phosphates of soda, or ammonia, mixed with the phosphate of lime. The most abundant part of muscles, and that which constitutes their predominating character, is the *fibrous matter*. Of the other matters contained in flesh, the lymph, and fat part, have been already spoken of.

Fourcroy found the muscular parts of bodies, which had been interred in the *Cemeterie des Innocens*, converted into a substance resembling spermaceti, which he terms *adipocire.—Annales de Chimie*, v.

Lord *Bacon*, in his *Sylva Sylvarum*, states, that such a change may be effected, by putting pieces of flesh into a glass covered with parchment, and allowing the glass to stand six or seven hours in boiling water.

Thomas Sneyd, Esq. of Staffordshire, found in the mud, at the head of a fish-pool, the body of a duck or young goose, converted into a hard fatty matter resempling spermaceti; having apparently suffered a similar change with that of the human bodies, observed by M. *Fourcroy*, in the *Cemeterie des Innocens.—Phil. Trans.* 1792.

Mr. *G. Smith Gibbes*, having placed the leanest part of a rump of beef in a box with holes, so as to float on the side of a river, found, at the end of a month, it was converted to a mass of fatty matter. He also found a piece of lean mutton, on which nitrous acid had been poured, three days before, to be exactly the same with some which he had before got from the water, and which, though changed, was not so much so as the beef.—*Phil. Tran.* 1794.

Mr. *Gibbes* further remarked, that the fatty matter formed from the flesh of quadrupeds, does not crystallize, whilst that from the human subject assumed a very regular and beautiful crystalline appearance. To purify this matter, he exposed it to the sun and air for a considerable time, reduced it to powder, and poured on it diluted nitrous acid, this remaining on it an hour; he then washed it repeatedly, and finally melted it with hot water, and, on allowing it to concrete, it was of a beautiful straw colour, and had the agreeable smell of the best spermaceti.—*Phil. Tran.* 1795.

Dr. *Crawford*, by his ingenious experiments, discovered that *cancerous matter* renders syrup of violets green; and that, with oil of vitriol, effervescence takes place, the mixture becoming of a dark brown; a gas being disengaged, which has many of the properties of hepatic air; and which the doctor called *animal hepatic air*. This he found to be mixed, in the matter, with volatile alkali, forming an *hepatised ammonia*, which may occasion the black deposition from the solution of sublimate, when employed to wash venereal ulcers in the throat; on saturine poultices applied to ill-conditioned ulcers; and on silver probes introduced into sinous ulcers, the animal fibres undergoing, in cancerous and other malignant ulcers, nearly the same changes which are produced by putrefaction, or destructive distillation.

Lean animal substances yield, by heat, alkaline air, carbonic acid, and, what he terms, animal hepatic air, from which sometimes is deposited an oily empyreumatic substance, a diminution of the volume of the gas, at the same time, taking place. It seeming probable, the doctor thought, that these three aërial fluids combining together, formed the oily empyreumatic substance.

The doctor also obtained a gas resembling what he calls animal hepatic air, from the leaves of cabbage.

V. The BLOOD is that red fluid which circulates in the animal body, by means of the arteries and veins; and supports life, by supplying all the organs with the peculiar juices they demand. It varies in the same individual, not only with regard to the state of health, but as to the part it occupies. The blood, which circulates through the veins, possesses a greater intensity of colour and degree of consistence, than that which is passing through the arteries. It putrifies by a gentle heat, and when slowly dried, effervesces with acids; if exposed to the air, it extracts humidity, and at the end of several months, yields a saline efflorescence ascertained by *Rouelle* to be soda.

The blood, when at rest, coagulates; and then separates into a yellow liquid, called SERUM, and a clot or COAGULUM. It may also be coagulated by alcohol and the acids, but alkalies render it more fluid.

The SERUM has a greenish yellow colour, is of a slightly saline taste, turns syrup of violets green, and hardens in a moderate heat. Being poured into boiling water, it directly coagulates, a part communicating a milky colour to the water, and possessing, according to *Bucquet*, all the properties of milk. It easily putrifies, and then affords much carbonate of ammonia. Distilled on a water bath, it yields an insipid fluid, very readily putrifying; the residue being transparent, like horn, and no longer soluble in water. By a higher degree of heat, ammonia, carbonate of ammonia, sulphuretted hydrogen, water, and a fetid blackish oil, more or less thick, are obtained: the remaining coal is very voluminous, and difficult to incinerate. The ashes afford muriate, carbonate, and phosphate of soda. The extravasated fluid, in dropsy, does not appear to differ much from the serum of the blood in its constituent principles.

The serum appears to contain, besides certain salts and much water, albumen and gelatin; from the former it obtains its property of coagulating by heat, and from the latter that of becoming a jelly by cold.

The whole of the blood, which by anatomists is divided into serum, red globules, and coagulating lymph, is found, when chemically examined, to consist of albumen, gelatin, and fibre. The *serum* which remains liquid after the coagulation of the blood, is composed of albumen, gelatin, some saline matter, and much water. The clot of *crassamentum* also affords, by repeated washing, a large portion of albumen and gelatin; after which a substance remains, in appearance very analogous to animal fibre, excepting that it is in a more attenuated state. This substance (fibrin) may be regarded as that part of the blood which has undergone the most complete animalization; and from which the muscular fibre and other organs of the body are formed.—*Mr. Hatchett. Phil. Trans.* 1800.

The *colouring matter* of the blood being burned, and the coal lixiviated, an oxide of iron is left, of a fine red colour, said to be obedient to the magnet.

The colour of the blood appears certainly to depend on the iron it contains; but on considering the changes which take place during respiration, and the different colour of arterial and venal blood, it seems that the colour is produced by the oxidizement of the iron, during the passage of the blood through the lungs.—The blood which has just circulated through every part of the animal, and has been brought back by the veins to the heart, is propelled into the lungs of a dark red colour, and impregnated with hydrogen and carbon. By inspiration the lungs are distended with air, the oxygen of which combines with the carbon, forming carbonic acid; and with the hydrogen, forming water; another part of the oxygen unites with the blood, which returns from the lungs, and passes into the arteries of a bright red.

Gren, in a letter to *Van Mons*, says, that the oxygen does not unite with the arterial blood, and that all the water in respired air is newly formed, and not separated from the blood. The oxygen is absorbed, and forms water and carbonic acid, but no part is left to unite with the blood; the change in the venous blood depending therefore on the separation of carbon and hydrogen.—*Ann. de Chim.* xxiii.

VI. The CHYLE has not hitherto been subjected to any analysis, from which its chemical history can be much illustrated. It separates in the air into a gelatinous coagulum and a milky fluid: the coagulated parts possessing the semi-transparence of opal, with something of the rosy tint, both in its substance and on its surface.

VII. The GASTRIC JUICE is secreted in the stomach of animals, and produces the digestion of their food, which may be considered almost as a chemical process. The gastric juice varies in different animals, according to the nature of their aliments: this difference extending to its chemical properties, and hence a variety in the analysis of the gastric juice of different animals. It, however, in general, yields water, animal gelatin, and phosphates.

VIII. The PANCREATIC JUICE is next added to the *ingesta*, this liquid appears to be resolvable into the same principles as those of the gastric juice.

IX. The BILE is a fluid secreted by the liver, deposited in the gall-bladder, and thence conveyed into the duodenum. It is glutinous, of the fluidity of oil; of a very bitter taste, a green colour, inclining to yellow; and froths by agitation like a solution of soap.

It contains a considerable portion of water, albumen, and soda, in a caustic state, united with an oily matter, which, according to *Fourcroy*, although it does not nearly approach to either, has somewhat of the nature of fat, resin, and *adipocire;* with a colouring matter not hitherto separated from the last mentioned oily matter. Besides pure soda, the bile also appears to contain muriate of soda, phosphate of soda, and phosphate of lime.

An oily bitter substance, yielding the smell of musk, has also been spoken of, but has never been exhibited in a separate state; it is, perhaps, only the result of some new combination, formed during the decomposition of the oily matter already mentioned.

On the addition of alcohol, the albumen is separated, whilst the other constituent parts are held in solution.

Bile is decomposed by acids, by which a coagulum is separated, which is soluble in excess of acid, and which forms, with the muriatic acid, a red solution; an oily substance, analogous to resin, also rises, and salts are formed which have soda for their basis. It unites with oils, and cleans stuffs in the same manner as soap; but does not appear to mix with oily substances in the same manner as soap.

Biliary concretions seem to owe their origin to inspissation of the bile, and to the deposition of a peculiar matter in a crystallised or laminated form. This matter was supposed by *Poulletier* to resemble the light brilliant particles of the acid of benzoin; but *Fourcroy* is of opinion, that it is a true adipocire, a matter resembling spermaceti.

These concretions appear to be soluble in alcohol, ether, caustic alkalies, the fixed and volatile oils, and in the solutions of soaps.

X. Milk is secreted in the breasts of the females of certain animals, therefore called lactiferous animals; but the following observations will chiefly refer to that of cows. It is the least animalized of all the secreted fluids, partaking of the nature of the chyle, and even of the qualities of the aliments. When exposed to the air, *cream* rises on its surface, the remaining *skimmed milk* becoming sour, in a longer or shorter time, according to the temperature of the atmosphere, in summer acquiring its greatest acidity in three or four days, and separating into a *coagulum* or *curd*, and a *serum* or *whey*.

Milk appears to contain a fat oil, and a particular gluten, formed into a kind of animal emulsion, by means of a saccharine substance.

Milk is very remarkable for the phosphate of lime it contains, and which seems to be destined to favour the first period of ossification.—*Fourcroy, Tabl. Synop.* 1800.

By distillation, milk first yields an insipid water, then a fetid, coloured water, containing zoonic acid and ammonia, a fluid brown oil, a concrete empyreumatic oil, carbonate of ammonia in a solid form, carburetted hydrogen, and carbonic acid gas. In the ashes of the remaining coal are found muriate of soda, but much more of muriate of pot-ash, and phosphate of lime.

Rouelle remarks, that the muriate of pot-ash is not found in the blood, and that therefore the milk must derive this from some other source; and if from the chyle, then the salts contained in the chyle must be changed in their passage into the blood.

LACTIC ACID, or the ACID OF MILK, is thus obtained. Sour milk being evaporated to one eighth, the cheesy matter separated by the filtre, and *lime-water* poured on the residue, an earth is precipitated, and the lime combines with the acid of the milk. The lime may then be displaced, by adding the *oxalic acid*, which forms with it an insoluble oxalate and is precipitated, the acid of milk remaining disengaged. The fluid is then evaporated to the consistence of honey, and upon this very pure alcohol is poured, which takes up the acid, all the other principles remaining undissolved. The mass being now filtered, the lactic acid may be separated from its solvent by distillation.

The lactic acid forms deliquescent LACTATES with the *alkalies, baryt, lime, alumine, magnesia*, &c. It dissolves *iron* and *zinc*, and produces hydrogen gas. With *copper* it assumes first a blue colour, then a green, and afterwards an obscure brown. It also dissolves *lead*, the solution depositing a white sediment, considered by *Scheele* as a sulphate of lead, and as evincing the presence of a small portion of sulphuric in this acid.

SUGAR OF MILK is obtained from *whey*, or milk, deprived of its cream and of its curd, and evaporated to the consistence of honey. This is formed into cakes, which are dried in the sun, then dissolved, clarified, and set to crystallize; it then yielding white crystals, in tetrahedral prisms, with tetrahedral summits. It has a slight earthy saccharine taste, is soluble in three or four pints of hot water, and exhibits the same appearances as sugar, either by distillation, or on the fire. By distilling the nitric acid from twelve ounces of sugar of milk, *Scheele* obtained five drachms of oxalic acid in long crystals, and seven drachms and a half of the ACID OF SUGAR OF MILK, in a white powder; which has been spoken of as *mucic acid.*

The serum of milk may, by several processes, be made to pass into the vinous fermentations. Six spoonfuls of alcohol, with three pints of milk, exposed in closed vessels for a month, giving vent occasionally to the gas, will be converted into good acetous acid. A spirituous liquor is also made from mares' milk. Milk is turned, or its various constituent parts are separated, spontaneously, or by the addition of rennet, and several other substances, such as neutral salts, acids, and even certain vegetables. The solid mass thus separated from the whey, contains two substances, *cheese* and *butter.*

Milk may be curdled by passing through it the electric fluid, and then restored to its fluid state by fixed alkali.—*Bouillon le Grange's Manual,* 1800.

CHEESE is formed by the curd undergoing a commencement of the putrid fermentation, by which it acquires consistency, taste, and colour; and is then pressed and dried for use. No substance has a stronger resemblance to cheese than boiled white of egg, both being soluble in diluted acid, in caustic alkali, and in lime water. The earth of cheese, according to *Scheele,* is a phosphate of lime. *Ammonia* dissolves cheese more effectually than fixed alkalies, and *nitric acid* disengages nitrogen from it.

BUTTER is procured from the cream which floats on the top of milk, by agitation, the remaining milk being termed BUTTER-MILK. Butter, unless salted, soon changes, becoming rancid like oils; the acid, thus developed, may be washed off by water, or by the spirit of wine. With *fixed alkali,* butter forms a soap. By distillation it yields water, a coloured concrete oil, and a strong pungent acid, the sebacic acid.

At Constantinople the butter is obtained from the Crimea and the Cuban, they do not sell it, but melt it over a slow fire, and scum off what rises; it will then preserve sweet a long time, if it was fresh when melted.—*Eaton's Survey of the Turkish Empire.*

Cadet de Vaux recommends the following mixture, as a cheap substitute for oil-paint:—Skimmed milk, two quarts; lime newly slaked, six ounces; linseed oil, four ounces; Spanish white or chalk, well ground, three pounds. Pour over the lime such a portion of the milk as renders it of the consistence of a thick soap, add gradually the oil, then pour in the remainder of the milk, with the chalk diluted in it.

For out-door work he adds to the above, slaked lime, two ounces; oil, two ounces; white Burgundy pitch, two ounces; melted in the oil and added to the smooth mixture of milk and lime.—*Decade Philos.* 1801.

Darcet, who thinks the serous part of the milk, the oil, Burgundy pitch, and part of the lime, may be omitted, recommends the following:—Cheese or curd, five ounces; slaked lime, a quarter of an ounce; whiting, ten ounces; charcoal, one drachm; water, three ounces; and a sufficient quantity of water to be again added to give it a proper degree of fluidity, when it is used.

XI. Fat is a condensed inflammable animal juice, contained in its proper membrane. Its colour is usually white, but sometimes yellow; its taste insipid, and its consistence varying in different animals. It is obtained in a state of purity, by boiling in water, after being finely shred: it being thus separated from the membranes, fibres, &c. It differs with the individual and the part of the body which produces it, thus we have *tallow*, mixed with offal parts; *lard*, from the hog; and *train oil* and *spermaceti* from fish. Fat much resembles oils; like them it is not miscible with water, is liable to rancidity, forms soap with alkalies, and burns by the contact of an ignited substance.

Beef suet distilled on the water bath, affords oils and phlegm; the phlegm is reddish, has an acid taste, effervesces with alkalies, and turns the syrup of violets brown. *Marrow* yields the same products, and a substance of the consistence of butter.

Sebacic acid, or acid of fat, has been supposed to have been concentrated by various processes by Mr. *Crell.*

This acid, he supposed, exists ready formed in the fat, since earths and alkalies disengage it.

Mr. *Crell* also obtained it, as he thought, by distillation from the butter of cocoa, and from spermaceti. He observed that it seems to approach to the nature of the muriatic acid in some respects, but not in others.

It appears that fat is a kind of oil or butter, rendered concrete by an acid, being, in fact, an *acid soap*. By still nicer analysis, it has been estimated, that six parts of fat consists of nearly five of carbon, and one of hydrogen, with some sebacic acid: and not yielding so much oxygen and nitrogen as the fleshy parts.

Dr. *Gren* remarks, that though esteemed as a peculiar acid, yet after being purified and concentrated, it manifests the same properties as the acetic acid.

Thenard contends, that *Crell* only obtained, by some of his processes, muriatic acid, which was derived from muriate of pot-ash, which is always contained in the pot-ash of commerce, and which it is probable he used. By *Crell's* other processes, he believes he obtained acetous acid.

He distilled pork fat, washed the product, and precipitated with acetite of lead, and distilling it with sulphuric acid, a matter resembling fat was found floating in the retort, which, by the aid of heat, was dissolved in water, and afterwards crystallized, proving to be the real *sebacic acid*, hitherto not discovered. It is inodorous, slightly sour, more soluble in hot than cold water, and does not render the waters of lime, baryt, and strontia turbid.

Dr. *Beddoes* appears to think that fat is produced in the animal system, in proportion to the diminution of oxygen.

Oxygenated lard is formed by melting one part of *nitric acid* with sixteen parts of *axungia*, stirring it with a glass rod, and leaving it over the fire till it throws up bubbles. The nitric acid is decomposed, the nitrogen is disengaged, and the oxygen combines with the fat, without giving it acidity.—*Alyon*.

Spermaceti is a concrete oil, extracted from a species of the whale, the *cacholot*. It burns with a very white flame, and rises totally if distilled on a naked fire, assuming a reddish tinge, and losing its natural consistence by repeated distillations.

Alcohol dissolves it by the assistance of heat, but lets it fall as it cools. It is also dissolved by *ether*, and by the *fixed* and *volatile oils*. It seems to bear the same relation to fixed oils which camphor does to the volatile oils, whilst wax seems to be analogous to their resins.

XII. Urine is an excrementitious fluid, secreted by the kidneys; in its natural state, it is transparent, of a peculiar smell, a citron yellow colour, and a saline taste. Besides the differences proceeding from peculiarity of habit, there are other differences in the urine, arising from other circumstances. That which is voided soon after copious drinking, is aqueous; having hardly colour or smell, and is called *crude urine*, or *urina potus*: whereas that which is made after the sanguification, succeeding to a full meal, possesses all the characters of urine, and may be called the *fæces sanguinis*.

By the spontaneous decomposition of urine, it soon loses its original smell, and acquires that of ammonia; which being also dissipated, the smell becomes very fetid and offensive, and the colour brownish: in this state it manifests much less acid than when fresh.

By evaporating urine to the consistence of a syrup, and allowing it to stand in a cool place, crystals are formed. This precipitate of crystals has been called *fusible salt, native salt,* and *microcosmic salt.* It is chiefly composed of the phosphates of soda and of ammonia, and is used as a flux to the earths.

The analysis of urine is very difficultly accomplished, owing to the complication with the substances employed as reagents, and to its vast susceptibility of change by the application of the slightest degree of heat, or even exposure to the air. A carefully conducted spontaneous evaporation, afterwards aided by heat, fermentation, the action of alcohol, and a close observation of the several appearances yielded by the action of various reagents, are all necessary to ascertain the principles which urine contain.

According to *Fourcroy*, there are twelve principles which are constantly found in urine. 1. *Urée*, the substance on which the characteristic properties of urine depend, which is contained in the urine of all quadrupeds, and which *Rouelle* distinguished by the name of *soapy*; *Scheele*, *extractive oil*; and *Cruickshank*, who has ascertained several of its properties, particularly its immediate formation into a mass of crystals by the addition of nitric acid, *animal extractive water*. To obtain it in a state as pure as it will admit, urine is to be gently evaporated to the thickness of honey, and to this alcohol is to be added, which dissolves the urée and but few of the other principles. The alcohol being distilled, leaves a thick mass, which on cooling crystallizes in brilliant micaceous lamina, composed of urée and muriate of ammonia, with benzoic acid, from which it cannot be entirely freed. It is undoubtedly a quarternary compound of *nitrogen, hydrogen, carbon*, and *oxygen*, in which the nitrogen predominates; but which is the least durable, and most easily decomposable, of any known animal compound, since the slightest change in the equilibrium of its constituent principles, by the action of the gentlest heat, of alkalies, and even of baryt and strontia, is sufficient to decompose it, and make it pass into the state of ammonia, and of carbonic, prussic, and acetic acids, its constituent principles quitting their quarternary combination to form one ternary compound and several binary ones. It possesses the curious property of occasioning the reciprocal inversion of the forms of the crystals, of muriate of soda, and of ammonia, giving to the former the figure of the octahedron, and to the latter that of the cube. 2. Uric acid, which sometimes forms the urinary calculus: it was discovered by *Scheele*, and is the red sandy matter which concretes on the sides of vessels containing urine, and perhaps forms the pink sediment deposited in some diseases. 3. Phosphoric acid, existing in excess in the following substance. 4. Phosphate of lime, which being supersaturated with the acid, becomes soluble, and yields the sensible acidity, discoverable in recent urine. The ammonia, which is so speedily produced, seizes the excess of acid, and the phosphate, now insoluble, is precipitated. 5. Phosphate of magnesia, hardly separable from the other salts. 6. Phosphate of soda, remarkable for not yielding its phosphorus in the ordinary mode, and for uniting, when added to metallic solutions, with the precipitate so formed, and then being capable of yielding the phosphorus, with the aid of charcoal. 7. Phosphate of ammonia. This salt crystallizes the first, after the inspissation of the urine, and from it phosphorus is obtained. It is always mixed with the phosphate of soda, forming a triple salt, which is the basis of the mass of crystals which form in inspissated urine, and which have been called fusible or microcosmic salt. 8. Benzoic acid, chiefly abounding in the urine of children. 9. Muriate of soda in octahedra. 10. Muriate of ammonia, in cubes. To these perhaps may be added, 11. Gelatinous animal matter. These substances being held in solution in a large proportion of, 12. water.

These substances, particularly the phosphoric acid, may be considered as excrementitious, and destined to be carried off by this channel.

The following substances, muriate of pot-ash, sulphate of soda, sulphate of lime, oxalate of lime, albumen, silex, and saccharine matter, which exists in the urine in diabetes, and other diseases, may be considered as only accidentally present in urine.

Fermentation takes place in urine very rapidly, the animal gelatin and urée, the only substances it contains susceptible of this kind of change, yielding ammonia, carbonic acid, and acetic acid: hence the following additional combinations, benzoate, urate, acetate, and carbonate of ammonia, and ammoniaco-magnesian phosphate. The urée, as appears from the colour of the precipitated matter, has a portion of its carbon separated, and on the whole the urine becomes a very different liquor from what it was at its evacuation, ammonia prevailing in the place of acidity.

A particular acid, said by M. *Gaertner* to exist in urine, the colouring matter, the odorant principle, a particular extract, and an attenuated oil, may be mentioned as principles, the existence of which in urine have not been proved.

The urine of young children does not contain the earthy phosphates, but much benzoic acid; whilst in that of the aged is contained a large proportion of the uric acid and the phosphate of lime, with which the osseous part of the system is surcharged.

In rachitis, *C. Bonhomme* is of opinion, that the softness of the bones is in consequence of an abstraction of the earthy matter by the action of oxalic acid, generated by faulty digestion in weakened stomachs.

In diabetes mellitus, Dr. *Rollo* has proved the urine to contain a very large proportion of saccharine matter, depending on an hyperoxygenized state of the system resulting from a morbid state of the stomach, and peculiar combinations formed in it.

The phosphorus contained in urine may be obtained by adding to urine nitrate or acetate of lead; an insoluble phosphate of lead, formed by the decomposition of the three phosphates contained in the urine, will be then precipitated. This precipitate, carefully washed, is then to be distilled with a quarter of its weight of charcoal, when the phosphorus will be liberated from the phosphoric acid by the attraction of the charcoal for its oxygen, and the saline matters which are volatilised will be dissolved in the water which receives the phosphorus. The urée and uric acids form carbonate of ammonia, and soil the phosphorus by a small portion of oil yielded by the decomposition of urée, from which it may be cleared by redistillation, or by melting it, and passing it through chamois leather in water.

From stale urine, by distillation, carbonate of ammonia is obtained. By the addition of concentrated muriatic acid to the urine of graminivorous animals, the benzoic acid may be precipitated. It is also serviceable in promoting the formation of nitrate of pot-ash in saltpetre beds, and is employed for cleansing woollen cloths, &c. from grease.

Urinary calculi were supposed by *Scheele*, before whom nothing was known respecting their composition, to be chiefly formed of a peculiar acid, the *lithic acid*, which, on further examination, Dr. *Pearson* concluded to be an animal oxide endued with peculiar properties. This substance, which he termed the uric oxide, and the phosphate of lime, were the only matters known to exist in calculi, until the enquiries of *Fourcroy*, who discovered in them five other substances. The principles discoverable in different calculi, he considers to be—

1. *Uric acid*, which is tasteless, inodorous, and forms in yellow crystals, not soluble in cold, and requiring a large quantity of warm water. It unites with the alkalies, and with an excess of them becomes very soluble. The sulphuric and muriatic acids have little action on it. The nitric acid, acting on the animal colouring matter, changes it to a red colour, and converts a portion of it to oxalic acid. The oxygenized muriatic acid dissolves it, and decomposes it into ammonia, and the carbonic, oxalic, and malic acids. By the action of fire, it in part sublimes, and also yields carbonic acid, carbonate of ammonia, prussic acid, and a charcoal not containing any saline matters.

The concretions it forms are known by their reddish brown colour, like wood, being never white, black, or grey; by their rounded form, being hardly ever sharp or spiny; and by their being generally formed in smooth layers. They dissolve in alkaline solutions without smell. Red gravel is commonly formed by this substance.

2. *Urate of ammonia*, which, like the uric acid, is soluble by the alkalies, but at the same time yields the smell of ammonia. This circumstance characterises its concretions, which are ge-

nerally small and smooth, of a light coffee colour, their layers being thin and close. It is generally combined with ammoniated magnesian phosphate.

3. *Ammoniaco-magnesian phosphate* has its ammonia separated by alkalies, without suffering dissolution, the phosphoric acid being taken away and the magnesia left. It forms spathose, semi-transparent layers, but is never found alone in calculi. It frequently covers a kernel of the uric acid, or of phosphate of lime.

4. *Phosphate of lime* is generally combined with gelatinous animal matter, and with the last mentioned phosphate. These calculi are known by their lightness, whiteness, friability, and solubility in acids, whilst the alkalies have no action on them. Such are the incrustations which form on foreign bodies in the bladder.

5. *Oxalate of lime* forms the light brown heavy calculi, known by the term *mulberry-form.* These are very little affected by acids, nor by pure alkalies, but are completely decomposed by the alkaline carbonates. They are susceptible of a good polish, break with a conchoidal fracture, and when cut give the peculiar faint spermatic smell of bone or ivory.

6. *Silex* is but a rare ingredient in calculi; out of more than six hundred *Fourcroy* found but two in which it existed: and in these it was combined with phosphate of lime. The concretions were of the mulberry form, but their colour more pale and clear than that of the calculi in general.

7. *Animal matter,* which forms the substratum of every calculus, and varying both the texture and composition, in all the different species. With the uric species it is albuminous; with the phosphates it is a mixture of albumen and gelatin, in a laminated form; with oxalate of lime and silex, it is albumen in a reticulated form.

Dr. *Pearson* has found the uric acid in *arthritic* concretions. Mr. *Tennant* discovered a combination of that acid and soda in them. *Fourcroy* and *Vauquelin* confirm this analysis, finding them to consist of urate of soda, with a considerable quantity of animal gelatinous matter.

Berthollet asserts, that during a fit of the gout, the urine contains no phosphoric acid. Whether at that period it contains the uric acid or not, is a subject proper for investigation.

XIII. CONCRETIONS, such as are found in the pineal gland, and discharged from the lungs, are in general formed of phosphate of lime.

Intestinal calculi are, generally, in man, oily concretions, formed of the fat waxy matter of the bile; in brutes, they are commonly formed of ammoniaco-magnesian phosphate, and sometimes of the phosphate of lime.

XIV. PRUSSIC ACID is the colouring matter of prussian blue, the mode of forming which was first discovered in 1709, by *Diesbach* and *Dippel:* they finding, by accident, that this beautiful pigment was precipitated from a solution of sulphate of iron, on the addition of a lixivium of fixed alkali, which had been exposed with animal matter to a high degree of heat. This property, it was afterwards found, was not only yielded to the alkali by horns, hoofs, blood, and various other animal substances, but also by bitumens and certain vegetables.

In 1775, *Bergman* ascertained the colouring matter of prussian blue to be a peculiar acid. In 1782, *Scheele* discovered that this acid might be obtained in a gaseous form, by distillation from prussian blue and sulphuric acid. He obtained it in a small quantity, by a strong heat, from charcoal and fixed alkali, and in a very considerable quantity on adding ammonia. In 1787, *Berthollet* ascertained that this acid contained the three simple combustible bodies, hydrogen, nitrogen, and carbon; and not discovering in it oxygen, he concluded it did not contain this acidifying principle. He was able to oxygenize it, however, by exposing it to the oxygenized muriatic gas. Although it remarkably differs from other acids, yet, he concludes that it approaches the nearest to this class of bodies; at the same time possessing a close analogy to ammonia, as well as a strong tendency to change into that substance.

Fourcroy thinks the analysis of *Berthollet* not sufficiently nice to determine the presence of oxygen, which he supposes is to be inferred from the constant production of carbonic acid in every decomposition of prussic acid.

This acid is acrid to the taste, and yields a flavour like that of peach leaves. It has a strong tendency to the gaseous form, and is decomposed by light and heat into carbonic acid, carburetted hydrogen, and ammonia. It unites, difficultly, with alkalies, and so feebly as not to destroy their alkaline properties; yielding them even to the carbonic acid. It acts not on the metals themselves, but has a strong affinity for metallic oxides. It is by uniting with the red oxide of iron, that this acid forms prussian blue. Gold it precipitates yellow; lead, white; and copper, brownish red. It readily forms triple salts, with alkaline and metallic bases, more fixed than those with alkalies only, but these are not so permanent as its combination with the metallic oxides, which are not separable by the other acids; although, from the specific heat it possesses, and its tendency to assume a gaseous form, it cannot alone take these oxides from the other acids. The metallic prussiates may become hyper-oxygenized, and the prussiates of iron may exist in three degrees of oxygenizement, of which green shows the lowest, blue the next, and white the highest. When hyper-oxygenized, the mere contact of a fixed alkali converts it to carbonate of ammonia. The oxygen, uniting with the carbon, leaves the nitrogen to join the hydrogen and form ammonia, whilst the excess of hydrogen and carbon forms carburetted hydrogen.

The prussic acid may be obtained from animal substances by the mere action of fire, by alkalies aided by a strong heat, by the action of concentrated nitric acid, which forms, at the same time, carbonic acid, oxalic acid, and adipocerous matter, and lastly by putrefaction.

In these prussiates, in consequence of the volatility of the acid, a part of the alkali exists in a crude state, unneutralized: hence the precipitate of iron has a greenish cast from the yellow precipitate thrown down by this unsaturated alkali. This last precipitate is soluble by an acid and the other is not; therefore the addition of an acid to give its full blue colour, and, on the same principle, the prussiate may be previously saturated with dilute sulphuric acid.

Sulphate of alumine is profitably employed in the precipitation of prussian blue, its earth increasing the quantity: it may be deprived of this by digesting it with muriatic acid.

The prussic acid is obtained in a pure state, by supersaturating the prussiate of alkali with sulphuric acid, and by subsequent distillation. It may also be obtained by distillation of blood with nitric acid, or by passing ammoniacal gas through heated charcoal.

Proust describes prussian blue to be an oxide, whose basis contains 48-100 of oxygen.

XV. The BOMBIC ACID is found to exist in all the states of the silk worm, in all its stages of existence, even in the eggs; but in the egg and in the worm, it is combined with a gummy glutinous substance.—*Chaussier.*

XVI. HARTSHORN gives name to several products used in medicine, which, though the preference is given to this horn, may be yielded by any other. By distillation an alkaline phlegm is first procured, which is called the *volatile spirit of hartshorn*; a reddish oil next comes over, more or less empyreumatic, this rectified, is the *animal oil of Dippel*; then rises a considerable quantity of the *carbonate of ammonia*, coloured by the oil, but from which it may be purified to a beautiful degree of whiteness. The coaly residuum contains soda, with sulphate and phosphate of lime, from the latter of which phosphorus may be obtained. Burnt entirely to an ash, it is the *calcined hartshorn* of the shops.

Dr. *Woodhouse*, of Pennsylvania, has discovered that five times the quantity of ammonia was obtained in a given time by distilling without, than with a lute, he supposing that the nitrogen of the atmosphere entered into the apparatus and joined with the hydrogen of the bones, and so forms the ammonia. 1800.

XVII. BONES consist chiefly of jelly, fat, and an earthy neutral salt. By distillation they yield hydrogen and carbonic acid gas, a volatile alkaline liquid, an empyreumatic oil and dry carbonate of ammonia, the residuum is a coal, which, when obtained with certain precautions, is used in the arts, and is called *ivory black*. By open combustion this coal is reduced to ashes, which, unlike the ashes of vegetables, manifests no marks of fixed alkali.

The earth of calcined bones was discovered in 1769, to consist of lime united with the acid of urine. *(Gahn.)* It was then discovered, that by decomposing this salt of bones by the nitric and sulphuric acids, evaporating the residue, which contains the phosphoric acid in a disengaged state, and distilling the extract with powder of charcoal, phosphorus was obtained.—*Scheele.*

Pulverized burnt bones are to be mixed with half their weight of sulphuric acid, and after digesting two or three days, water must be added, and the mixture digested still further on the fire. The water of the lixivium, as well as the water with which the residuum is washed, to deprive it of its salts, is then to be evaporated in vessels of stone ware, until it affords an extract, which must then be dissolved in the least possible quantity of water, and filtered, that the sulphate of lime may be separated. This extract may be then put in a large crucible, and the fire urged; when it swells up, but at last settles, and at that instant a *white glass*, of a milky hue, is formed,* which mixed with an equal quantity of charcoal, and distilled in a porcelain well coated retort, yields the phosphorus by distillation.

The theory of this operation may be thus explained. During the combustion of the bones, oxygen combining with the proper radical, forms PHOSPHORIC ACID, which with the lime generates PHOSPHATE OF LIME. Carbonate as well as prussiate of lime being also formed in the same manner, and at the same time. The phosphoric acid here is considered by *Gren* as a *product* of combustion and not really an *educt*. But to return to the explanation of the process—the phosphoric acid is then displaced from the phosphate, by the sulphuric acid, which forms with the lime, sulphate of lime. By the succeeding operations, the sulphate is separated, and the acid is concentrated. By the distillation with charcoal, the phosphoric acid is decomposed; its oxygen unites with the coal, and affords carbonic acid, while the PHOSPHORUS itself is disengaged.

Fourcroy observes, that the acids decompose the phosphate of lime, only in part; that they take away only a portion of the base, and leave an acidulous phosphate, their action there ceasing. Two-fifths only in weight of the sulphuric acid is necessary for this, instead of two-thirds, which used to be employed.

After having dissolved the earthy base in any acid, its quantity may be known by separating it from its solution, by the addition of the oxalic acid; the precipitated oxalate shewing the quantity of earth, 100 parts of the precipitate containing 0,48 of lime. The free phosphoric acid being contained in the fluid. But to obtain the phosphorus, he recommends, instead of evaporating the lixivium, that acetate or nitrate of lead be added to the ley of the phosphate, when the acetic or nitric acid will unite with the lime,

* *Becker*, who was acquainted with this glass of bones, says, "*homo vitrum est, et in vitrum redigi potest.*" A skeleton of nineteen pounds, yields five pounds of phosphoric glass.

and the phosphoric acid will join the lead and be precipitated. This precipitate must then be well washed, and on being distilled with charcoal, double the quantity of phosphorus, in proportion, will be obtained, of what the usual process yields.

The phosphorus may be purified, by being immersed in a vessel of boiling water; as the phosphorus melts, and may be passed through a piece of chamois leather like mercury. The lower orifice of a funnel being stopped, phosphorus with water is to be put in it, and the funnel plunged in boiling water; as the heat is communicated the phosphorus melts, runs into the neck of the funnel, and takes that form; when cold it is to be thrust out of its mould, and kept under water: it leaves, according to *Proust*, a reddish phosphuret of carbon on the leather.—*Ann. de Chim.* c. 105.

C. Cabarris is of opinion, that the brain, with the nervous system, is the reservoir of phosphorus; phosphorescent lights accompanying its decomposition, the vividity of which, he thinks, bears some proportion to the activity of the nervous system during life.—*Institut. National.* 1801.

Scales of fish, and the *spicula of the shark's skin*, are, according to Mr. *Hatchett*, true bony substances, containing much phosphate of lime, with a greater proportion of the membranaceous part than in common bone.

XVIII. The ENAMEL OF TEETH, according to the very interesting experiments of Mr. *Hatchett*, dissolved without heat in muriatic acid, deposits selenite by the addition of sulphuric acid; after which the remainining fluid is rendered thick and viscid by evaporation. This, when diluted with water, precipitates lime from lime-water, in the state of phosphate. Acetite of lead also precipitates a white matter, which produces a light and smell, on burning charcoal, like phosphorus, and is soluble in nitrous acid; whereby it is distinguished from muriate or sulphate of lead. Enamel being also dissolved in nitric acid, and the solution saturated with carbonate of ammonia, a precipitate is formed, composed of lime combined with a portion of phosphoric acid: phosphoric acid is also precipitated from the remaining fluid, by solution of acetite of lead. The enamel is therefore not a carbonate, but a phosphate of lime. Lime and phosphoric acid appear to be the essentially constituent principles of *enamel*; the enamel appearing to differ from tooth or bone, by being destitute of cartilage, and by being principally formed of phosphate of lime, cemented by gluten.

XIX. Shells, according to the same celebrated chemist, as to the substance of which they are composed, are *porcellaneous*, with an enamelled surface, and when broken, often of a fibrous texture; or are composed of *nacre* or *mother of pearl*. It appears that the porcellaneous shells are composed of carbonate of lime, cemented by a very small portion of gluten; and that mother of pearl and pearl do not differ from these, except by a smaller portion of carbonate of lime; which, instead of being simply cemented by animal gluten, is intermixed with, and serves to harden, a membranaceous or cartilaginous substance; and this substance, even when deprived of the carbonate of lime, still retains the figure of the shell. These shells appear to be formed of various membranes applied *stratum super stratum*, each membrane having a corresponding coat, or crust or carbonate of lime. The inhabitants of these stratified shells increase their habitation by new strata, each stratum exceeding in extent those which were previously formed, the shell becoming stronger in proportion as it is enlarged, and its number of strata denoting its age.

Tooth and bone being steeped in acids, the ossifying substances are dissolved: the enamel of the tooth is completely taken up by the acid, while the cartilage of the bony part of the tooth is left, as is the case with other bones, retaining the shape of the tooth, and a cartilage or membrane of the figure of the bone remains. These effects, as well as those from exposure to fire, show a similarity between enamel and the porcellaneous shells, as well as between the substance of tooth and bone, and shells composed of mother of pearl. Thus porcellaneous shells resemble enamel, in suffering a complete dissolution in acids, and not leaving any pulpy or cartilaginous matter; whilst shells of *nacre*, like bone, and the substance of tooth, part with their ossifying substances in certain acids, and their bases remain in the state of membrane or cartilage. The basis varying in different shells, and in different bones, in its degrees of inspissation, from a very attenuated gluten to a tough jelly, and from this to a perfectly organized membrane composed of fibres, arranged according to the configuration of the shell or bone.

The CUTTLE BONE of the shops, appears in composition exactly to resemble shell, it consisting of various membranes, hardened by carbonate of lime, without the smallest mixture of phosphate.

The CRUST OF THE ECHINUS approaches most nearly to the shells of the eggs of birds, consisting of carbonate, with a small proportion of phosphate of lime, cemented by gluten.

The ASTERIAS RUBENS manifests a portion of carbonate of lime, without any mixture of phosphate, but in the ASTERIAS PAPPOSA a small quantity of phosphate of lime is discovered. In the *crustaceous covering of marine animals*, such as the *crab*, *lobster*, *prawn*, *and cray-fish*, carbonate and phosphate of lime, but the former in the largest proportion, are found. Phosphate of lime mingled with the carbonate, appearing to be the chemical characteristic which distinguishes the crustaceous from the testaceous substances. The presence of phosphate of lime evinces an approximation to the nature of bone, which consists principally, as far as the ossifying substance is concerned, of phosphate of lime. By these ingenious investigations of Mr. *Hatchett*, carbonate of lime was also discovered to enter into the composition of bones; but as the carbonate exceeds in quantity the phosphate of lime, in egg-shells and crustaceous animals; so in bones it is the reverse. It is possible that shells, containing only carbonate of lime, and bones containing only phosphate of lime, will form the two extremities of the chain. Bones of fish appear to contain more of the cartilaginous substance, and less of the phosphate of lime, than is commonly found in the bones of quadrupeds.

XX. CARTILAGE, and such HORNS as are distinctly separate from bone, as are those of the *ox*, the *ram* and *chamois*, also *tortoise-shell*, contain phosphate of lime, but in too small a quantity to be considered as one of their constituent principles. Five hundred grains of the horns of an ox yielding only 1,50 grains of residuum, less than half of which is phosphate of lime. *Buck's or stag's horn*, has every chemical character of bone, with some excess of cartilage. By experiment on dry hog's BLADDER, it appears that phosphate of lime is not an essential ingredient of membrane.

The *bones of the Gibraltar rock* consist principally of phosphate of lime; and the cavities have been partly filled by the carbonate of lime, which cements them together. Fossil bones resemble bones which, by combustion, have been deprived of their cartilaginous part, retaining the figure of the original bone, without being bone in reality, as one of the most essential parts have been taken away.

The destruction or decomposition of the cartilaginous parts of teeth and bones in a fossil state, must have been the work of a very long period of time, unless accelerated by the action of some mineral principle; for after steeping in muriatic acid, the os humeri of a man, brought from Hythe, in Kent, and said to be taken from a Saxon tomb, the remaining cartilage was found nearly as complete as that of a recent bone. Mr. *H.* questions, if bodies consisting of phosphate of lime, like bones, have concurred materially to form strata of limestones or chalk; for it appears to be improbable that phosphate is converted into carbonate of lime, after these bodies have become extraneous fossils. *Glossopetræ* also yielded phosphate and carbonate of lime, the latter appearing to be derived from the calcareous strata which had inclosed them, and which had taken the place of the decomposed cartilage. —Mr. *Hatchett*, *Phil. Trans.* 1799.

XXI. Madrepores and millepores, like the various shells, appear from the experiments of the same gentleman, to be formed of a gelatinous, or membranaceous substance, hardened by carbonate of lime; the only difference being in the mode according to which these materials have been employed. So completely the same is the nature of these bodies, that all the changes or gradations observable in shells are discoverable in these. *Tubipora musica* resembles the foregoing. *Flustra foliacea*, and *Corallina opuntia*, contain also a small portion of phosphate of lime; their membranaceous part resembling that of certain madrepores and millepores. *Isis ochracea*, and *Isis Hippuris*, are formed of regularly organised membranaceous, cartilaginous, and horny substances, hardened in the latter, merely by carbonate of lime, and in the former, by the addition of a very small portion of phosphate of lime. *Gorgonia nobilis* holds also a small portion of phosphate, but its membranaceous part is in two states, the interior being gelatinous, and the external a membrane completely formed. *Gorgonia ceratophyta*, *flabellum*, *suberosa*, *pectinata*, and *setosa*, consist of two parts, the horny stems and the cortical substance. The horny substance of the stems is found to contain a quantity of phosphate of lime, but scarcely any trace of carbonate, and by maceration in diluted nitric acid, this substance becomes soft and transparent, resembling a cartilaginous body; the cortical part, on the contrary, consists principally of carbonate of lime, with little or none of the phosphate, and is deposited on a soft, flexible membranaceous substance, which seems much to approach to the nature of cuticle. *Gorgonia antipathes* was found to be entirely formed of a fibrous membrane; and the *black, shining gorgonia*, afforded by maceration a beautiful specimen of membranes, concentrically arranged. A *gorgonia* resembling the *antipathes*, and similar to it in the membranaceous part, held so large a portion of phosphate of lime, as to approach to the nature of stag's or buck's horn. SPONGES appear to be completely formed, by a membranaceous substance, resembling that of the horny stems of the gorgoniæ, varying in construction rather than in composition. *Alcyonium asbestinum, ficus*, and *arboreum* are found to be composed of a membranaceous part, similar to the cortical part of some of the *gorgonia*, and, in like manner, slightly hardened by carbonate, with a small portion of phosphate of lime.

It appears, therefore, that the varieties of bone, shell, coral, and the numerous tribe of zoophytes, only differ in composition, by the nature and quantity of the hardening, or ossifying principle, and by the state of the substance with which it is mixed or connected. For the gluten or jelly which cements the particles of carbonate or phosphate of lime, and the membrane, cartilage, or horny substance, which serves as a basis, in and upon which the ossifying matter is secreted and deposited, seem to be only modifications of the same substance, which progressively graduates from a viscid liquid or gluten, into that gelatinous substance which has so often been noticed; and which again, by increased inspissation, and by the various and more or less perfect degrees of organic arrangement, forms the varieties of membrane, cartilage, and horn.

The membranaceous part of all these substances, shells, madrepores, *flustra*, &c. was dissolved in lixivium of caustic pot-ash, and formed animal soap.—*Philos. Trans.* 1800.

XXII. SYNOVIA appears to contain water, albumen, muriate of soda, carbonate of soda, and phosphate of lime; the latter, Mr. *Hatchett* found, but in a small quantity, 480 grains not yielding more than one grain. It can therefore be hardly considered as one of its constituent principles.

Margueron believes part of the albumen to exist in the synovia, *in a peculiar state.* *Fourcroy* is of opinion, that what he thus describes is an *animal substance of a peculiar nature*, not yet described.

XXIII. Tears are secreted by the lachrymal glands, and are chiefly composed of a peculiar kind of mucilage, muriate of soda, phosphate of lime, phosphate of soda, and soda in a free and apparently caustic state.—*Jacquin.*

XXIV. Mucus of the Schneiderian membrane. At its first secretion is analogous to the tears, but changes by remaining in the nose, probably from the oxygen it imbibes from the inspired air, and the carbonic acid of the expired air, saturating the free soda.

XXV. Saliva is secreted by its appropriate glands in the neighbourhood of the mouth; it does not appear to differ in its constituent parts from mucus, except in containing a greater quantity of water; and some phosphate from which concretions are sometimes formed in the ducts or glands, and perhaps the tartar on the teeth, both being of a bony nature.—*Fourcroy.*

XXVI. Cerumen, according to *Vauquelin*, is composed of an albuminous mucilage, with a fat oil and colouring matter, both much resembling what is contained in bile.

XXVII. Pus is secreted from vessels which are under the influence of some morbid change. It appears by its analysis to differ very little in its constituent parts from mucus: it is, however, said to undergo the acid fermentation, while the former becomes putrid. (*Salmuth.*) Mixed with an equal quantity of a saturated solution of carbonated pot-ash, pus, it is said, will disengage a transparent tenacious jelly, but that mucus will not.

XXVIII. Semen, in 1000 parts, appears to contain water, 900; animal mucilage, 60; soda, 10; and phosphate of lime, 30 parts: the latter crystallizing during evaporation in the air, and the soda by attracting carbonic acid being rendered a carbonate of soda. It has a peculiar smell and acrid taste, and changes violets green. When fresh, it it quite insoluble in water, but afterwards combines easily with it. After its discharge, it becomes more opaque and consistent, but in a few hours it becomes even more clear and fluid than before, and in a few days deposits rhomboidal and foliated crystals of phosphate of lime.

XXIX. Sweat. Its smell and taste varies much in different subjects; in general, it changes blue vegetable juices red; this property is said to be chiefly possessed by the sweat of gouty persons, and to be occasioned by the presence of phosphoric acid.

XXX. Liquor of the amnios. This, by the analysis of *Buniva* and *Vauquelin*, appears to differ considerably in women and in cows. In the former, albuminous matter, soda, muriate of soda, and phosphate of lime, is contained in the proportion of 0,012 only, in water. It deposits on the body of the fœtus a cheese-like matter, which is not acted on by oils, or by alcohol; appearing to be a mixture of animal mucilage and fat, formed, in their opinion, by a degeneration of the albuminous matter, which assumes the character of fat, in the same manner as happens to fœtuses detained in the uterus beyond the natural period. This liquor in cows differs from that of women in its taste, colour, specific gravity, and greater degree of viscosity. It contains a peculiar animal matter, soluble in water, and insoluble in alcohol; not convertible into jelly like animal mucilage, nor combining with tannin, ammonia, prussic acid, or empyreumatic oil, like the vegetable mucilage. They also ascertained that it contained an acid of a particular nature, which they term the amniotic acid. Unlike the *saccholactic* it yields ammonia by distillation, and unlike the *uric* it is soluble in boiling alcohol, and crystallizes in long, white, and shining needles.—*Ann. de Chim.* No. 99.

XXXI. The zoonic acid is a new acid discovered by *Berthollet.* The fluid obtained by distillation from animal substances, has been hitherto thought to contain no other principle than carbonate of ammonia and an oil. *Berthollet* has ascertained that it contains an acid, which he names zoonic acid. He has obtained it from bones, woollen rags, &c. also from the gluten of wheat, and the yeast of beer. To obtain it, after separating the oil from the liquor yielded by the destructive distillation, he adds lime to this liquor, then separates the carbonate of ammonia by a boiling heat, and adds more lime; thus obtaining the zoonate of lime. By distilling a mixture of phosphoric acid with the zoonate of lime, he obtains the pure zoonic acid.

The zoonic acid smells like meat which has been roasted; a process, in which indeed it is formed. It is of an austere taste, reddens turnsole, and effervesces with alkaline carbonates. It has a stronger attraction to the oxides of mercury and lead, respectively, than the acetic and nitric acids. The ZOONATE OF POT-ASH calcined does not form a prussiate of iron, with a solution of that metal.—*Ann. de Chim.* xxvi.

Tromsdorff thinks this acid of *Berthollet*, which he imagined to partake of both an animal and vegetable nature, is analogous to the sebacic acid.

Thenard conceives it to be only a peculiar combination of acetic acid with animal matter.

XXXII. The FORMIC ACID, or the *acid of ants*, exists in so disengaged a state, that the transpiration of these animals, and their simple contact proves its existence. The large red ant furnishes the greatest quantity, and seems to be most replete with it in the months of June and July, when its merely passing over blue paper, is sufficient to turn it red. This acid may be obtained by simple distillation, only mixed with a small quantity of empyreumatic oil, from which it may be separated by a funnel. Its specific gravity being to that of water, as 1,0075 to 1,0000: when exceedingly pure, it is as 1,0453 to 1. It may also be obtained by lixivation, washing the ants first in cold, and then in boiling water, until all the acid is procured. It may likewise be obtained in a FORMIATE OF POT-ASH, or of SODA, by placing linen cloths impregnated with an alkali in an ant-hill. It affects the nose and eyes in a peculiar, but not disagreeable manner. When pure, its taste is burning and penetrating; but agreeable, when diluted with water. It possesses all the characters of acids. When boiled with *sulphuric acid*, the mixture blackens, white penetrating vapours arise, and a gas is disengaged, which unites difficultly with distilled water, or lime water; the formic acid being hereby decomposed, for it is obtained in less quantity. The *nitric acid* distilled from it destroys it completely; a gas rising which renders lime-water turbid, and is difficultly and sparingly soluble in water. The *muriatic* only mixes with it, but the *oxy-muriatic acid* decomposes it. It unites perfectly with *spirit of wine*, but difficultly, even with heat, with the *fixed* or *volatile oils*. The order of its affinities seems to be baryt, pot-ash, soda, lime, magnesia, ammonia, zinc, manganese, iron, lead, tin, cobalt, copper, nickel, bismuth, silver, alumine, essential oils, water. It appears to be very analogous to the acetic acid. *(Ardvidson and Oeihn)*. An acid may likewise be obtained from the *millepedes. (Lister.)* From the fluid rejected by the *great forked tail caterpillar of the willow. (Bonnet.)*—From *grasshoppers*, the *may-bug*, the *lampyris*, and *silk-worm*. The acid is extracted by digesting the subject of experiment in alcohol, which dissolves the acid, and precipitates the foreign animal matters.

XXXIII. The EGGS OF BIRDS consist of an osseous covering called the shell, a membrane, the albumen or the white, and the yolk. The shell, like bones, contains a gelatinous principle, with the carbonate and the phosphate of lime. The white, which is in two layers, is of the same nature as the serum of blood: heat coagulates it, so do acids and alcohol. By distillation it affords water, carbonate of ammonia, and empyreumatic oil, a coal remaining in the retort which yields soda and phosphate of lime. That eggs contain *sulphur* is evident from the disengagement of sulphuretted hydrogen gas, manifested by its blackening silver, as soon as it comes in contact with the moisture of the mouth. Sulphur has also been said to have been obtained from it by sublimation. *(Deyeur.)* The yolk of eggs also contains a lymphatic substance, mixed with a certain quantity of mild oil, which, on account of this mixture, is soluble in water.

XXXIV. WOOL is but little acted on by water, even boiling; nor have the acids any particular action on it, except the nitric, which separates from it nitrogen gas, oxalic acid, and an oily matter. The caustic alkalies dissolve it intirely in a saponaceous form. It appears to be a semi-oily substance, highly hydrogenated, and is directly reduced to an oily state by the separation of its nitrogen.

XXXV. SCALES OF FISHES are formed of gelatin, and contain a beautiful pearl colouring matter. This is employed to form artificial pearls: the scales are rubbed off from the bleak *(cyprinus albula)* in which it is very brilliant; they are then dried and put into liquid ammonia, and diffused over the internal surface of small glass bubbles. This substance thus obtained is called *oriental essence of* PEARLS.

XXXVI. The HAIR and BRISTLES of animals differ both from the bones and white animal soft parts, containing less jelly, fat, and lymph; and appear most to resemble the structure and composition of horn.

XXXVII. FEATHERS appear to differ chiefly, chemically considered, from the foregoing substances in containing a still smaller proportion of fat and jelly. The quills, however, approach more to the nature of horn.

XXXVIII. SILK, and the web of other caterpillars much resemble wool in their chemical properties. *Welter* treated silk with the nitric acid, to obtain oxalic acid: when obtained he returned it, with some water and the contents of the receiver, into the retort, and by several distillations procured a *silky salt* of a golden yellow colour, which acted as gunpowder on the contact of an ignited body. Its crystals are octahedrous and of a bitter taste. He also found, in animal substances, another peculiar kind of matter, colourless, soluble in concentrated nitric acid, and precipitable by water.—*Phil. Journal, Sept.* 1799.

XXXIX. CANTHARIDES are insects which, applied in fine powder to the epidermis, cause blisters and excite heat in the urine, with strangury. They produce the same effects on the urinary passage, taken internally in small doses. Water extracts from them a reddish bitter extract, and a yellowish oily matter; and ether takes up a green, very acrid oil, in which the virtues of the cantharides most eminently reside. To form a tincture, which unites all the properties of the cantharides, equal parts of alcohol and water must be employed: if spirit of wine alone be used, it takes up only the caustic part.

XL. MILLEPEDES, *aselli, porcelli, woodlice*. These yield, by distillation, an insipid or alkaline phlegm, the residue affording an extractive matter, an oily waxy substance, soluble in spirit of wine only, and a muriate, with an earthy and an alkaline base.

XLI. COCHINEAL. These insects are more especially used in dyeing; their colour takes readily upon wool: the most suitable mordant is the muriate of tin. Florence lake is formed by precipitation, by fixed alkalies, of the colouring matter, and of alumine from a decoction of cochineal in sulphate of alumine.

XLII. AMBERGRIS is a light ash-coloured body, chiefly found on the sea-shores in the East Indies. It yields a grateful smell, softens with heat, and affords, by distillation, an acid and an oil, very similar to that of amber.

Ambergris has been found in the intestines of a whale, and has been also expelled by the fundament. It is found most commonly in sickly fish, and is supposed to be the cause or effect of disease. —*Phil. Trans.* 1791.

XLIII. Lac, or gum lac, is a kind of wax collected by red-winged ants from flowers in the East Indies, which they transport to the small branches of the tree where they make their nests. The Hindoos have six names for lac; but they generally call it Lácshà, from the multitude of small insects, which, as they believe, discharge it from their stomachs on the tree, on which they form their colonies. The Lácshà, or Lac insect, is a genus in the class of Hemiptera. The *chermes lacca* is always found on the branches of the *mimosa glauca*, or *mimosa cinerea*, or on a new species called by the Gentoos *conda corinda.—Dr. W. Roxburgh, Phil. Trans.* 1790.

XLIV. The human excrements, *Vauquelin* is convinced, are constantly acid, and very susceptible of fermentation, by which their acidity is augmented: but that, nevertheless, the formation of ammonia succeeds to this acidity, and continues until their complete decomposition is effected.

In the excrements of fowls are found carbonate, phosphate of lime, and silex. In the oats, on which they feed, exist silex and phosphate of lime, but not in a quantity nearly equal to what is found in the eggs and excrements; and although they appear to pick up stones indiscriminately, they prefer flint; hence it becomes difficult to ascertain whence this excess of lime is obtained. *Fourcroy* discovering that the excrement, at the same time, contains a less proportion of silex than the oats did on which the fowl had been nourished, asks—'*Ought we to conclude that the silex has served to furnish the excess of the lime?*'

The intestinal gases appear to vary with the state of the intestines; when digestion proceeds regularly, carbonic acid gas appears to be evolved; but when this, as well as the action of the intestines, is disturbed, sulphuretted hydrogen and carburetted hydrogen are separated. If a lighted taper be applied to the vapour which escapes from the punctured intestines of a cow, distended with flatus, it will directly inflame it.

OF ANIMAL PUTREFACTION.

Every animal body, when deprived of life, suffers a gradual decomposition or resolution, which is effected chiefly by the access of air, aided by a due degree of moisture and of heat. Its colour first becomes pale; its consistence diminishes, its texture is relaxed, and a faint and disagreeable smell is emitted. The colour at this time changes to blue and green, the parts become more and more softened, the smell becomes fetid, and the colour of an obscure brown. The fibres now yield, the texture is more resolved, the putrid and nauseous smell is mixed with a smell of a more penetrating kind, arising from the disengagement of ammoniacal gas; after this the mass becomes of still less and less consistence, the smell more faint and nauseous, and the effluvia exceedingly active and injurious; arising, it has been said, from the separation of phosphuretted and carburetted hydrogen gas; a separation of phosphoric light taking place at the same time. When it has continued in this state some time, the mass again swells up, and carbonic acid gas is separated; this part of the process is protracted for some time, when it changes into a soft putrid mass.

A great part of the hydrogen, and the remaining carbon, with the other fixed radicals, now gradually form a dark, brown, soft, earthy matter. This result forms *soil*, which, mixed with *mould*, the remains of vegetable putrefaction, forms the common receptacle for the roots, and germinating seeds of vegetables.

When this resolution takes place at the same time with vegetable matter, as in marshes, some portion of the hydrogen and phosphorus produces the *ignes fatui*, and such luminous appearances. If this resolution is accomplished in a confined place a foul *musty* smell is discoverable.

Heat, moisture, and the access of air should be avoided if it be intended to prevent this process from taking place. In one or other of these modes the various antiseptic processes act, such as covering with resins and balsams, drying, salting, and smoking, immersion in spirits, freezing water, &c.

ELECTRICITY.

The electric fluid, the active influence of which is such as to manifest itself in many of nature's grandest processes, and to be suspected in many others where positive proof of its agency is wanting, demands our particular notice.

The particles of this fluid are supposed to repel each other, and to attract and be attracted by the particles of other bodies, with a force diminishing as the distances increase. This fluid is supposed to pass through the pores of some bodies with ease and velocity; these bodies are, therefore, called *CONDUCTORS*: whilst it is incapable of passing through others, which are, therefore, called *NON-CONDUCTORS*. Metals, charcoal, fluid acids, water, and moist animal or vegetable substances, possess the property of conducting this fluid in a high degree. Glass, wax, resin, sulphur, phosphoruses, oils, dry gases, and the solid compounds containing earths only, or alkaline substances, are among the non-conductors.

It is capable not only of being transferred from one body to another, but even of being accumulated in one, whilst the proportion of it in another body is thereby proportionally diminished. In the former of these cases, the body is said to be *positively*, and in the latter *negatively* electrified.

Its chemical powers are very considerable; by its aid, *oxygen* and *nitrogen* are made to unite and form *nitric acid*. *Water* is decomposed by it into *oxygen* and *hydrogen*, and *ammonia* into *nitrogen* and *hydrogen*.

The electric fluid is excited into a state of activity by the friction of two non-conductors, or of a conductor and a non-conductor. It is also excited by change of temperature, and most probably, every change of aggregation, if attended to, would manifest the marks of an alteration taking place in the quantity of this fluid.

Its presence, in different substances, is generally indicated by their attracting or repelling light bodies, on being subjected to friction. Lightning, thunder, aurora borealis, and various other meteorological phenomena, show the importance of this fluid in some of the grandest operations of nature.

GALVANISM.

Galvanism embraces the phenomena which result from different conductors of electricity being placed under different circumstances of contact.

The conductors must be either perfect, or imperfect conductors of electricity; and the galvanic phenomena may be produced by two conductors of one of these classes placed in contact with each other, in one or more points, and in other distinct points with a conductor of the other class: thus gold and zinc may be made to touch each other in some points, and may be connected in other points, by a portion of common water. To produce the galvanic phenomena with any considerable effect, several series of conductors, thus disposed, should be employed. Then, not only may an acid taste, a flash of light, the contractions of muscles just detached from a living body, the oxidizement of metals, and the decomposition of acids and of water, be produced; but shocks on the human body analogous to the electric shock, and brilliant sparks, with the deflagration of even silver and gold, may also be occasioned by this fluid, under certain circumstances.

Galvani discovered, in 1791, the contraction of detached muscles, by means of this fluid. He thought it to be the consequence of the forming of an equilibrium of the galvanic fluid, between the interior and exterior of the muscle, he supposing the former to be charged *plus*.

Volta, in 1793, denied this hypothesis, and supposed the effects to be caused merely by a small quantity of electricity being excited by the action of two different metals on each other, which stimulates the limb, which by its preparation is rendered exceedingly sensible of this species of irritation. He found it affected only such animals as had distinct limbs, and only such muscles as are subject to the will. By the application of a plate of silver on one side, and of zinc on the other side of the tongue, and then bringing them in contact at one point, he found an acid taste was produced.

Valli, in 1793, from these and other phenomena, formed a theory of animal electricity: conceiving that, in these cases, the metals effected an equilibrium in parts charged with different quantities of the fluid.

Dr. *Fowler* refuted this theory, and doubted the identity of the fluid by which galvanic and electric phenomena were produced. He first discovered a flash of light, perceived as in the eye, when it was subjected to this influence.

Dr. *Robison* discovered the increase of this power in a pile composed of alternate pieces of zinc and silver.

Dr. *Darwin*, in 1794, regarded the phenomena of galvanism as electrical, and accounted for the muscular contractions by the extreme sensibility of the nerves to this particular stimulus.

Mr. *Bennet*, in 1789, had discovered that a separate plate of zinc is in a *minus* state, and one of silver in a *plus* state; on being brought nearly together therefore, a small plate of air becomes charged like a Leyden phial.

Dr. *Wells*, in 1795, found that one metal and charcoal produced the effects as well as two metals, and that contractions could be excited by one metal, when it had been rubbed upon another metal, or even upon the hand. He found that charcoal might, by the same means, be made to produce the same effects; and although he does not allow any electricity to be thus excited, either in the charcoal or the metal; he believes that the phenomena are electrical, since the influence is conducted by conductors of electricity only.

Fabroni, in *Nicholson's* Journal for 1800, noticing the oxidizement of metals, whilst under this influence, concluded it to be a chemical phenomenon merely. In this year, *Volta* announced his discovery of the galvanic pile, formed by plates of two different metals, as zinc and silver, disposed alternately with moistened pasteboard between them. By connecting the ends of the pile by the hands, he obtained a strong shock, and produced many curious experiments.

Mr. *Nicholson*, in the same year, employed much of his ingenuity in examining these phenomena, and devoted a considerable portion of his excellent journal to their investigation. By making a tube of water form part of the line connecting the two ends of the pile, he found from the wire passing into the water from the silver end, hydrogen separated; whilst the other, if an oxidable metal, became oxidized, but, if platina, he found oxygen was evolved. Thus was ascertained its *chemical action, and its powers of decomposing water.*

Mr. *Carlisle* assisted Mr. *Nicholson* in these experiments, and these gentlemen discovered the electricity to be *minus* in the silver end, and *plus* in the zinc end of the pile; and distinctly saw the spark.

Mr. *Cruickshank* confirmed the observations derived from these experiments, by subjecting to the influence of the two wires, various chemical tests. Mr. *W. Henry* proceeded still farther, by thus producing the decomposition of sulphuric, nitric, oxygenized muriatic acids and ammonia.

Col. *Haldane*, about this time, ascertained that the effects of the galvanic pile were suspended, if it was immersed in water, or placed in *vacuo*; and from its not acquiring an increase of power by a connection with the electrical machine, he concluded that its effects are not referable to electricity. The Colonel also discovered that the effects were increased in oxygen, but suspended in nitrogen.

Mr. *Cruickshank* proposed the disposal of the plates in a trough, as more convenient and efficient.

Mr. *Davy* found the gases were produced when the wires were made to terminate in two portions of water, kept distinct from each other. By connecting the ends of the pile with two glasses of water, by pieces of muscular fibre, and connecting the glasses also by a single intermediate wire, the effects of the pile were reversed, at the zinc end hydrogen, and at the silver end oxygen being disengaged.

Mr. *Cruickshank* found that a small portion of oxygen and of ammonia was mixed with the hydrogen discharged from the wire of the silver end; and when the wire at the zinc end was not oxidizable with the oxygen gas, a little nitrogen and nitrous acid were evolved. He discovered that the influence of the pile was capable of being transmitted through charcoal, from an apparatus formed of this substance and silver, from the silver end carbon being disengaged with the hydrogen, and from the other end little gas of any kind; he supposing carbonic acid to be formed, which became directly absorbed. He found that pure water is ineffectual in the pile, and supposed the effects to be produced in proportion to the degree of oxidizement of the zinc. Thus sulphuric acid he found less powerful than when it was diluted, its oxidizing effects being thereby increased; and nitric acid still more powerful than either. He found, by the aid of a little acid, the pile would act in *vacuo;* and that a pile of zinc and charcoal was found to possess great energy.

Mr. *Cruickshank*, about this time, charged the Leyden phial by means of the galvanic pile.

Mr. *Davy* constructed a pile with one metal only, employing fluids of different conducting powers.

Tromsdorff and Mr. *Pepys* consumed pieces of gold leaf by the spark, and Mr. *Cruickshank* discovered the silver end emitted a brush-like emanation, indicating a *plus* state, and the zinc end a dense spark, shewing a *minus* state.

Guyton and *Biot* have found that the absorption of the oxygen of the air, by the pile, is very considerable. *Garthenet* has made effective galvanic piles, without any metallic substance whatever.

Fourcroy discovered that combustion took place in proportion to the quantity of surface, and that the shock was in proportion to the number of the plates.

Dr. *Wollaston*, agreeable to Mr. *Davy's* remark, found the galvanic effects proportioned to the degrees of oxidizement. A piece of silver and of zinc being placed in diluted sulphuric acid, but not in contact, the zinc only was acted on, and yielded hydrogen: but on being brought into contact, the silver was also acted on in the same manner. During the action of acids on metals, he concludes that electricity is disengaged, and observes that the amalgam employed in electrical machines becomes oxidized, as electricity is generated. The Doctor concludes with Mr. *Nicholson*, that it differs from electricity, only by existing in a state of low intensity. The Doctor first discovered that, by taking a spark between two silver wires, connected with the two conductors of an electrical machine, through a solution of copper, the copper became reduced at the end of the negative wire.

Mr. *Davy's* next important discovery was, that the pile might be formed by pieces of charcoal only, their different sides being exposed to the action of different fluids.

Dr. *Van Marum* charged even batteries from the pile, and found many points of resemblance between the galvanic and electric influence; and observed, with *Fourcroy*, that the facility of combustion agreed with the size of the plates.

Dr. *Priestley*, with his accustomed assiduity and well-known intelligence, has furnished some interesting experiments. The *Philosophical Magazine* of Mr. *Tilloch* contains some useful observations on this curious subject.

Dr. *Bostock*, of whose compendious history of galvanism, contained in Mr. *Nicholson's Journal*, the above is a slight sketch, ingeniously endeavours thus to account for the phenomena. He conceives that the electric fluid is separated during oxidizement, and that it has a strong attraction for hydrogen, with which it combines, when passing through water from an oxidizable substance, and from which it is again separated when it returns to the oxidizable conductor. At the zinc or plus end, he supposes the water to be decomposed, the oxygen either escaping or combining with the wire, if ozidizable, in consequence of the hydrogen being attracted by the electric fluid, which is thereby enabled to pass through the water; but on the arrival of this compound at the other wire, the electricity is received by it, and the hydrogen, if it be in water, is separated in a gaseous form, and, if it be in a metallic solution, it unites with, and reduces the metal. In the pile he supposes repetitions of this process to take place, by which the electric matter becomes accumulated in increasing degrees of quantity and power, in each successive pair of plates.

Guyton described an ore of antimony, in which the metal was in a state of oxide, having passed from sulphuret to oxide without change of form. This he supposed to have been accomplished by the decomposition of water, by which the oxygen would be furnished, whilst the sulphur would be removed by the hydrogen. This change he supposes to have been the result of affinities put into action by the *galvanic* fluid.—1801.

TABLE OF SOME GALVANIC CIRCLES,

Composed of two perfect Conductors and one imperfect Conductor.

More oxidizable substances.	Less oxidizable substances.	Oxidizing fluids.
Zinc.	With gold, charcoal, silver, copper, tin, iron, mercury.	Solutions of nitric acid in water, of muriatic acid, sulphuric acid, &c. Water holding in solution, oxygen, atmospheric air, &c.
Iron.	...... gold, charcoal, silver, copper, tin.	
Tin.	...... gold, silver, charcoal.	
Lead.	...... gold, silver.	
Copper.	...... gold, silver.	Solution of nitrate of silver and mercury. Nitric acid, acetic acid.
Silver.	...... gold.	Nitric acid.

TABLE OF SOME GALVANIC CIRCLES,

Composed of two imperfect Conductors and one perfect Conductor.

Perfect Conductors.	Imperfect Conductors.	Imperfect Conductors.
Charcoal. Copper. Silver. Lead. Tin. Iron. Zinc.	Solutions of hydroguretted alkaline sulphurets, capable of acting on the first three metals, but not on the last three.	Solutions of nitrous acid, oxygenized muriatic acid, &c. capable of acting on all the metals.

Mr. Davy's Syllabus of a Course of Lectures.

TABLE OF EXPANSION OF GASES.

From Du Vernois and Prony.

Tempe-rature.	Hydro-gen gas.	Nitrous gas.	Carbonic acid gas.	Air.	Oxygen gas.	Ammo-nial gas.	Nitrogen gas.
32°	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
41	1.01746	1.01042	1.01734	1.01109	1.00492	1.03633	1.00326
50	1.03552	1.02202	1.03679	1.02415	1.01146	1.07944	1.00779
59	1.05420	1.03492	1.05861	1.03952	1.02017	1.13059	1.01408
68	1.07352	1.04927	1.08307	1.05760	1.03177	1.19128	1.02284
77	1.09350	1.06523	1.11051	1.07890	1.04720	1.26330	1.03500
86	1.11417	1.08299	1.14129	1.10397	1.06775	1.34876	1.05192
95	1.13554	1.10695	1.17580	1.13347	1.09510	1.45017	1.07010
104	1.15764	1.12471	1.21452	1.17585	1.13151	1.57050	1.10814
113	1.18050	1.14915	1.25793	1.20908	1.17998	1.71328	1.15360
122	1.20414	1.17634	1.30663	1.25720	1.24450	1.82270	1.21680
131	1.22860	1.20659	1.36125	1.31385	1.33039	2.08384	1.30468
140	1.25389	1.24023	1.42250	1.38052	1.44473	2.32230	1.42685
149	1.28004	1.27766	1.49121	1.45901	1.59692	2.60536	1.59669
158	1.30709	1.31929	1.56826	1.55139	1.79953	2.94125	1.83283
167	1.33507	1.36560	1.65468	1.66014	2.06923	3.33982	2.16113
176	1.36401	1.41712	1.75161	1.78814	2.42825	3.81275	2.61656
185	1.39793	1.47443	1.86032	1.93882	2.90619	4.37393	3.25214
194	1.42488	1.53818	1.98224	2.11618	3.54238	5.03983	4.13438
203	1.45689	1.60909	2.11899	2.32495	4.38928	5.82299	5.36095
212	1.49000	1.68798	2.27236	2.57069	5.51666	6.76759	7.06623

TABLE OF COMPONENT PARTS OF

NITRIC ACID AND OF NITROUS ACID,

Of different Colours and Densities.

100 Parts.	Sp. Gra.	Component Parts.		
		Nitric Acid.	Water.	Nitrous Gas.
Solid nitric acid	1.504	91.55	8.45	——
Yellow nitrous	1.502	90.5	8.3	2
Bright yellow	1.500	88.94	8.10	2.96
Dark orange	1.480	86.84	7.6	5.56
Light olive	1.479	86.00	7.55	6.45
Dark olive	1.478	85.4	7.5	7.1
Bright green	1.476	84.8	7.44	7.76
Blue green	1.475	84.6	7.4	8.00

Davy's Researches, p. 37.

TABLE OF THE COMPOSITION OF SALTS. *(By Mr. KIRWAN.)*

COMPONENT PARTS.

Salts.	Basis.	Acid.	Water.	State.
Carbonate of pot-ash	41.	43.	16.	Crystallized.
Pearl-ash	60.	30.	6.	Dry.
Carbonate of soda	21.58	14.42	64.	Fully crystallized.
ditto	59.86	40.05		Desiccated.
barytes	78.	22.		Natural or ignited.
strontian	69.5	30.		Natural or ignited.
lime	55.	45.		Natural if pure, or artificial ignited.
magnesia	25.	50.	25.	Crystallized.
common do	45.	34.	21.	Dried at 80°.
Sulphate of pot-ash	54.8	45.2		Dry.
soda	18.48	23.52	58.	Fully crystallized.
ditto	44.	56.		Desiccated at 700°.
ammonia	14.24	54.66	31.1	
barytes	66.66	33.33		Natural and pure, artificial ignited.
strontian	58.	42.		Natural and pure, artificial ignited.
lime	32.	46.	22.	Dried at 66°.
ditto	35.23	50.39	14.38	Dried at 170°.
ditto	38.81	55.84	5.35	Ignited.
ditto	41.	59.		Incandescent.
magnesia	17.	29.35	53.65	Fully crystallized.
ditto	36.68	63.32		Desiccated.
Alum	12. ignited	17.66	51. of crystals. + 19.24 in the earth.	Crystallized.
Ditto	63.75	36.25		Desiccated at 700°.

TABLE OF THE COMPOSITION OF SALTS, *continued.*

COMPONENT PARTS.

Salts.	Basis.	Acid.	Water.	State.
Nitrate of potash	51.8	44.	4.2 of Composition	Dried at 70°
soda	40.58	53,21	6.21 of Composition	Dried at 400°.
ditto	42.34	57.55		Ignited.
ammonia	23.	57.	20.	
barytes	57.	32.	11.	Crystallized.
strontian	36.21	31.07	32.72	Crystallized.
lime	32.	57.44	10.56	Well dried, that is, in Air.
magnesia	22.	46.	22.	Crystallized.
Muriate of potash	64.	36.		Dried at 80°.
soda	53.	47. aqueous, 38.88 real		Dried at 80°.
ammonia				Crystallized.
ditto	25.	42.75	32.25	Sublimed.
barytes	64.	20.	16.	Crystallized.
ditto	76.2	23.8		Desiccated.
strontian	40.	18.	42.	Crystallized.
ditto	69.	31.		Desiccated.
lime	50.	42.	8.	Red hot.
magnesia	31.07	34.59.	34.34.	Sensibly dry.

TABLE OF SALTS,

Which are incompatible with each other, in water, except in very minute proportions.

Extracted from *Kirwan* on Mineral Waters, *passim*, by Dr. *Thompson*, in his excellent System of Chemistry.

SALTS.	INCOMPATIBLE WITH
1. Fixed alkaline sulphates	Nitrates of lime and magnesia, Muriates of lime and magnesia.
2. Sulphate of lime	Alkalies, Carbonate of magnesia, Muriate of barytes.
3. Alum	Alkalies, Muriate of barytes, Nitrate, muriate, carbonate of lime, Carbonate of magnesia.
4. Sulphate of magnesia	Alkalies, Muriate of barytes, Nitrate and muriate of lime.
5. Sulphate of iron	Alkalies, Muriate of barytes, Earthy carbonates.
6. Muriate of barytes	Sulphates, Alkaline carbonates, Earthy carbonates.
7. Muriate of lime	Sulphates, except of lime, Alkaline carbonates, Carbonate of magnesia.
8. Muriate of magnesia	Alkaline carbonates, Alkaline sulphates.
9. Nitrate of lime	Alkaline carbonates, Carbonates of magnesia and alumine, Sulphates, except of lime.

TABLE OF THE RELATIVE PROPORTIONS OF THE GALLIC ACID IN DIFFERENT PLANTS.

By Mr. Biggin.

Elm	7	Sallow	8
Oak cut in winter	8	Mountain ash	8
Horse chesnut	6	Poplar	8
Beech	7	Hazel	9
Willow (boughs)	8	Ash	10
Elder	4	Spanish chesnut	10
Plumb tree	8	Smooth oak	10
Willow (trunk)	9	Oak cut in spring	10
Sycamore	6	Huntingdon or Leicester Willow	10
Birch	4		
Cherry tree	8	Sumach	14

A TABLE,

Shewing at one View the Degrees in which the Metals possess their Brilliancy and other physical Properties.

Group	Metal	Brilliancy.	Specific Gravity.	Hardness.	Ductility.	Tenacity.	Degrees of Therm. and Pyrom. at which they fuse.
The most ductile, and most difficultly oxidized.	1 Platina	1	20, 85	2	2	3	160—*x. pyr.*
	2 Gold	5	19,258	5	1	5	32. *pyr.*
	3 Silver	3	10,474	4	3	4	28. *pyr.*
Ductile and easily oxidized.	4 Copper	6	7,788	3	6	2	27. *pyr.*
	5 Iron	2 as steel	7,6	1	4	1	130. *pyr.*
	6 Lead	11	11 352	7	7	7	
Oxidizable, but slightly ductile.	7 Tin	7	7,291	6	5	6	168+0. *th.*
	8 Mercury......	4	13,568	—	9	—	31—0. *th.*
	9 Zinc	8	7, 19	5	8	—	296+0. *th.*
Fragile and oxidizable.	10 Tellurium	—	—	—	—	—	
	11 Antimony ...	9	6,702	7	14	—	345+0. *th.*
	12 Bismuth	10	9,822	3	12	—	205+0. *th.*
	13 Manganese ..	—	6, 85	1	15	—	160—*x. pyr.*
	14 Nickel	—	7,807	2	10	—	130. *pyr.*
	15 Cobalt	13	7,811	6	13	—	130. *pyr.*
	16 Uranium......	—	6, 44		16		
	17 Titanium ...	—	—	—	18		
Fragile and acidifiable.	18 Chrome	—	—	—	19		
	19 Molybdenum	—	—	—	17		
	20 Tungstein....	—	17, 6	5	11		
	21 Arsenic	12	5,763	8	20		
	22 Columbium ..						

The higher degrees of brilliancy, hardness, ductility, and tenacity, are signified by the lower numbers. Thus platina is marked as possessing the first and highest degree of brilliancy.

A TABLE OF THE PROPORTION OF

THE CONSTITUENT PARTS OF THE BONES,

And other Hard Parts, of various Animals.

	Gelatinous Matter.	Phosphate of Lime.	Carbonate of Lime.
Dry Human bones	23	67	2
Bones of the Ox	3	93	2
——— Calf	25	54	traces of it
——— Horse	9	67,5	1,25
——— Sheep	16	70	0,5
——— Elk	1,5	90	1
——— Hog	17	52	1
——— Hare	9	85	1
——— Hen	6	72	1,5
——— Pike	12	64	1
——— Carp	6	45	0,5
——— Viper	21,5	60,5	0,5
——— Cuttle Fish	8	0	68
Teeth of the Horse	12	85,5	0,25
——— Elephant, or Ivory	24	64	0,1
Horns of the Stag	27	57,5	1
Egg Shells	3	2	72
Lobster Shells	18	14	40
Mother of Pearl	2,5	0	66
Crabs Eyes	2	12	60
White Coral	1,5	0	50
Red ditto	0,5	0	53,5
Articulated Coralline	7,5	0	49

The difference to make up 100 parts, is to be reckoned as loss in water, &c.—*Ann. de Chim. Merat. Guillot.* 1800.

TABLE

Of the Quantity of real ACID *taken up by mere Alkalies and Earths.*

MR. KIRWAN.

100 parts.	Sulphuric.	Nitrous.	Muriatic.	Carbonic Acid.
Pot-ash.	82,48	84,96	56,3	105, almost.
Soda.	127,68	135,71	73,41	66,8.
Ammonia.	383,8	247,82	171,	Variable.
Baryt.	50,	56,	31,8	282.
Strontia.	72,41	85,56	46,	43,2.
Lime.	143,	179,5	84,488	81,81.
Magnesia.	172,64	210,	111,35	200, *Fourcroy.*
Alumine.	150,9			335, nearly, *Bergman.*

TABLE

Of the Quantity of ALKALIES *and* EARTHS *taken up by* 100 *Parts of real Sulphuric, Nitrous, Muriatic, and Carbonic* ACIDS, *saturated.*

MR. KIRWAN.

100 parts.	Pot-ash.	Soda.	Ammonia.	Baryt.	Strontia.	Lime.	Mag.
Sulphuric.	121,48	78,32	26,05	200,	138,	70,	57,92
Nitrous.	117,7	73, 3	40,35	178,12	116,86	55,7	47,64
Muriatic.	177,6	136,2	58,48	314,46	216,21	118,3	898,
Carbonic.	95,1	149,6		354,5	231, +	122,	50,

A TABLE, SHEWING THE

POWERS OF DIFFERENT FREEZING MIXTURES.

MIXTURES.	SINK THE THERMOMETER.
Snow, or pounded Ice 1 part, and Common Salt 1 part	From 32° to 0°
Snow 2, Salt 1	From 0° to —5
Snow 1, Salt 5, Nitre and Muriate of Ammonia 5	From —5° to —18°
Snow 12, Salt 5, and Nitrate of Am. 5	From —18° to —25°
Snow and diluted Nitric Acid	From 0° to —46°
Snow 2, dil. Nitric 1, and Sulph. Acid 1	From —10 to —56°
Snow 1, diluted Sulphuric Acid 1	From 20° to —60°
Snow 2, Muriate of Lime 3	From 32° to —50°
Snow 1, Muriate of Lime 2	From 0° to —66°
Snow 1, Muriate of Lime 3	From —40° to —73°
Snow 8, diluted Sulphuric Acid 10	From —68° to —91°
Snow 3, Pot-Ash 4	From 32° to —51°

The materials employed, ought first to be separately cooled, in a freezing mixture, and then mixed together in a similar mixture. The vessels in which the several mixtures are made should be also cooled, as thin as possible, and no larger than necessary. Thus snow and nitric acid being put separately into the first mixture, are cooled to 0°, and mixed together in a vessel plunged in a similar mixture, when the thermometer will sink to —46. *Walker. Phil. Trans.* 1795.

TABLE OF PRECIPITATIONS,

APPARENTLY BY

SINGLE ELECTIVE ATTRACTIONS, FROM BERGMAN;

WITH ALTERATIONS AND ADDITIONS,

BY GEORGE PEARSON, M. D. F.R.S.

1
CALORIC.
In Water.

Oxygen

Æther
Alcohol
Ammonia

Water

Vol. Oils

Glass

Q. Silver

Bases of all Gases

2
OXYGEN.
In Water.

Basis of Muriatic, and various other Acids.

Carbon
Phosphorus
Sulphur
Light ?

Zinc
Copper
Lead
Iron
Silver
Platina
Q. Silver
Gold

Nitrous Gas

Muriatic Acid

Nitrous A.

Sulphuric A.

Manganese Ox. white

Hydrogen

Vol. Oils
Alcohol
Water

In Fire.

Carbon

Zinc

Iron

Hydrogen

Metal-Mang.
Cobalt
Nickel
Lead
Tin
Phosphorus
Copper
Bismuth
Antimony
Q. Silver at 600°
Arsenic
Sugar
Sulphur
Caloric
Gold
Silver
Platina
Q. Silver at above 1000°.
Manganese Ox. white

3
SULPHUR.
In Water.

Oxygen

Molybd. Ox. and Acid
Ox. of Lead
——Tin
——Silver
——Q. Silver
——Arsenic
——Antimony
——Iron
Fixed Alkalies

Barytes
Strontia
Lime
Magnesia
Phosphorus
Fat Oil
Vol. Alkali
Æther
Hydrogen G.?

In Fire.

Fixed Alkali
Oxygen
Iron
Copper
Tin
Lead
Silver
Cobalt ?
Nickel ?
Bismuth
Antimony
Q. Silver
Arsenic
Uranite ?
Molybdena
Sylvanite

4
SALINE SULPHURETS.
In Water.

Oxygen

Ox. of Gold
Silver
Q. Silver
Arsenic
Antimony
Bismuth
Copper
Tin
Lead

Ox. of Nickel
Cobalt
Manganese
Iron
Other Oxides
Carbon
Water
Alcohol
Æther ?

In Fire.

Manganese
Iron

Copper
Tin
Lead

Silver
Gold ?
Antimony
Cobalt
Nickel
Bismuth
Q. Silver ?
Arsenic ?
Carbon

5
SILICA.
In Water.

Fluor A.

Fixed Alkali
Barytes ?
Strontia ?

6
ALUMINE
In Water.

Sulphuric

Nitric

Muriatic

Fluoric
Arsenic
Oxalic
Suberic
Tartarous
Phosphoric

Acetous and other Acids.

Alkalies

Barytes ?
Strontia ?

In Fire.

Phosphoric
Boracic
Arsenic
Sulphuric
Nitric
Muriatic
Fluoric
Sebacic
Succinic
Formic
Lactic
Benzoic
Acetous Acids
Fixed Alkali
Sulphur
Ox. of Lead

7
BARYTES.
In Water.

Sulphuric

Oxalic

Succinic

Fluoric

Phosphoric

Lacteo-Sac.
Molybdic

Nitric

Muriatic
Suberic
Sebacic
Citric
Tartarous
Arsenic Acids
Formic

Lactic
Benzoic
Acetous

Boracic
Sulphureous
Nitrous
Carbonic
Prussic Acids

Fixed Alkali ?
Lime ?
Water

Fat Oil
Sulphur

In Fire.

Phosphoric
Boracic
Arsenic
Sulphuric
Succinic
Fluoric
Nitric
Muriatic
Sebacic
Formic
Lactic
Benzoic
Acetous Acids

Fixed Alkali

Sulphur
Ox. of Lead

8
SHRONTIA.
In Water.

Sulphuric

Oxalic

Tartarous

Fluor

Nitric

Muriatic
Succinic

Phosphoric

Acetous

Arsenic

Boracic

Carbonic

Other Acids ?

Fixed Alkalies
Water
Fat Oil
Sulphur

In Fire.

Not ascertained

9
LIME.
In Water.

Oxalic
Sulphuric

Tartaric

Succinic
Phosphoric
Lacteo-sacch.

Nitric
Muriatic
Suberic
Sebacic

Fluoric
Arsenic
Formic
Lactic
Citric
Benzoic
Acetous
Boracic
Sulphurous
Nitrous
Carbonic
Prussic Acid

Barytes ?
Water

Fat oil
Sulphur
Phosphorus

In Fire.

Phosphoric
Boracic
Arsenic
Sulphuric
Succinic
Fluoric
Nitric
Muriatic
Suberic
Sebacic
Formic
Lactic
Benzoic
Acetous Acids
Fixed Alkali
Sulphur
Ox. of Lead

10.
MAGNESIA.
In Water.

Oxalic

Phosphoric
Sulphuric
Fluoric
Sebacic
Arsenic
Lacteo-saccharine
Succinic
Nitrous
Muriatic
Suberic
Tartaric
Citric ?
Formic
Lactic
Benzoic
Acetous
Boracic
Sulphurous

Carbonic
Prussic Acids

Sulphur

In Fire.

Phosphoric
Boracic
Arsenic
Sulphuric
Succinic
Fluoric
Nitric
Muriatic
Sebacic
Formic
Lactic
Benzoic
Acetous Acids

Fixed Alkali
Sulphur
Ox. of Lead

11. 12. 13.
VEG. FOS. AND VOL-ALKALIES.
In Water.

Sulphuric

Nitric

Sebacic

Muriatic

Suberic

Fluoric

Phosphoric

Oxalic

Tartaric
Arsenic
Succinic
Citric
Formic
Lactic
Benzoic
Acetous and

Lacteo-saccharine Acids

Boracic
Sulphurous
Nitrous Acids

Carbonic A.

Prussic A.

Water

Fat Oil

Sulphur

Metallic Oxides

In Fire.

Phosphoric
Boracic
Arsenic
Sulphuric
Succinic
Fluoric
Nitric
Muriatic
Sebacic
Formic
Lactic
Benzoic
Acetous Acids

Barytes
Lime
Magnesia
Alumine
Silica
Sulphur

14.
WATER.
Pot-Ash
Soda
Ammonia

Alcohol

Carbonate of Ammonia

Æther

Sulphuric A.

Sulphate of Pot-Ash
Sulphate of Alumine
Sulphate of Iron
Oxy-Muriate of Q. Silver
Other compounds, not decomposed by Sulphuric Acid
Silica

15.
SULPHURIC ACID.
In Water.

Barytes

Strontia

Pot-Ash

Soda

Lime

Magnesia
Ammonia

Alumine

Jargonia ?

Metallic Oxides

Water
Alcohol

In Fire.

Pot-Ash
Soda
Barytes

Strontia
Lime
Magnesia
Jargonia
Metallic Oxides
Ammonia
Alumine

16.
SULPHUREOUS ACID.
In Water.

Barytes
Strontia
Lime
Pot-Ash
Soda
Magnesia
Ammonia
Alumine
Jargonia
Metallic Oxides
Water
Alcohol

17. 18. 19. 20. 21.
NITROUS, NITRIC, MURIATIC, OXYMURIATIC, NITRO-MURIATIC ACIDS.
In Water.

Pot-Ash
Soda
Barytes
Strontia
Lime
Magnesia
Ammonia
Alumine

Metallic Oxides

Water
Alcohol

In Fire.

Barytes
Strontia
Pot-Ash
Soda
Magnesia
Metallic Oxides
Ammonia
Alumine

22.
FLUORIC ACID.
In Water.

Lime
Baryt
Strontia
Magnesia
Pot-Ash
Soda
Ammonia
Alumine
Metallic Oxides

Silica
Water
Alcohol

In Fire.

Lime
Baryt
Strontia
Magnesia
Pot-Ash
Soda
Metallic Oxides
Ammonia
Alumine

23.
BORACIC ACID.
In Water.

Lime
Barytes
Strontia
Magnesia
Pot-Ash
Soda
Ammonia
Alumine

Metallic Oxides

Water
Alcohol

In Fire.

Lime
Baryt
Strontia
Magnesia
Pot-Ash
Soda
Metallic Oxides
Ammonia
Alumine

24. 25.
OXALIC AND TARTACEOUS ACIDS.
In Water.

Lime
Barytes
Strontia
Magnesia
Pot-Ash
Soda
Ammonia
Alumine
Metallic Oxides
Water
Alcohol

26.
CITRIC ACID.
In Water.

Lime
Barytes
Strontia
Magnesia
Pot-Ash
Soda
Ammonia
Alumine
Metallic Oxides

Water
Alcohol

27.
BENZOIC ACID.
In Water.

W. Ox. of Arsenic

Pot-Ash
Soda
Ammonia
Barytes
Lime
Magnesia
Alumine
Tromsdorff.

In Fire.

Lime
Barytes
Strontia
Magnesia
Pot-Ash
Soda
Metallic Oxides
Ammonia
Alumine

28.
SUCCINIC ACID.

Barytes
Lime
Magnesia
Pot-Ash
Soda
Ammonia
Alumine
Metallic Oxides

Water
Alcohol

In Fire.

Barytes
Strontia
Lime
Magnesia
Pot-Ash
Soda
Metallic Oxides
Ammonia
Alumine

29.
LACTEO SACCHARINE ACID.
In Water.

Lime
Barytes
Magnesia
Pot-Ash
Soda
Ammonia

Alumine
Metallic Oxides

Water
Alcohol

In Fire.

Lime
Barytes
Strontia
Magnesia
Pot-Ash
Soda
Metallic Oxides
Ammonia
Alumine

30. 31. 32.
ACETOUS, LACTIC, AND FORMIC ACIDS.
In Water.

Barytes
Pot-Ash
Soda
Strontia
Ammonia
Lime
Magnesia
Alumine
Metallic Oxides

Water
Alcohol

In Fire.

Barytes
Strontia
Pot-Ash
Soda
Lime
Magnesia
Metallic Oxides
Ammonia
Alumine

33. 34.
SEBACIC AND PHOSPHORIC ACIDS.
In Water.

Lime
Barytes
Strontia
Magnesia
Pot-Ash
Soda
Ammonia
Alumine
Metallic Oxides

Water
Alcohol

In Fire.

Lime
Barytes
Strontia
Magnesia
Pot-Ash
Soda
Metallic Oxides
Ammonia
Alumine

35.
PRUSSIC ACID.
In Water.

Alkalies
Barytes
Strontia
Lime
Henry

36.
CARBONIC ACID.
In Water.

Barytes
Strontia
Lime
Fixed Alkalies
Magnesia
Ammonia
Alumine
Metallic Oxides

Water
Alcohol

37.
ARSENIC ACID.
In Water.

Lime

Barytes
Strontia
Magnesia

Pot-Ash

Soda

Ammonia

Alumine

Metallic Oxides
Water
Alcohol

In Fire.

Lime
Barytes
Strontia
Magnesia
Pot-Ash
Soda
Metallic Oxides

Ammonia
Alumine

38.
CHROMIC ACID.
In Water.

Fixed Alkali

Oxide of Lead
Oxide of Copper

39.
MOLYBDENIC ACID.

Sulphur
Fixed Alkalies
Absorb. Earths
Metallic Oxides

40.
TUNGSTENIC ACID.

Lime
Barytes
Magnesia
Alkalies
Alumine
Elhuyarts

41.
OXIDE OF ARSENIC.
In Water.

Muriatic Acid

Oxalic

Sulphuric

Nitric
Sebacic
Tartaric
Phosphoric
Fluoric
Lacteo-saccharine
Succinic
Citric
Formic
Arsenic
Lactic
Acetous
Prussic Acids
Ammonia
Fat Oil

Water

ARSENIC.
In Fire.

Nickel
Cobalt
Copper
Iron
Silver
Tin
Lead

Gold
Platina
Zinc
Antimony
Sulphuret of Alkali
Sulphur

42.
OXIDE OF TITANITE.
In Water.

Sulphuric
Nitrous and Muriatic Acids
Prussic A.

Oxy-Muriatic

Nitro-Muriatic

TITANITE.
In Fire.

43.
OXIDE OF URANITE.

Sulphuric
Nitro-Muriatic
Muriatic
Nitric
Phosphoric
Acetous
Gallic
Prussic
Carbonic Acids
Sulphur

Water

URANITE.
In Fire.

44.
OXIDE OF SYLVANITE.
In Water.

Nitrous
Nitro-Muriatic
Sulphuric Acid

Sulphur
Alkalies
Q. Silver

Water

SYLVANITE.
In Fire.

Q. Silver

Sulphur

45.
OXIDE OF MANGANESE.
In Water.

Oxalic
Tartaric
Citric
Fluoric
Phosphoric Acids

Nitrous
Sulphuric
Muriatic
Sebacic
Arsenic

Acetous
Other Acids

MANGANESE.
In Fire.

Copper
Iron
Gold
Silver
Tin

Sulphuret of Alkali

46.

OXIDE OF NICKEL.
In Water.

Oxalic Acid

Muriatic
Sulphuric
Tartareous
Nitric
Sebacic
Phosphoric
Fluoric
Lacteo-Saccharine
Succinic
Citric
Formic
Acetous
Arsenic

Lactic Acids

Arsenic
Boracic
Prussic

Carbonic
Vol. Alkali

NICKEL.
In Fire.

Iron

Cobalt
Arsenic
Copper
Gold
Tin
Antimony
Platina
Bismuth
Lead
Silver
Zinc
Sulphuret of Alkali

Sulphur

47.

OXIDE OF COBALT.
In Water.

Oxalic Acid

Muriatic A.

Sulphuric A.
Tartareous
Nitric

Sebacic
Phosphoric

Fluoric
Lacteo-Saccharine
Succinic
Citric
Formic
Lactic
Acetous

Arsenic
Boracic
Prussic

Carbonic
Vol. Alkali

COBALT.
In Fire.

Iron
Nickel
Arsenic
Copper
Gold
Platina
Tin
Antimony
Zinc
Sulphuret of Alkali
Sulphur

48.

OXIDE OF BISMUTH.

Oxalic A.
Arsenic
Tartaric
Phosphoric
Sulphuric
Sebacic
Muriatic
Nitric

Fluoric
Lacteo-Saccharine
Succinic
Citric
Formic
Acetous
Prussic
Carbonic
Vol. Alkali

BISMUTH.
In Fire.

Lead
Silver
Gold
Q. Silver
Antimony
Tin
Copper
Platina
Nickel
Iron
Zinc
Alkaline Sulphuret

Sulphur

49.

OXIDE OF ANTIMONY.
In Water.

Sebacic

Muriatic

Oxalic

Sulphuric
Pyromuc.
Nitric
Tartaric
Lacteo-Saccharine
Phosphoric
Citric
Succinic
Fluoric
Arsenic
Formic
Lactic
Acetous
Boracic
Prussic
Carbonic Acids

Sulphur

ANTIMONY.
In Fire.

Iron
Copper
Tin
Lead
Nickel
Silver
Bismuth
Zinc
Gold
Platina
Q. Silver
Arsenic
Cobalt
Alkaline Sulphuret
Sulphur

50.

OXIDE OF ZINC.
In Water.

Oxalic

Sulphuric
Pyromuc.

Muriatic
Sach. Lactic
Nitric
Sebacic
Tartareous
Phosphoric
Citric
Succinic
Fluoric
Arsenic
Formic
Lactic

Acetous
Boracic
Prussic

Carbonic Acids
Vol. Alkali

Zinc.
In Fire.

Copper
Antimony
Tin
Q. Silver
Silver
Gold
Cobalt
Arsenic
Platina
Bismuth
Lead
Nickel
Iron

51.
Oxide of Iron.
In Water.

Oxalic
Tartar

Gallic
Camphoric
Sulphuric
Lacteo-Saccharine

Muriatic
Pyromuc.
Nitric

Sebacic
Phosphoric
Arsenic
Fluoric
Succinic
Citric
Formic
Lactic

Acetous
Boracic
Prussic

Carbonic Acids

Iron.
In Fire.

Nickel

Cobalt
Arsenic
Manganese
Copper
Gold
Silver
Tin
Antimony
Platina
Bismuth
Lead
Q. Silver
Alkaline Sulphuret

Sulphur

52.
Oxide of Tin.
In Water

Pyromuc. A.
Sebacic

Tartareous
Muriatic
Sulphuric
Oxalic

Arsenic
Phosphoric
Nitric
Succinic
Fluoric
Sach. Lactic
Citric
Formic
Lactic
Acetous
Boracic
Prussic Acids

Fixed Alkali
Vol. Alkali

Tin.
In Fire.

Zinc
Q. Silver
Antimony
Copper
Gold
Silver
Lead
Iron
Manganese
Nickel
Arsenic
Platina
Bismuth
Cobalt
Alkaline Sulphurets
Sulphur

53.
Oxide of Lead.
In Water.

Pyromuc.
Sulphuric

Sebacic

Lacteo-Saccharine
Oxalic

Arsenic
Tartaric
Phosphoric

Muriatic
Molybdic
Suberic
Zoonic
Nitric
Pyromuc.
Fluoric
Citric
Formic
Acetous
Lactic
Boracic
Prussic
Carbonic Acids
Fixed Alkali
Fat Oil

Lead.
In Fire.

Gold
Silver
Copper
Q. Silver
Bismuth
Tin
Antimony
Platina
Arsenic
Zinc
Nickel
Iron
Alkaline Sulphuret

Sulphur

54.
Oxide of Copper.
In Water.

Pyromuc.
Oxalic

Tartaric

Muriatic
Sulphuric

Sach. Lactic
Nitric
Sebacic
Arsenic
Phosphoric
Succinic
Fluoric
Citric
Formic
Acetous
Lactic
Boracic
Prussic

Carbonic Acids
Fixed Alkali
Vol. Alkali
Double Salts
Fat Oil

COPPER.
In Fire.

Gold
Silver
Arsenic
Iron
Manganese
Zinc
Antimony
Platina
Tin
Lead
Nickel
Bismuth
Cobalt

Q. Silver
Alkaline Sulphuret

Sulphur

55.
OXIDE OF Q. SILVER.
In Water.

Sebacic

Muriatic

Oxalic
Succinic
Phosphoric
Arsenic
Sulphuric
Lacteo-Saccharine
Tartar
Citric
Nitric
Fluor
Acetous
Boracic
Prussic
Carbonic Acids

Q. SILVER.
In Fire.

Gold

Silver

Platina

Lead

Tin

Zinc

Bismuth

Copper

Antimony

Arsenic

Iron
Sulphuret of Alkali
Sulphur

56.
OXIDE OF SILVER.
In Water.

Muriatic

Sebacic

Oxalic

Sulphuric

Lacteo-Saccharine

Phosphoric

Nitric
Arsenic
Fluoric
Tartaric
Citric
Formic
Acetous
Lactic
Succinic
Prussic
Carbonic Acids

Vol. Alkali

SILVER.
In Fire.

Lead
Copper
Q. Silver
Bismuth
Tin
Gold
Antimony
Iron
Manganese
Zinc
Arsenic
Nickel
Platina

Sulphuret of Alkali

57.
OXIDE OF PLATINA.
In Water.

Æther

Muriatic
Nitric
Sulphuric
Arsenic
Fluor
Tartaric

Phosphoric
Sebacic
Oxalic
Citric
Formic
Acetous
Lactic
Succinic Acids

PLATINA.
In Fire.

Arsenic
Gold
Copper
Tin
Bismuth
Zinc
Antimony
Nickel
Cobalt
Manganese
Iron
Lead
Silver
Q. Silver
Sulphuret of Alkali

58.
OXIDE OF GOLD.
In Water.

Æther

Muriatic
Nitro-Muriatic
Nitric
Sulphuric
Arsenic
Fluoric
Tartaric
Phosphoric
Sebacic
Prussic Acids

Fixed Alkalies

Vol. Alkalies

Gold.
In Fire.

Q. Silver
Copper
Silver
Lead
Bismuth
Tin
Antimony
Iron
Platina
Zinc
Nickel
Arsenic
Cobalt
Manganese

Sulphuret of Alkali

59.
Alcohol.

Water

Æther

Volatile Oils
Vol. Alkali
Fixed Alkali
Sulphuret of Alkali

Sulphur

Muriates
Phosphoric A.

60.
Æther.

Alcohol
Volatile Oils
Water

Sulphur

Phosphorus

Caoutchuc

61.
Volatile Oil.

Æther
Alcohol
Fixed Oil
Fixed Alkali

Sulphur
Phosphorus

62.
Fixed Oils.

Lime
Baryt
Pot-Ash
Soda
Magnesia
Ammonia

Ox. of Mercury
Other Oxides
Alumine
Sulphur
Phosphorus

The affinities of oxygen, as ascertained by later observations, appear to be nearly in this order:—

Oxygen—Charcoal, titanium, manganese, zinc, iron, tin, uranium, molybdenum, tungstein, cobalt, antimony, hydrogen, phosphorus, sulphur, nickel, arsenic, nitrogen, chrome, bismuth, lead, copper, tellurium, platina, mercury, silver, nitrous gas, gold, muriatic acid.

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