The chemical pocket-book, or Memoranda chemica : arranged in a compendium of chemistry : with tables of attractions, &c.; Calculated as well for the occasional reference of the professional student, as to supply others with a general knowledge of chemistry / by James Parkinson ; with the latest discoveries ; from the London second edition of 1801 ; to which is added an appendix, containing the principal objections to the antiphlogistic system of chemistry / by James Woodhouse, M.D. ... ; embellished with copperplates.

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W. B. Magruder M. D.
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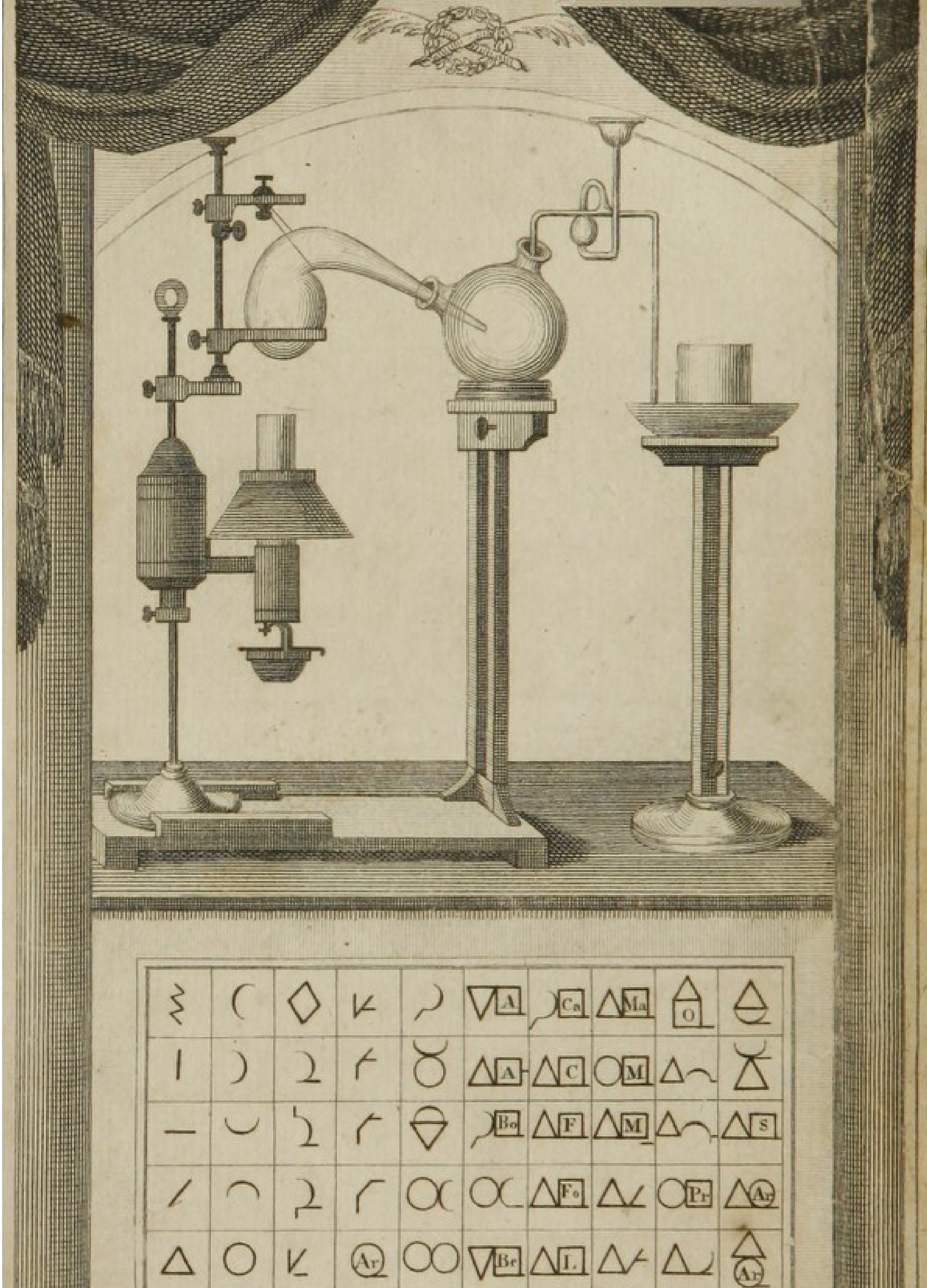

The Chemical Characters of Hassenfratz & Adet.

Tanner, Sc.

Engraved for J. Humphreys.

THE

CHEMICAL POCKET-BOOK;

OR

MEMORANDA CHEMICA:

ARRANGED IN A

COMPENDIUM OF CHEMISTRY:

WITH TABLES OF ATTRACTIONS, &c.

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BY JAMES PARKINSON.

WITH THE LATEST DISCOVERIES.

FROM THE LONDON SECOND EDITION OF 1801.

To which is now added

An Appendix,

Containing

THE PRINCIPAL OBJECTIONS TO THE

ANTIPHLOGISTIC SYSTEM OF CHEMISTRY.

BY *JAMES WOODHOUSE,* M. D.

Profeſſor of Chemiſtry in the Univerſity of Pennſylvania, &c.

EMBELLISHED WITH COPPERPLATES.

Philadelphia:

PRINTED AND SOLD BY JAMES HUMPHREYS,
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1802.

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.

A fuller deſcription of this apparatus is to be found in Mr. Nicholſon's excellent Journal.

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 atmoſphere.* The next denotes FIXED ALKALI, which, by the central inſertion of the initial letter, ſerves to denote either *pot-aſh* or *ſoda*. 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, SULPHUR, HYDROGEN, CARBON, 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. To denote the *addition of caloric*, in ſuch a portion, to any ſubſtance as gives it the ſtate of FLUIDITY, the character for that ſubſtance is affixed to the *bottom* of the perpendicular line which ſtands for caloric; and its GASEOUS ſtate is implied by its being affixed to the *upper* part of the perpendicular line. 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 OXY-NITRIC 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 earthly 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 TARTAROUS, MOLYBDIC, TUNGSTIC, CHROMIC, SUBERIC, ZOONIC, PYROTARTARIC, PYROMUCIC, PYROLIGNIC, SACCHOLACTIC, and SEBACIC ACIDS, may be eaſily inferred from an attentive conſideration of the formation of the characters already deſcribed.

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 the Author hoped it might be more particularly beneficial: furnishing, like a bird's eye view to a traveller, a general view of the relation and connection of the several parts of that region, which is soon to become the object of a nearer and closer investigation.

It is hardly necessary to acknowledge the Author's obligations to the various labours of BERGMAN, FOURCROY, LAVOISIER, CHAPTAL, KIRWAN, HATCHETT, PEARSON, BABINGTON, &c. *as they must appear on the face of the work. 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 most other sciences; and the vast advantages a knowledge of its principles may yield to those who are engaged in the most 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.

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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 affected.

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, or AFFINITY of COMPOSITION, is that by which the heterogeneous particles of bodies are united. The general principles, or laws by which this power acts, are—

1. *It takes place between the conſtituent parts of bodies of different natures.* Thus acids combine with alkalies, alkalies with ſulphur, metals with acids, &c.

2. *It acts in the inverſe* ratio *of the affinity of aggregation.* For as it appears to act on the infinitely ſmall particles of bodies, its operation muſt be impeded by that force of aggregation which allows but few of theſe ultimate molecules to be expoſed to its influence. Thus metals are not acted on by ſulphur or ſaline ſubſtances, whilſt each retains a ſolid form; but when by a ſtate of fluidity, a more extended application of the particles of one of the bodies takes place, the capacity of action is thereby increaſed, and a combination enſues, which, in the caſe of a ſolid and a fluid body, is termed *ſolution*; and the fluid body has been termed a *ſolvent*, and has been ſuppoſed to act with a ſuperior degree of force than the ſolid aggregate. This, however, is not the caſe, ſince the action is equal on both ſides; and the new combination is the conſequence of the affinity of compoſition between the two ſubſtances exceeding the affinity of aggregation.

3. *Bodies, immediately on being united by it, ſuffer a change of temperature.* This depends on the change which takes place with reſpect to the degree of attraction for the matter of heat.

4. *The Compound poſſeſſes properties differing from thoſe which were before poſſeſſed by the bodies of which it is compoſed.* This difference may exiſt not only in the taſte, but alſo in the conſiſtence, form, ſmell, colour, fuſibility, &c.

5. *All bodies have their own peculiar affinities with other bodies.* Thus ſome bodies refuſe to unite, whilſt others form an almoſt inſeparable union.

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.

Conſidering the degrees of affinity to be preciſely as the points of ſaturation, he therefore marks the degree of affinity of any body with an acid, by the quantity of that body which may be diſſolved in 100 parts of the acid. Thus ſuppoſing 96 grains of lime to be required to ſaturate 100 grains of nitric acid, he takes 96 for the numerical expreſſion of its degree of affinity with that acid. The affinity of pot-aſh with the ſame acid he thus finds to be 215, and therefore ſays, the affinities of lime and of pot-aſh to nitric acid is as 96:215; and that, therefore it may be inferred that a combination of nitric acid and lime muſt be decompoſed by pot-aſh.

Theſe numbers however are not to be conſidered as expreſſive of the *exact* forces of attractions, but ſufficiently ſo to enable us to foretel decompoſitions and compoſitions.

The real nature of what are termed *reciprocal attractions*, cannot be underſtood, unleſs the agency of certain interpoſing attractions be alſo conſidered, ſuch as thoſe of caloric, light, and the ſurrounding air; with the difference of coheſion, and of gravitation in the particles of the compounds, as well as in the particles of the menſtrua and baſes, &c. Theſe apparent reciprocal affinities being generally the reſult of certain combinations not hitherto ſufficiently examined.

OF EARTHS.

EARTH is an inodorous, dry, brittle, uninflammable, naturally white, and generally taſteleſs ſubſtance; of very ſparing ſolubility in water, but ſoluble in one or other of the acids: from which ſolution no precipitate is produced by pruſſiate of pot-aſh, or of lime. Sp. gr. to water not exceeding 5 to 1. There appear to be nine different earths, which may be conſidered as ſimple ſubſtances.

1. Lime, when perfectly pure, is termed *QUICK-LIME*, or *pure calcareous earth*. To obtain it in that ſtate, after clearing it as much as poſſible from extraneous matters, 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 28,7 of water, and becoming *SLAKED LIME*, during which change a degree of phoſphoreſcence may be diſcovered in the dark.

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

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

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 effervеſcence. It has been ſuppoſed to be entirely of animal origin; but this is doubtful where it exiſts as primitive lime-ſtone, or in granite.

2. **Magnesia** has not been met with native in an uncombined ſtate. When pure it is very light and white, and requires 7,900 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.

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

3. **Alumine**, or *EARTH OF ALUM*, is the true *argillaceous* part of common clay. It is never found pure, in a native ſtate. When pure it is white, ſmooth, and of an unctuous feel, adherent to the tongue, diffuſible in water, and not more ſoluble than magneſia. Sp. gr. 2,00. When heated it diminiſhes in bulk, and 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 chryſtallizes difficultly.

It is fuſible alone, only by the flame of oxygen gas; but with *phoſphate* or *borate of ſoda*, it may be fuſed with nearly the ſame degree of facility as lime and magneſia.

4. **Silica** is the earth which chiefly forms flint, rock cryſtal, and many of the gems. It is of a rough and harſh feel, and appears to be ſoluble in water itſelf. Fifty grains of colourleſs fluid, contained in the cavities in baſalt, have been found to hold a grain of ſiliceous earth in ſolution.

It is acted on by no other known *acid*, but the *fluoric*, and yet an alkaline ſolution of this earth admits of ſuperſaturation with an acid without any precipitation.

It is infuſible alone, and is but little acted on by *phoſphate of ſoda*, and but little more by *borate of ſoda*. *Fixed alkalies* are the effectual ſolvents of this earth, forming with it glaſs. Efferveſcence takes place in this caſe, but not with the borate of ſoda. The fixed alkalies act on it even in the moiſt way.

5. **Baryt**, alſo termed from its high ſpecific gravity *PONDEROUS EARTH*, is not found pure; but when it is obtained pure, by the action of a ſtrong heat on it in combination with nitric acid, it is more cauſtic than lime, and abſorbs water eagerly, forming a very tenacious cement. When covered with water it is diſſolved with a hiſſing noiſe, and cryſtallizes in tranſparent needles, forming a compages like beaten plaſter. Cold water diſſolves a 25th

part of its weight, and boiling one-half. It is alſo ſoluble in alcohol, and is dreadfully poiſonous.——*Annals de Chimie*, xxi.

It is not fuſible alone but is acted on by the ſame fluxes as lime.

It has the greateſt affinity with *muriatic acid*, of all alkaline or earthy ſubſtances. The ſulphate which precipitates on the addition of *ſulphuric acid* to its ſolution in the nitric or muriatic acids, requires 40,000 times its weight of water for its ſolution.

6. STRONTIA has not been found pure; when obtained ſo by art it is more ſoluble, and 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, 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, only glitters with a phoſphoric flame; but it may be fuſed if it be mixed with moſt of the other earths.

7. JARGONIA, 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. exceeds 4,000. It appears to be inſoluble in water.

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 ſemi-tranſparency of horn, which 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.

8. 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 ammoniac*. It decompoſes aluminates, and is completely precipitated from its ſolutions by ammoniac. 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.

9. AGUSTINE is an earth which, as its name imports, forms, with acids, ſalts which are taſteleſs. It was found by Trommſdorff in a mineral reſembling the beryl. This earth reſembles alumine, in not being acted on either by the fixed alkalies or ammoniac. 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.

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.

Guyton alſo obſerves, that the action which BARYT, STRONTIA, and LIME exert on oils, ſoaps, and animal matters, with their union with the Pruſſian colouring principle, ſulphur, and the acids, form ſo many points of reſemblance with the alkaline ſubſtances. But he does not ſeem to think they are ſufficient to warrant a common claſſical denomination.——*Annales de Chimie*, xxxi.

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.

OF 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 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 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.

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 a 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 affinity with 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 has been termed the *capacity for heat*; and the quantity of caloric thus required, *ſpecific heat*.

The caloric thus abſorbed, is termed *combined caloric*, or in the language of the celebrated Dr. Black, *latent heat*. But when it is perceptible by the organs of feeling, it is termed *free caloric*, or according to Dr. Black, *ſenſible heat*.

The caloric which enters into the compoſition of bodies may be *chemically combined*, or only *adherent*. In the former caſe new combinations may extricate the combined caloric; but in the latter, mere mechanical preſſure, or a 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 becomes *latent*; entering 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*.

If a body be not of a nature to undergo ſuch ſeparation of its parts, by the addition of caloric, as may occaſion 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.

Count Rumford, from the great quantity of heat produced by friction, is induced to aſk, What is heat? Is there any ſuch thing as an igneous fluid? Is there any thing that can with propriety be called caloric? He obſerves, the ſource of the heat generated by friction, appears evidently to be inexhauſtible; and adds, that any thing which any inſulated body, or ſyſtem of bodies, can continue to furniſh without limitation, cannot poſſibly be a *material ſubſtance*. He concludes it to be almoſt impoſſible to form any diſtinct idea of any thing capable of being excited and communicated in the manner that heat is excited and communicated, except it be *Motion.*——*Phil. Trans.* 1798.

Heat, Mr. Davy ſays, or that power which prevents the actual contact of the corpuſcles of bodies, and which is the cauſe of our peculiar ſenſations of heat and cold, may be defined *a peculiar motion*, probably *a vibration of the corpuſcles of bodies*, tending to ſeparate them. It may with propriety be called THE REPULSIVE MOTION. The *non-exiſtence* of caloric, or the fluid of heat, he thinks his experiments have proved.

Dr. Beddoes is alſo of opinion that moſt of the phenomena relative to heat, are more eaſily reconcileable to the *mechanical* than the *chemical* doctrine of heat.—*Contributions to Phyſical and Medical Knowledge*, 1799.

This 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.

OF 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 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.

Sugar, borax, ſiliceous ſtones, and many other ſubſtances, yield light merely by attrition; other bodies yield it upon being heated. This property has been termed *Phosphoriſm.*

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.

Mr. T. Wedgwood found that the phoſphoriſm of almoſt all bodies might be made apparent, either by heat or by attrition. By placing them on a plate made nearly red hot, he obtained a phoſphoric light, not only from different combinations of earths, and other ſubſtances which might be expected to poſſeſs this property; but alſo from pieces of white paper, linen and woollen, hair-powder, ſaw-duſt, wax and oils. The light yielded by bodies upon attrition, he conjectures, may be attributed to a ſudden heating (red hot) of particles in their ſurfaces.——*Phil. Tranſ.* 1792.

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.

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.*

OF OXYGEN.

OXYGEN, or the *acidifying principle*, 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 excluſively 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, and by changing vegetables 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 *oxygenated.*

When metals and various other ſubſtances are expoſed to its action, the acidifying proceſs ſometimes takes place unaccompanied by the uſual marks of combuſtion, and 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 is termed *OXIDATION.*

OXYGEN GAS is the reſult of the combination of *oxygen* with *caloric.* It exiſts in atmoſpheric air, in the proportion of 27 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.

COMBUSTION is a proceſs in which this gas is decompoſed, the oxygen is 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 the 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; and *detonation*, when inflammation occurs with great rapidity and noiſe. 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.

OF 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 is about 12 times as light as common air, being the lighteſt of all the gaſes we know; and has a diſagreeable odour, which it loſes when deprived of the water which it holds in ſolution, in a quantity equal to half its weight.

It is abſorbed by vegetation, and is then ſuppoſed to become one of the conſtituents of oil, reſin, &c. It is not fitted for reſpiration, though not immediately injurious. When by itſelf, it extinguiſhes flame; but being mixed with *oxygen* it burns with brilliancy, when any body, already ignited, is brought into contact with it. It is produced by the reſolution of animal and vegetable ſubſtances, in all which it exiſts as a conſtituent principle. It is alſo obtained from ſeveral mineral ſubſtances, by certain chemical proceſſes; it containing various impurities, according to the ſubſtances from which it is obtained.

WATER is formed by the union of *hydrogen* and *oxygen*. 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.

Water is an uninflammable fluid, and when pure, is tranſparent, colourleſs, and void both of taſte and ſmell.

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 marked by 32° F. water parts with caloric, has its volume increaſed by a confuſed cryſtallization, and aſſumes a *ſolid* form, when it is termed *ICE.* The temperature being increaſed, it re-aſſumes 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.*

By certain natural proceſſes the atmoſphere is conſtantly impregnated with this vapour. When in conſequence of cooling or compreſſion, the caloric ſeparates from the finely divided particles of water, which formed the baſis 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 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.

Simple cold waters	Malvern. Holywell.
Simple thermal	Briſtol. Matlock. Buxton.
Simple ſaline, containing chiefly neutral purging ſalts	Sedlitz. Epſom. Sea.

Highly carbonate alkaline	Seltzer.
Simple carbonate chalybeate	Tunbridge.
Hot carbonate 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 forms more than two-thirds of the air of the atmoſphere; but alone, deſtroys animal life, and ſtops combuſtion. 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 the air, the oxygen gas, has been abſorbed. It is obtained from moſt bodies in the vegetable and animal kingdom, nitrogen exiſting in theſe as a radical principle. It is lighter than common air, in the proportion of 985 to 1000, and is not in the leaſt acid, or ſoluble in water.

NITROGEN, as its name imports, is the chief conſtituent, the baſe, of the *NITRIC ACID*; an attention to the following proceſſes will render this ſufficiently manifeſt.

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.

Mr. Cavendiſh has manifeſted the compoſition of nitric acid, he having formed it by taking reiterated electrical ſparks through a mixture of oxygen, and of nitrogen gas.

NITROS 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, NITROS 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 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, iron, braſs, 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.

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 ammoniac at temperatures below 440°. It is heavier than air, and 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 combuſtible bodies at very high temperatures, is combinable with alkalies, 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.

The nitric acid unites with oils, and forms with them a ſub-reſinous ſubſtance, ſomewhat reſembling muſk, ſometimes producing inflammation. It rapidly corrodes organic bodies, ſtaining ſkin, hair, and other animal matters, of a permanent yellow: and 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 ſubtracted from it by the acidifiable baſis, now rendered a peculiar acid. Thus are acids obtained from ſugar, arſenic, &c. as will be hereafter ſhown.

Mr. Mayer firſt conjectured 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 earthly 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 conſidered it, with Mayer, as a *compound of oxygen and hydrogen*, terming it an *oxide of hydrogen.*——*Ann. de Chim.* No. 100.

Berthollet agrees, with Dieman, Van Trooſtwyk, 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. Mitchell, of New-York, ſuppoſes the matter of peſtilence to be Septon (azote,) 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.

The doctor employs the term *ſepton*, for nitrogen.

Septous gas, for nitrogen gas.

Septic gas, for nitrous gas, &c.

The Doctor contends that the nitric acid is, in fact, a mixture of the muriatic and ſulphuric with the ſeptic, (nitric,) and that nitrous air, nitrous oxide, &c. are ſimilar farragoes.

The Critical Reviewer obſerves, that nitre obtained from the air has, indeed, always a proportion of muriatic acid, and that ſulphuric acid gains admiſſion during refining, but that theſe are accidental impurities, not component parts.—*Crit. Rev. Aug.* 1800.

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 73 of the former, and 27 of the latter, in a ſtate of mixture, not of intimate combination; and is ſoluble in about 30 times its bulk of water.

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. Atmoſpheric air contains in every 100 parts, 27 of oxygen, and 73 of nitrogen gas.

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.

From the avidity with which nitrous gas abſorbs oxygen to form nitric acid, it has been employed by Prieſtly, 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.

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.

ALKALIES,* whoſe general characteriſtics are, 1, an acrid, urinous taſte; 2, changing the vegetable blues green; 3, combining with acids, and forming neutral ſalts; 4, facility of ſolution in water; appear to be derived from *nitrogen*, which has therefore been eſteemed the *alkaligen* principle. They are divided into *volatile* and *fixed*.

AMMONIA, or the *Volatile Alkali*. This has been proved to be a compound of *nitrogen* and *hydrogen*. It ſeems to owe its origin to animal and vegetable decompoſition. It is diſtinguiſhed from the other alkalies by its pungent ſmell,

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* By treating of alkalies in this place, they are not only conſidered in connection with one of their ſuppoſed principles, but a knowledge of their reſpective natures is acquired, previous to an examination of neutral ſalts, and other combinations of which they form a part.

Dr. Pearſon recommends to employ the ancient name *alkali* for the genus, and the ancient names of theſe ſalts for the ſpecies, abbreviated thus into one word, viz. *Veg-alkali*, *Foſ-alkali*, and *Vol-alkali*.——*Chemical Nomenclature*.

and great degree of volatility. 1000 parts contain 807 of nitrogen, and 193 of hydrogen.

ALKALINE GAS is formed by the combination of *ammoniac* with *caloric*. It is lighter than common air, is unfit for combuſtion, the flame enlarging before it is extinguiſhed. It deſtroys animal and vegetable life; its other properties reſemble thoſe which have already been attributed to ammoniac.

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

Analogy, and even experiment, lead to the concluſion that fixed alkalies are formed by the combination of nitrogen, with ſome unknown baſis, probably earth.

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.

SODA, or the *Mineral fixed Alkali*, is ſometimes found in a native ſtate, but is in general obtained by the combuſtion of maritime plants, particularly of the *kelp*, and of the *ſea-graſſes*, and *ſea-tang*. It differs from pot-aſh, in not being deliqueſcent, and in cryſtallizing in rhomboidal octahedrons; but the chief differences between them are obſervable in their reſpective combinations.

Like the former, this alkali is ſuppoſed to be formed by a combination of nitrogen with ſome other principle, which has alſo been ſuppoſed to be an earth: this earth has been ſuppoſed to be magneſia by Fourcroy and Lorgna.

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*.

GLASS is a combination of ſilica with fixed alkali. 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 one 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 Seigling 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.

Girtanner obſerves, that in making glaſs, a complete analyſis of the alkali is made, the hydrogen eſcapes in the form of gas, and the oxygen combines with the flint, the glaſs being nothing elſe but an *oxide of ſilica*.

Profeſſor Klaproth has diſcovered the *vegetable alkali* in the foſſil called *leucite*. It has alſo been found in *lepidolite*, *lava*, *pumice*, and *zeolite*. Profeſſor Abilgaart found that the *pot-aſh* formed a conſtituent part of animal blood; and La Metherie and Gren have diſcovered the *foſſil alkali* in the ſalſula ſoda.

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.

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 ammoniac; 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. 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 7 parts of cold and 1 of hot water. By diſtillation, it yields 12000 cubit 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 what is 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 1 part of charcoal and 3 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 potaſh of the nitre, forming a carbonate of pot-aſh, which remains, and was formerly 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 a nitrogen gas.

The above proceſs being performed in cloſe veſſels, a liquor diſtils, which is ſometimes impregnated with nitrous acid and ammoniac, and has been called *clyſſus of nitre*; carbonate of pot-aſh remaining in the retort, in conſequence of the oxygen combining with the inflammable body, by which an acid is formed, which uniting with the pot-aſh of the nitrate, forms a new neutral ſalt. 100 grains of nitrate of pot-aſh is found to contain 30 of acids, 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 *gunpowder-mills*. The *powder-paſte* is afterwards *grained*, and for nice purpoſes *glazed*. Its exceſſive power appears to proceed from the ſudden generation of carbonic, hydrogen, and nitrogen gaſes, aided by the vaſt expanſive power of the immenſe quantity of caloric they in a moment ſet free.

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 3 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 28,80 of acid, 50,09 of alkali, and 21,11 of water.

The ſtrongeſt nitrous acid is to be found in nitrated ſoda. ——*Kirwan*.

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

NITRATES with *earthy baſes*.

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 lixivation of old plaſter, and by the mother waters of ſaltpetre, as they are termed by the manufacturers. It forms acicular 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.

This ſalt being diſſolved in alcohol, gives to it the property of burning with a red flame. 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, 22 of lime, 35 water of cryſtallization.

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, ſulphate of baryt, or ponderous ſpar, 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.

NITRATE of **MAGNESIA**, is found in decayed walls, &c. It forms tetrahedral columnar cryſtals, 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 **ALUMINE** forms in ſmall priſms, which are deliqueſcent, and give an aſtringent taſte. In the fire they ſwell, and are decompounded, loſing their oxygen. Alkalies, magneſia, and lime, decompoſe this ſalt.

NITRATE of **STRONTIAN** forms octahedral cryſtals, and gives to the flame of alcohol a bright carmine red.

NITRITES, or neutral ſalts formed with *nitrous acid* have been very little attended to.

OF SULPHUR.

SULPHUR is a ſimple, inflammable, acidifiable, brittle ſubſtance, yielding a peculiar odour when heated, and manifeſting electric powers on being rubbed.

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, excluding the external air 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*, have any apparent attraction to ſulphur; nor is it acted on by water; but that *hydrogen* may enter into union 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.

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. 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 precipitated in the form of a white powder, which has been called *milk of ſulphur*; its oxygen gas uniting with one part of the ſulphur, whilſt its hydrogen gas, diſſolving alſo a portion, forms

SULPHURATED HYDROGEN GAS, or *Hepatic Gas*, which is diſtinguiſhed by a peculiar diſagreeable ſmell. It blackens moſt of the metals, and their oxides, deſtroys life, renders violets green, and 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. If mixed with oxygen gas it unites with it, forming water and depoſiting ſulphur. The *mineral ſulphurous waters* are formed by ſaturation with this gas.

SULPHURET of AMMONIAC, 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 ammoniac and ſulphur uniting, whilſt in a ſtate of gas, during diſtillation, from one part of ſulphur, two of ammoniac, 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 pulveriſed 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 BONONIAN 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 being ignited burns with a blue flame, but if the combuſtion is carried on more rapidly the flame becomes more vivid and white, oxygen combining with the acidifiable baſe, and forming an acid more or leſs perfect according to the greater or leſs rapidity of the combuſtion.

SULPHURIC ACID, formerly called *Spirit* or *Oil of Vitriol*, is formed by the combination of the full portion of oxygen with its baſis; but it is produced with more facility by the addition of nitre, 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 from 69 to 72 of ſulphur, and from 28 to 31 of oxygen.

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 its oxygen, which uniting with the carbon, forms carbonic acid gas.

SULPHUREOUS ACID is formed by this addition of inflammable matter, in conſequence of a decompoſition of the acid, the inflammable body having thus deprived it of a conſiderable portion of its oxygen. This change is effected by digeſting almoſt any animal or vegetable ſubſtance, or even ſulphur in the ſulphuric acid, but it gradually abſorbs oxygen from the atmoſphere, and returns to the ſtate of ſulphuric acid.

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 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.

SULPHATES are neutral Salts, formed by the ſulphuric acid with certain baſes.

SULPHATE of POT-ASH, formerly called *Arcanum Duplicatum*, *Sal de duobus*, *Vitriolated Tartar*, *and Vitriol of Pot-aſh*. It forms in cryſtals of hexahedral priſms, terminating in hexahedral pyramids, with triangular faces. It gives rather a penetrating bitter taſte, and is ſoluble in 16 parts of cold water. 100 grains containing 30,21 of acid, 64,61 of alkali, and 5,18 of water. It decripitates on hot coals; but with greater heat it fuſes, and is volatilized without decompoſition.

The ſtrongeſt ſulphuric acid, Mr. Kirwan remarks, exiſts in this ſalt.

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 re-production 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 its own acid. This ſalt effloreſces in the air.

SULPHATE of SODA, formerly called *Glauber's Salt, Sal Mirabile, Vitriol of Soda, &c.* It 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 ſtriated, flattened hexangular priſms, with hexangular ſummits, ſwells and boils upon heated coals, effloreſces in the air, and is ſoluble in its own weight of boiling water, and in 3 parts of cold. 100 parts contain 27 of acid, 15 of alkali, 58 of water. It is decompoſed by pot-aſh and baryt.

ACIDULOUS SULPHATE of SODA, is formed when the ſulphate of ſoda is ſuperſaturated by its own acid.

SULPHATE of AMMONIAC, 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.

SULPHATES with *earthy baſes.*

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 rhomboidal octahedron. Expoſed to fire, it is reduced to a white powder, called *burned gypſum*, or *plaiſter 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 infuſible *per ſe*, but melts at 130° on clay. It may be decompoſed by the carbonated alkalies and baryt, which unite with the ſulphuric acid, and leave the lime diſengaged. 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 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, with obliquely truncated ends, 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 24 of acid, 19 of magneſia, and 57 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 ALUMINE, or *Alum*, is formed by the *ſulphuric acid* and *alumine*, the acid exiſting in exceſs. The alum of commerce alſo contains pot-aſh, and from the experiments of Prof. Hildebrandt it appears that pot aſh is a conſtituent of alum, ſince the acid and the earth alone will not form it, neither is it formed by the addition of ſoda, but it is produced by the addition of carbonate of ammoniac.——*Scherer's Journal.*

It forms octahedral cryſtals, which generally group ſo as to repreſent an indented column. Theſe diſſolve in 17 times their weight of cold water, and in rather leſs than their own weight of boiling water.

In a moderate heat it ſwells, loſes its water of cryſtallization, and becomes a light white ſubſtance called *burnt-alum.* In a more violent degree of heat, it loſes part of its acid, and becomes taſteleſs; is no longer ſuſceptible of cryſtallization, but precipitates from its ſolution, in a very fine adheſive powder. Magneſia, baryt, and the alkalies, precipitate it from this ſolution; but the alkalies added in exceſs, re-diſſolve it. 100 parts contain 38 of ſtandard acid, 18 of earth dried in a high red heat, and 44 of water in cryſtallization.

By the addition of more alumine the *glaſs ſelenite* of *Baumé* is formed, which is almoſt taſteleſs and inſoluble, and exhibits cubic cryſtals.

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 the 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.

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. *Sauvigny* attributed it to the ſulphuric acid heating by the moiſt air, and inflaming the diſengaged ſulphur. *Prouſt* denied the preſence of ſulphuric acid; and *Mr. Bewley* 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 STRONTIAN is earthy, has no taſte, and is ſcarcely ſoluble in 1000 times its weight of water.

SULPHATE of ZIRCONIA becomes ſoluble by exceſs of acid, and gives tetrahedral priſms, in cluſters of an aſtringent taſte.

SULPHATE of BARYT, or *Ponderous Spar* or *Baroſelenite*, is generally found in rhomboidal plates, and in other cryſtals derived from the regular octaëdron. It is leſs ſoluble than ſulphate of lime; when heated it becomes luminous, and by violent heat, vitrifies. Neither alkalies nor the other acids have any action on this ſulphate. 100 parts contain 30 of acid, 67 of baryt, and 3 of water. That which comes from *Mount Paterno*, in *Bologna*, in *Italy*, has been called the *Bolognian ſtone*, which, when heated, becomes the BOLOGNIAN PHOSPHORUS.

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 Vaucquelin, 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 by 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 potaſh, or with ſalt-petre, and become ſulphates. 6. Laſtly, the ſulphite of lime is not decompoſed by the alkalies, like the ſulphate.

OF 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.

THE DIAMOND which exceeds all other gems in hardneſs, denſity, and refraction of the rays of light, cryſtallizes in two tetrahedral or trihedrul pyramids, united baſe to baſe, or in hexahedral priſms terminating in trihedral ſummits, or in irregular polyhedral grains.

Newton conjectured the diamond to be a combuſtible body. *Guyton* in 1785 inferred its ſimilarity to charcoal, from its leaving an effervеſcent 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. Tenant*, 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 mat-*

ter 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 oxidation 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 oxidated 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 Chim.* 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 a 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 Chim.* No. 93.

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

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

CARBONIC ACID GAS, formerly termed *fixed air*, or *aërial acid*, was diſcovered by Dr. Black, it is formed by the combination juſt mentioned, of carbon, oxygen, and caloric. 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, of which, according to Von Humboldt, it forms a 66th part, in the proportion of 1½ to 1; 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. It readily combines with cold water, to which it gives a peculiar pungent taſte, rendering it manifeſtly acid, heat or congelation again ſeparating it from the water. It exiſts in a concrete ſtate, in combination with alkalies; and with the earths, particularly with the calcareous; 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. The ſuperior degree of attraction of carbon for oxygen, renders this gas very difficult of decompoſition.

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

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.*

CARBONATED HYDROGEN GAS, or *Hydro-carbonate Gas*, is formed by the union of *hydrogen* with a portion of *carbon* and *caloric*. It may be obtained by diſtillation from moiſtened charcoal.

In illuſtration of the different ſtates of compoſition in which the conſtituent principles of azote 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 or 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.

CARBONATES are neutral ſalts compoſed of ths *carbonic acid*, and certain *baſes*.

CARBONATE of POT-ASH, formerly called *aërated potaſh*, or *aërated vegetable alkali*, is made by expoſing a ſolution of alkali to the carbonic acid gas until ſaturated, when it will yield oblique tetrahedral priſms, terminating in dihedral truncated ſummits. It has now leſs of the urinous taſte, but 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, CAUSTIC 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 a urinary taſte. It is decompoſed by quick-lime, by the acids, and by fire, in the ſame manner as the former carbonate; but it is more eaſily decompoſable by phoſphorus, than the other carbonates. 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 AMMONIAC, 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 ammoniac; by expoſing the ammoniac in a veſſel of the carbonic acid gas; or by diſtilling it from a mixture of ammoniac 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. It may be decompoſed by moſt of the acids, their affinity with ammoniac exceeding that of the carbonic. Its cryſtals are tetrahedral; or octahedral priſms, 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, charcoal, nitrogen, and hydro-carbonate.

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, in its primitive form. 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 BARYT, *Barolite*, *Kirw.* *Witherite*, *Werner*. This combination has no taſte, is not altered in the air, is almoſt inſoluble in water, but is decompounded by heat, and by all the acids. 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.——*Guyton.*

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.——*Butini.*

When fully ſaturated with carbonic acid, it becomes more ſoluble, and by ſlow evaporation will cryſtallize in hexagonal priſms with hexagonal ſummits.——*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.——*Tabl. de Fourcroy*, 1800.

CARBONATE of ALUMINE is formed by the acid of the carbonates of alkalies, combining with the earth thereby precipitated from a ſolution of alum. It has been found near *Halle*, in Magdebourg, and is alſo called *lac lunæ*. It varies in its proportions.

CARBONATE of STRONTIAN is found at *Strontian*, in Scotland, formed in ſmall ſtriated hexahedral priſms, of a light green, and not quite opake. It 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. It is only decompoſable by baryt.——*Fourcroy.*

CARBONATE of ZIRCONIA is inſipid, and indiſſoluble in water. It contains 55,5 of zirconia; and 44,5 of acid and water.

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.

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.

OF MURIATIC ACID.

MURIATIC ACID, formerly termed *Marine Acid*, or *Acid of Sea Salt*, &c. is conjectured, from analogy, to conſiſt of *oxygen*, in combination with a peculiar, but hitherto *unknown baſis*.* It is obtained by diſtillation, from a mixture of ſea ſalt, with half its weight of ſulphuric acid. The reſiduum is *ſulphate of ſoda*, ſhewing the ſea ſalt employed to have been a neutral ſalt compoſed of this acid and ſoda.

When pure, it is colourleſs, and of a leſs ſpecific gravity than the nitric acid. 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, but ſeizes the oxygen of oxided bodies. It abſorbs the carbonic acid, and its affinities with baryt, pot-aſh, ſoda, ammoniac, lime, magneſia, and alumine, appear to be in the order they are here placed.

MURIATIC ACID GAS, is eaſily obtained in this form: it has a ſtrong ſmell, and is ſharp, without being cauſtic. It is heavier than common air, extinguiſhes flame, firſt en-

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* *Girtanner* ſuppoſed this radical to be *hydrogen*; and *Armet* thought it to be the metal *zinc*.

Mr. W. Lambe ſuppoſes that ſulphurated 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.

larging it, by a greeniſh or bluiſh circum-ambient flame. It ſuffocates animals, and is unchangeable by light, caloric, or combuſtible bodies. It unites with water with great rapidity and heat, forming the fluid muriatic acid.

Oxygenated Muriatic Acid, is formed by the addition of *oxygen* to the *muriatic acid*, which it ſeizes with avidity, whenever it is preſented to it. 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 mangaueſe. The acid is, in this ſtate, of a yellowiſh colour, of an auſtere taſte, and of an exceſſively ſtrong diſagreeable ſmell; its vapours irritating the larynx violently. It renders the blue colours of vegetables white, and thus deſtroys the colour of moſt ſubſtances, thereby loſing its oxygen. When about the freezing point, it cryſtallizes, in quadrangular ſpiculæ. It oxidates metals with rapidity, and thickens oils. By communicating its oxygen to ſulphur, it produces the ſulphuric acid. Expoſed to the light, oxygen gas is ſeparated, and ordinary muriatic acid is left; and 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 oxygenated 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.

When it is mixed with ammoniac, decompoſition with great effervescence, takes place; no neutral ſalt is formed; but the hydrogen of the ammoniac, 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 ammoniac are mixed in the ſtate of gas, conſiderable detonation and inflammation ſucceed.

Phoſphorus and carbon immediately unite with its oxygen, and form phoſphoric and carbonic acids.

Phoſphorus, charcoal, cinnabar, antimony, biſmuth, zinc, and ſeveral other combuſtible bodies, reduced to powder, are ſpontaneouſly inflamed when thrown into this acid, warmed and in a ſtate of vapour.——*Gren.*

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.*

It powerfully bleeches linen, cotton cloths, and paper; and in the proportion of twelve ounces to forty-eight pounds of ſpirit of wine, it is exceedingly efficacious in bleaching raw ſilk, and even entire garments.——*Journal de Phyſique,* XLIII.

MURIATES are neutral ſalts, formed by the *muriatic acid*, and certain *baſes.*

MURIATE of POT-ASH, the *febrifuge Salt of Sylvius.* It contains in 100 grains, 29,68 acid, 63,47 alkali, and 6,85 water. It is found in ſea-water, in old plaiſter, and in vegetable and animal fluids. It cryſtallizes in cubes, which have a ſtrong, bitter, diſagreeable taſte.

MURIATE of SODA, *Marine Salt*, *Common Salt*, *Rock Salt*, *Bay Salt*, or *Sal Gem*, contains 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, purification, &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, decripitates on hot coals, and by great heat, is volatilized without decompoſition. It cryſtallizes in cubes, or in hollow tetrahedrons, ſoluble in 2,5 their weight of cold water.

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 AMMONIAC, or *Sal Ammoniac*, 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 ammoniac, and 8 water. It cryſtallizes in quadrangular priſms, with tetrahedral pyramids; 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 ammoniac 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 ammoniac* is obtained, but if the carbonate of lime or of alkali be employed, then a *carbonate of ammoniac* is the reſult of the proceſs.

MURIATE of LIME, *Muriated Calx, Calcareous Marine Salt,* or *Glauber's fixed Sal ammoniac,* 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 ammoniac. 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 is decompoſed by baryt, and the alkalies. It fuſes with a moderate heat, 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. Like the nitrate of lime, this ſalt renders the flame of alcohol red.

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.

MURIATE of BARYT does not ſeem to exiſt native. When obtained artificially, it forms in tabular cryſtals, which do not ſuffer any change in the air or fire, and have a nauſeous and burning taſte. Pure alkalies and earths have no effect on this ſalt. The ſulphuric and fluoric acids decompoſe it very readily; hence this ſalt is highly uſeful to detect the preſence of theſe acids in any mixture. This ſalt produces the ſame effect on the flame of alcohol as the nitrate of baryt does, giving it a yellowiſh white hue.

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

MURIATE of STRONTIAN forms hexahedral priſms with alternate broad and narrow ſurfaces, with trihedral pyramids. It gives to the flame of alcohol a bright red colour.

MURIATE of GLUCINE forms in ſweet and very ſmall cryſtals.

MURIATE of ZIRCONIA 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 exiſts only in a liquid and cold ſtate, heat precipitating the ſilica. ——*Fourcroy*, 1800.

AMMONIACO-MAGNESIAN MURIATE is formed by a mixture of the ſolutions of the two muriates. It forms ſmall, irregular polyhedra ; is ſoluble in ſeven parts of water, and contains muriate of magneſia 73, and of ammoniac 27.

OXY-MURIATE of POT-ASH is formed by introducing the oxygenated muriatic gas into a ſolution of pot-aſh; 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 emit light by attrition.

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.

It is ſaid to be decompoſed by the action of light, parting with its oxygen, and becoming ſimple muriate.

This is, however, denied by Mr. Hoyle.——*Mancheſter Memoirs*, vol. v.

Heat ſeparates its oxygen from it, in the form of oxygenous 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 equal quantities of ſublimed ſulphur, it explodes, by mere trituration ; and ſpontaneouſly, if kept in a bottle. ——*Nicholſon's Journal*.

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

A little of this muriate being put into the ſulphuric acid, violent cracklings or ſmall exploſions ſucceed, and if a ſmall piece of phoſphorus be alſo dropped in, a violent exploſion takes place: the addition of heat will alſo occaſion its exploſion. This muriate being rubbed with an equal quantity of phoſphorus, a violent exploſion follows with a flaſh of light. If mixed with charcoal, and ſmartly ſtruck with a hammer, flame, but not much noiſe, ſucceeds; but with pit-coal, ſparks, and ſome ſmall reports are produced: with ſulphur a report and flame; and with ſulphuret of pot-aſh, and of arſenic 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, aurum muſivum, &c.——*Mancheſter Memoirs*, vol. v. part 1.

The oxy-muriate of carbonated 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.

Being employed in the fabrication of gun-powder inſtead of nitre, the effects produced by its ignition, are augmented to a four-fold degree; and the mixture will explode by mere trituration.

OXY-MURIATE of SODA differs from that of pot-aſh, in being more diſpoſed to efferveſcence, and to ſolution in alcohol.

Of the other oxy-muriates but little is known. *Van Mons* ſays, he formed the OXY-MURIATE of AMMONIAC; but *Gren* aſſerts that ſuch a combination cannot exiſt.

NITRO-MURIATIC ACID, or *Aqua Regia*, is formed by diſtillation of the *nitric* and *muriatic* acids in the proportion of two parts of the former, and one of the latter. Four ounces of ſal-ammoniac 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, as well as a portion of nitrous gas; forming a mixture of muriatic acid thus oxygenated 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 oxidates without diſſolving.

OF ACID OF BORAX.

ACID OF BORAX, formerly called *Homberg's Sedative Salt*, 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. 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. Its acidifiable baſe has not yet been ſeparated.

BORATE of SODA, or *Borax*, is formed by the combination of *acid of borax* and *ſoda*. The borax of commerce is a borate ſuperſaturated 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 it is diſſolved in ſix times its weight of boiling water. Expoſed to a moderate heat, it melts with its water of cryſtallization, and is reduced into 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 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 AMMONIAC 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 **STRONTIAN**, 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.

OF FLUORIC ACID.

FLUORIC ACID 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 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 volatiliꝫing it with itſelf, depoſits it as a ſiliceous cruſt on the ſurface of the water in the receiver. In ſmell and taſte it reſembles the muriatic acid.

It does not act on gold, or ſilver, but combines in preference with their oxides. From its power of diſſolving ſiliceous earth, it is employed for the purpoſe of etching on glaſs.

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 *oxygenated* ſtate, and that it therefore deſerves farther inveſtigation.

FLUATE of POT-ASH is a gelatinous ſubſtance, which readily diſſolves in water, deliqueſces in the atmoſphere, and is with difficulty chryſtallized. 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 AMMONIAC 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, or *Fluor Spar*, 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 in a moderate heat. It promotes the fuſion of clay, and other earthy ſubſtances, but is not very fuſible itſelf. 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.

FLUATE of ARGILL has been found in Greenland. But 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 analyſis 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.*

METALLIC SUBSTANCES.

THESE are diſtinguiſhed by their abſolute *opacity*, great degree of *gravity*, and peculiar *brilliancy*; to which may be added their *ductility*, which property, however, is not perhaps poſſeſſed by all metals.

They are concealed in the earth, and from *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 appear to be ſimple ſubſtances. They are *aſſayed*, and their ſpecies aſcertained, by the *Docimaſtic Act*, 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 *ſlich*, 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 eoally principle, to diſengage the oxygen, with which the metal has been impregnated, during the previous calcination, or torrefaction.

They are found. 1. In the form of a native metal. 2. In the form of calx or 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, arſenical, 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*, or *calx*; 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*.

That metals are calcined, or rather oxidated, 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 oxidation, 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 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.

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 HYDRO-SULPHURET. They may alſo be made to enter into combination with ammoniac, when ſubſtances are formed which are termed AMMONIURETS.

If calcined, and not too volatile, they communicate a tinge to borax and microſcomic ſalt, after fuſion, or render them opake. 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, charcoal, ammoniac, hydrogen, and alkaline ſulphurets. Thus we have *metallic* SULPHURETS, PHOSPHURETS, CARBURETS, AMMONIURETS, HYDRURETS, and HYDRO-SULPHURETS.

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. Uranite. 16. Sylvanite. 17. Titanite. 18. Chrome. 19. Arſenic. 20. Molybdenite. 21. Tungſtenite.

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

PYRITES, or *Marcaſites*, are METALLIC SULPHURETS, which are formed by the union of metals with *ſulphur*. The moſt common of theſe are the SULPHURETS OF IRON.

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 between the tin and ſilver white. Sp. gr. 20,6 to 23: being the moſt ponderous of all known bodies. It is conſiderably malleable, and ductile; but harder than gold. It is not affected by the action of the air, nor by the heat of an ordinary furnace; but yields to the heat produced by powerful burning glaſſes, and to that excited by ignited oxygen gas.

It is often mixed with quickſilver, and gold, and is intimately 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 ammoniac. This precipitation of platina, by the muriate of ammoniac, affords a ſimple method of aſcertaining the mixture of this metal, with gold, ſince the muriate of ammoniac has no viſible effect on the ſolution of gold.

It is ſoluble in the *nitro-muriatic*, and the *oxy-muriatic acid*; the ſaturated ſolution being of a dark-red colour. It is precipitable from this ſolution, by pot-aſh, and muriate of ammoniac; leſs freely by ſoda, not viſibly by the Pruſſian alkali, and not 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.——*Bergman.*

It amalgamates, though with difficulty and very ſparingly, with *quickſilver*, and is capable of being alloyed with moſt of the known metals.

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*, is very fuſible, and unleſs the tin is in large proportion, the alloy is 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 is prodigiouſly altered, and the alloy poſſeſſes conſiderable ductility.

Platina free from iron, being fuſed with *phoſphorus*, by long continued heat, is obtained in a concrete porous form, and may be formed into a ſolid maſs, under the hammer, being a PHOSPHURET of PLATINA.

GOLD.—Its colour is orange red, or reddiſh yellow. Sp. gr. 19,3. melts at 32°. Wedgwood. It may be volatilized and calcined, in high and long continued heats. It is the moſt perfect, ductile, tenacious, and unchangeable of all the known metals. Not being combinable with oxygen, ſulphur, &c. in low heats, it can never be found, ſtrictly ſpeaking, mineralized.

It is found in compact maſſes, or interſperſed in various modes. Its form of cryſtallization is generally the aluminiform octahedron, with its modifications.

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 is not attacked by the *ſulphuric acid*, and is very ſlightly acted on by the *nitric acid*; but is attacked with moſt energy by the *nitro-muriatic* acid, or *aqua regia*, as it is called, and the *oxy-muriatic acid*, which are the true ſolvents of 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 a red liquor, 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*.

When precipitated by *ammoniac* from the yellow ſolution, it is called FULMINATING GOLD, it detonating when gently heated. Fulminating gold has been proved to be a mixture of ammoniac, and oxide of gold; the oxygen of the latter, and the hydrogen of the alkali, taking fire by ſimple heat, detonate; and the gold is reſtored to its metallic ſtate.

It does not unite with nitrogen, hydrogen, carbon, nor ſulphur; nor does it act on water or the metallic oxides.——*Fourcroy*, 1800.

It is precipitated from its ſolution by ſeveral 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 *æther*, the gold immediately forming a ſtratum at the ſurface of the now colourleſs liquor.

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, pulveriſed, and diſſolved in hot water, being an HYDRO-SULPHURET of GOLD. Stahl affirms, that by this proceſs Moſes diſſolved the golden calf. 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 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.

Mr. Alchorne expreſſes an opinion, that the addition of a very ſmall quantity of tin to fine gold, is not ſo injurious as workmen have imagined.——*Phil. Tranſ.*

But after repeating Mr. Alchorne's experiments, M. Tillet is convinced, that the alloy of a very ſmall quantity of tin with gold is injurious, the mixture poſſeſſing both hardneſs and rigidity.——*Mem. de l'Academie*, 1790.

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 purpoſe 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 *gilders 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. 2nd. *Grecian gilding of ſilver* is performed by a ſolution of gold in nitric acid, to which ſal-alembroth (a triple ſalt formed by ſal ammoniac 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* 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.*

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SILVER is of a pure white. Sp. gr. before malleation, 10,474: after, 10,510. It is malleable, ductile, and laminable, in a high degree, though inferior to gold; and is not changed by the contact of air. 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.* If by means of ſolution of *borax*, a ſmall bit of leaf ſilver, be ſtuck to the top of a ſmall glaſs cylinder, and melted into it, it will give it a golden tinge.——*Bergman.*

By long expoſure to violent heat, it has been converted into a glaſs of an olive green colour. In the focus of a burning glaſs, it yields a white pulverulent matter; but there appears to exiſt but little affinity between it and oxygen.

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.

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

With *ſulphuric acid*, if concentrated, ſulphureous gas is diſengaged, and the ſilver is converted into a true OXIDE of SILVER, mixed with a ſmall quantity of SULPHATE of

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

SILVER, in ſmall needles, or in plates formed of theſe needles, united length-ways.

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; but this colour diſappears 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*.

By fixed alkalies it is precipitated from its ſolution, white; by ammoniac, grey; and by lime-water, olive-green.

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. It is likewiſe precipitated by *mercury*, with which it will alſo amalgamate. Theſe cryſtals, being articulated into each other, give them the form of a vegetation, known by the name of the TREE of DIANA, *Arbor Dianæ*, &c.

Nitrated ſilver, being precipitated from its ſolution, ſeparated from the fluid, expoſed three days to the air and light, and mixed with liquid ammoniac; becomes, when dry, FULMINATING SILVER. This exceeds in power, gun powder, and even fulminating gold. Once obtained, it 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 ammoniac, by which water, in the ſtate of vapour is produced. This water, inſtantly vaporiſed, and poſſeſſing all the elaſticity, and expanſive force of that ſtate, is the principal cauſe of the phenomenon; in which the nitrogen of the ammoniac, with its whole expanſibility, bears a part.

It is readily combined with *the muriatic acid*, by adding this acid to a ſolution of ſilver in the nitric acid, the MURIATE of SILVER being precipitated; 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 ſulphate of pot-aſh, and the remaining alkali. It may likewiſe be decompounded by ſeveral other metals.

Profeſſor Hildebrant ſays, I have frequently re-diſſolved, in pure nitrous acid, the ſilver which I obtained from horn ſilver, and always found a ſmall quantity of black-powder remaining at the bottom, which ſeemed to have the properties of gold. To appearance, part of the ſilver is converted to gold; but the Profeſſor, accounts for it, from the ſilver, though called pure, containing the gold thus found.

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.

CARBONATE of SILVER may be obtained, by precipitating it by the carbonate of alkali.

Sulphur unites with it; this SULPHURET of SILVER is known as *vitreous ſilver ore.*

An ALKALINE SULPHURET of SILVER may be obtained by fuſion with *alkaline ſulphuret*, and from the ſolution of this an HYDRO-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.*

Mr. Keir diſcovered that a *mixture of the vitriolic and nitrous acids*, in a concentrated ſtate, has a peculiar faculty of diſſolving ſilver copiouſly: and at the ſame time, oxidating 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 as indeſtructible by fire as gold and ſilver, and has therefore been arranged among the perfect metals. It is volatile in heat, and boils in the ſame manner, as other liquids when heated.

It remains liquid between 600° above, and 72° below the freezing point. When congealed by cold, it acquires malleability. Mr. Walker ſays, that quickſilver may be frozen by a mixture of ſnow and nitrous acid, each being at + 70°. By ground ice, and nitrous acid, at + 10°. To make it perfectly ſolid and hard, a mixture of diluted ſulphuric acid and nitrous 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 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 befofe fuſion took place, whilſt others were twiſted and bent into various forms.——*Philoſ. Mag.* Feb. 1799.

It is but little affected by the air, except 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.

Mercury does not appear to be at all changed, or deprived of any part of its weight, by the action of *water*. The *ſulphuric acid* acts on mercury, only if aſſiſted by heat, firſt rendering it an oxide, and then diſſolving the oxide. Cold water being added, a *white oxide* falls, and hot water being poured on it, it becomes a YELLOW, *imperfect*, OXIDE, called *Turbith mineral*; the water holding in ſolution a SULPHATE of MERCURY, cryſtallizable in ſmall, ſoft, and deliqueſcent needles. The ſulphates may 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, nitrous gas being diſengaged; one part of the acid oxidating the metal, whilſt the other diſſolves it, as it is oxidated. With cold dilute acid, the oxidation is but imperfect, but with heat and concentrated acid, it is complete.

The nitric acid becomes loaded with an exceſs of mercurial oxide, which it lets fall on dilution with water, and yields cryſtals, in the form of flat and acute needles, ſtriated lengthways. 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 this ſame ſolution be evaporated, long and acute blades are obtained, ſtriated obliquely acroſs.

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, it yields oxygen or nitrogen gaſes, the remaining oxide becoming yellow, and at length a lively red, being the *red precipitate*, and 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.

100 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 36° 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.——*Howard. Phil. Tranſ.* for 1800.

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 ammoniac 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*.

The *muriatic acid* does not ſenſibly act on mercury, except by long digeſtion, when it oxidates 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, the OXY-MURIATE of MERCURY, or *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, decripitated 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 may be obtained by diſſolving mercury in the oxygenated 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 *phagœdenic 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 oxygenated muriate, are completely blended by trituration, and this mixture expoſed to ſublimation, the reguline mercury becomes oxidated at the expence of the oxygen of the oxide, and yields the mercurius dulcis, which is inſipid, inſoluble in water, and 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.

Borax 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 this *phoſphoric*, *fluoric*, and *carbonic* acids are made to unite with mercury.

Corroſive ſublimate is 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 tin.

Mercury long triturated and digeſted with moiſtened *muriate of ammoniac*, forms an AMMONIACO-MERCURIAL MURIATE.

The *acetic acid* diſſolves the oxides of mercury, and affords white foliated cryſtals, the ACETATE of MERCURY. Mercury precipitated from the ſolution of the *acetate of mercury*, combines with the acidulous tartrite of pot-aſh, and forms the *vegeto-mercurial water* of Preſſavin. The acetate of mercury is the baſis of *Keyſer's Pills*.

Mercury mixed with *ſulphur*, forms the RED SULPHURET, or the BLACK SULPHURATED 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 ſulphurated oxide of mercury*, or mineral æthiops, is formed.

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

The Count Apollos 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 æthiop's not ſur-compoſed.——*Nicholſon's Journal.*

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 muddy red, with a ſhade of yellow, malleable, flexible, and ductile, though inferior in theſe reſpects to ſilver. Sp. gr. 7,780 to 8,584. A wire 1-10th of an inch, will ſupport 299½ pounds. It melts at 27° Wedgwood. Expoſed to the fire, it becomes blue, yellow, and at laſt, violet. When in contact with the coals, it gives a greeniſh blue tinge to the flame, and if kept long in fuſion, part is volatilized. Heated in contact with air, it burns at its ſurface, and becomes changed into an *imperfect blackiſh red* OXIDE, which by a more violent heat, is converted into a *brown glaſs*, or *more perfect* OXIDE. If melted and cooled ſlowly, it forms, according to *Mongez*, in quadrilateral pyramids. It has no action on *water*, yields oxygen to many of the metals; but takes it from *mercury* and *ſilver*. ——*Fourcroy*, 1800.

It combines readily with ſulphur, forming a very fuſible maſs, termed SULPHURET of COPPER. It alſo unites readily with *phoſphorus*, forming a grey, brilliant PHOSPHURET of COPPER.

It is acted on by the *ſulphuric acid,* only when concentrated, and very hot. It is then oxided by it, and affords blue oblong rhomboidal 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 precipitate the copper of a bluiſh white, as well as ammoniac; but the precipitate from this, is diſſolved at the inſtant it is formed, and the reſult is a beautiful blue liquor, called *aqua celeſtis.*

It is attacked by diluted *nitric acid* with efferveſcence, abundance of nitrous gas being emitted. A blue ſolution is thus obtained, yielding cryſtals of NITRATE of COPPER, in long parallelograms, or rhomboidal cryſtals.

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

When acted on by the *acetous acid,* it is corroded, and yields the ſubſtance known by the name of *verdegris.* Being combined with oxygen, it becomes more readily ſoluble in vinegar. The oxide of copper diſſolved in vinegar, forms the ACETITE of COPPER, *diſtilled verdegris,* 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.*

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. It is alſo readily acted on by rancid fats or oils.

It is precipitated from its ſolutions, in its metallic form, by a clean 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 SIMILOR, 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.

Copper filings being added to a cauſtic ſpirit of ammoniac, 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.——*Gren.*

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, ſomewhat bluiſh grey. 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. It is the moſt generally diffuſed metal in nature: almoſt every mineral ſubſtance deriving a colour from it, from the blue to the deepeſt red. Animal ſubſtances contain it, and it exiſts in the vegetable kingdom; even in vegetables ſupported merely by air and water. It requires for its fuſion a heat equal to 130° Wedgwood.

It is obedient to the magnet, is the only metal capable of combuſtion, on colliſion with quartz, and the only metal conſtantly found exiſting in the fluids of organized bodies. It is difficult of fuſion, but may be hammered with heat into any form. When ſlowly cooled, it cryſtallizes into octahedra almoſt always implanted one in the other. It is oxidated 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 oxidated, and ſeparates in the form of black ſcales.

This oxide is ſtill attracted by the magnet, and contains from 0,20 to 0,27 oxygen.——*Fourcroy*, 1800.

This oxide of iron, when moſt degraded, and of a reddiſh brown colour, is the BROWN OXIDE of IRON, formerly called the *aſtringent ſaffron of Mars*. It contains 0,40 to 0,49 oxygen.——*Fourcroy*, 1800.

The colour varies with the degree of oxidation, becoming yellow and even red; and is reduced to a black powder, by heating it with coally matters.

Iron in filings, being conſtantly agitated in water, a black powder is depoſited, being a *perfect* BLACK OXIDE of IRON, alſo called the *martial æthiops of Lemery*. The oxidation is effected by the air contained in the water; but more eſpecially by the decompoſition of the water itſelf, hydrogen gas being developed during the proceſs. With heat this proceſs is rapidly performed, and much hydrogen gas is ſeparated. After oxidation it is leſs attractable by the magnet and leſs ſoluble in nitric acid: poſſeſſing theſe properties, inverſely, as to the quantity of oxygen it contains. It is oxided 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.

An iron wire, heated red-hot, being plunged in pure oxygen gas, burns and deflagrates with wonderful brilliancy.

Iron, when fuſed, may be caſt into ſuitable moulds, in which ſtate it is called *caſt iron*. If inſtead of this it be ſtirred when in fuſion, and then carried to the forge hammer, and hammered into bars, it aſſumes a fibrous texture, and becomes more ductile: in this ſtate it is called *bar*, or *forged iron*. If placed in contact with coally ſubſtances, and ſoftened to ſuch a degree that theſe may penetrate into its texture, a ſubſtance is formed poſſeſſing a greater degree of hardneſs and elaſticity than either of the former, and it is then termed *ſteel*.

Theſe three ſtates appear to be modifications of the ſame ſubſtances.

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.

I. 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. Its varieties are:

1. Oxygenated crude iron, which contains a ſmall proportion of carbon, and a ſuper-abundance of oxygen, is called *white-iron, forge-pigs, ballaſt-iron,* &c.

2. Carbo oxygenated crude iron, contains equal quantities of carbon and oxygen; known by the name of *grey-iron.*

3. Carbonated crude iron,—carbon fully predominating with an extra privation of oxygen.

4. Super-carbonated crude-iron,—approaching to and even becoming a true plumbago.——*Philoſ. Mag.*

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, which is malleable when cold, but brittle when ignited, is ſuppoſed to derive theſe properties from arſenic, or from concrete carbon, not extirpated during the operation for rendering it malleable.——*Vander Monde, Monge,* and *Berthollet.*

Cold ſhort iron which is brittle when cold, but not when ignited, being diſſolved in the ſulphuric acid, 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, or combination of *phoſphorus* with iron.

Every ſolution of iron is precipitated in the form of ſiderite, by the phoſphoric acid.

STEEL is a kind of iron containing *carbon* only, it may be impregnated with this. 1. During the fuſion, which happens when the iron is contained in the ore in nearly a diſengaged ſtate, and a large proportion of coal is employed; the iron being ſcarcely at all calcined, becomes charged with carbon only, the reſult being ſteel. 2. Afterwards, by the cementation of iron in a ductile ſtate, and free from all foreign matters, with coally ſubſtances, the iron in both theſe caſes paſſing into the ſtate of ſteel, or CARBURET of IRON.

The nature of the combination producing ſteel, will plainly appear from ſteel kept plunged for a conſiderable time in crude iron, abounding with oxygen, being converted into ſoft iron. Soft iron on the other hand, kept for a time in crude iron, in which carbon predominates, is converted into ſteel.

Steel is ductile, whether cold or ignited; but being *tempered*, by plunging 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.

Iron may contain a much greater quantity of carbon than is neceſſary as a conſtituent part of ſteel; in this ſtate it is hard and unmalleable, and may be called HYPER-CARBURET of IRON.——*Dr. Pearſon, Phil. Tranſ.*

Clouet has obſerved that 1-32 of charcoal is ſufficient to convert iron into ſteel; and that 1-6th affords a ſteel more fuſible, but ſtill malleable. After this it comes nearer to the ſtate of caſt iron, and by augmenting the doſe of charcoal, the fuſibility is increaſed, and at laſt it acquires the ſtate of *grey caſt iron.*

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 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 the 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 Chimie*, 1798.

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.*

Mr. Muſhet, on the ſuggeſtion of the Editor, obſerves that carbon exiſts in ſteel, in a concrete ſtate, though not crude—in chemical union, however, and not in mere mixture, as in crude iron.——*Philoſ. Mag.*

The tempering of iron, effected by ſuddenly cooling it after heating, ſeems to produce its hardneſs, brilliancy and brittleneſs, by the integrant parts, ſeparated by the heat, being kept and left at a certain diſtance from each other; the ſudden cold checking their approximation by the affinity of aggregation.

Steel is capable alſo of fuſion, when it is termed *caſt ſteel.*

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. Beddoes obſerves, that in the converſion of caſt into malleable iron, in the reverberatory furnace, the oxygen of the imperfectly reduced metal, combines with the charcoal to form fixed air; at the ſame time another portion of charcoal is thrown into an elaſtic ſtate, that is, into inflammable air, and burns on the ſurface with a very deep blue flame, on account of the admixture of fixed air. By ſubſequent experiments, the Doctor aſcertained beyond doubt, the real extrication of air, varying in its nature at various periods of the proceſs.——*Philoſ. Tranſ.* 1791.

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.

A drop of nitrous acid placed on poliſhed iron and waſhed off, leaves a white ſpot. On poliſhed ſteel it forms a black ſpot, by the coally part which is depoſited during the ſolution of the iron.

ANTHRACOLITE, or incombuſtible pit-coal, may be conſidered as a foſſil carburet, it has a metallic luſtre, marks a little, is ſoft and brittle. Sp. gr. 1,468. It contains 0,90 carbon, 0,04 alumine, 0,03 ſilex, 0,03 iron.

PLUMBAGO, alſo called *Graphite*, and *Black-lead*, 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 *oxygenated muriatic acid* diſſolves it; the reſult being a true combuſtion 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 deſtroyed; the reſidue being a ſtrongly carbonated 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; it thereby appearing 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 encloſed 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.——*Philoſ. 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 earth, ſomewhat reſembling ſteel, Sir George repeating Guyton's experiment with compleat ſucceſs——*Nicholſon's Journal*, June, 1800.

Iron combines eaſily with ſulphur by fuſion, forming a *true martial pyrites,* or ſulphuret of iron.

By the combination of the SULPHUR with iron, in the bowels of the earth, are formed the *ſulphureous iron ores*, the *martial pyrites*, or SULPHURETS of IRON. Theſe ſulphurets are very abundant, and are evidently formed by the decompoſition of vegetables.——*Chaptal.*

The 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 holding the iron in ſolution, forms the SULPHATE of IRON, called alſo *copperas*, *ſal martis*, *vitriol of iron*, and *ſalt of ſteel*. This ſalt is alſo obtained by pouring *diluted ſulphuric acid* on iron filings, an efferveſcence ariſing, from the eſcape of the hydrogen gas of the water, its oxygen helping to oxydate the metal, which the acid diſſolves. It cryſtallizes in rhomboids of a beautiful green colour, of which it is deprived by expoſure to the air, from its efflореſcing, and loſing its water of cryſtallization; expoſed to heat, it liquefies, becomes thick, and is reduced to a powder. This powder mixed with pulveriſed nutgalls, forms *ink-powder,* only requiring the addition of water to render it fit for uſe. The ſame powder urged by ſtronger heat, loſes all its ſulphuric acid, a *martial oxide,* named *colcothar,* remaining.

The *concentrated acid* is decompoſed by boiling in this metal. The mixture being diſtilled to dryneſs, ſublimed ſulphur, and a white incryſtallizable maſs, but ſoluble in water, will be found in the retort.

Prouſt has diſcovered that the common ſulphates of iron contain a *green* and *red* ſulphate.

The green is inſoluble in ſpirits of wine, affords a white precipitate with alkaline pruſſiates, is not altered by the gallic acid, and its oxide contains 0,27 of oxygen. It has a ſtrong affinity for oxygen, becoming red by attracting it.

The red is ſoluble in alcohol and uncryſtallizable, gives a fine blue precipitate with alkaline pruſſiates, and with the gallic acid a ſtrong black one; its oxide contains 0,48 of oxygen. It has no affinity for oxygen, being already a *ſuroxygenated* SULPHATE of IRON.

The green may be changed to red by oxy-muriatic or nitric acid, and the common ſulphate to green by ſulphurated hydrogen.

The muriatic and other acids may by combining with either of theſe oxides that form diſtinct ſalts.——*Annales de Chimie,* 1800.

It may be alſo precipitated by the *carbonate of pot-aſh,* and re-diſſolved by the ſuperabundant alkali, forming the *martial alkaline tincture of Stahl.* Or if it be precipitated by cauſtic alkali, the æthiops is formed at once.——*Maret.*

Iron is rather oxidated than properly diſſolved by the *nitric acid,* which at the ſame time is rapidly decompoſed. 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 nitrous 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 ammoniac, the veſſel alſo now holding oxygenated nitrous gas. The water and nitrous acid being deprived of their oxygen by the iron, their hydrogen and nitrogen combine whilſt in a ſtate of condenſation and compoſe the ammoniac in this form.——*Fabroni, Ann. de Chi.* 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; there remaining at the bottom of the retort, a deliqueſcent ſalt of a brilliant colour, and foliated appearance, like fine large talc. 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, by adding the ſoluble phoſphates to a ſolution of ſulphate of iron. Thus is formed an almoſt inſoluble PHOSPHATE of IRON, becoming *phoſphate of iron*, by fuſion with powdered charcoal ——*Fourcroy*, 1800.

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.

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 Chi.* 100.

With the *Pruſſic acid*, it forms PRUSSIATE of IRON, or *Pruſſian blue.* If the oxide of iron predominates in this combination of iron and the pruſſic acid, the precipitate is yellowiſh; but if its proportion be leſs, the product is Pruſſian blue. The pruſſiate of iron is decompoſed by the oxide of mercury. 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.

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 *Zwelſer's ſaffron of Mars*. Iron decompoſes the muriate of ammoniac, very well, yielding an aeriform fluid, half alkaline, and half hydrogenous. Iron, in filings, ſublimed with muriate of ammoniac, in the proportion of an ounce to a pound, forms the MARTIAL FLOWERS, or *ens martis*, being a MURIATE of AMMONIAC COLOURED BY IRON.

The filings mixed with ſulphur, and moiſtened with water, forms a maſs which ſwells, and becomes heated in a few hours. The water is decompoſed, the iron is ruſted, and the ſulphur is converted into acid; the hydrogen gas exhales, and the heat is ſometimes ſufficient to ſet the mixture on fire. By this proceſs is produced the *volcano of Lemery*, the maſs being placed under ground.

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 oxygenated.

It may be alloyed with ſeveral metallic ſubſtances, but the only union which is uſed in the arts, is that which it contracts with tin, by which *tin plates* are formed.

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 oxidated or rather carbonated, and it may be claſſed among the moſt fuſible of metals. It affects the organs both of ſmell and taſte. It melts before it becomes red-hot, at 540° Farenheit. In a cupelling heat it evaporates and loſes from 6 to 8 per cent. of its weight. *Abbe Mongez* obtained it in quadrangular cryſtals, recumbent on one ſide.

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 coally matter, the metal is revived; if diſtilled 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.

Sulphuric acid being boiled on lead, much ſulphureous gas ariſes, and an oxide of lead is formed, as well as a very cauſtic SULPHATE of LEAD, which cryſtallizes in the octohedron and its ſeveral modifications.

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.

The *muriatic acid* aſſiſted by heat, oxidates 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 horn-like matter, called *plumbum corneum*.

The *oxy-muriatic acid* forms a *brown perfect*, or *ſuper-oxygenated*, OXIDE of the white or red oxides.

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 ammoniac*: 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.*

All the oxides of lead are ſoluble in vinegar, forming the ACETITE of LEAD, which cryſtallizes in efflorescent tetrahedral priſms, formerly called *ſalt of ſaturn*, or *ſugar of lead.*

The oxides of lead attract the *carbonic acid* of the atmoſphere with great eagerneſs.

Cauſtic 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.*

Sulphur combines readily with lead, forming a brilliant ſemi-cryſtallized maſs, termed SULPHURET of LEAD, which aſſumes the forms of the cube and octohedron, with their modifications, and is the artificial *galena.*

It has no known union with *carbon* or *hydrogen.* 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 *tin*, a very uſeful ſolder; but with *zinc*, its union is very weak.

As lead has the property of being eaſily oxided 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. Hanhemann. 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.

From this property of precipitating the lead of a dark colour, the alkaline ſulphurets, and even the ſulphurated 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 the lighteſt of all metals; is exceedingly ductile, but inconſiderably tenacious. It is very flexible, and crackles when bended. It fuſes 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.* Kept in fuſion eight or ten hours in a lined crucible, and in contact with charcoal, it becomes more white, hard, and ſonorous. It takes fire with a violent heat, a white oxide ſubliming, and part of the tin being converted into a glaſs of an hyacinthine colour.——*Geoffroy.*

After repeated fuſions, an aſſemblage of priſms are obtained, united together ſideways.——*De la Chenaye.*

All the acids attack reguline tin, requiring for their ſaturation more of the imperfect than of the perfect oxide.

The *ſulphuric acid* oxidates it without diſſolving it, but the *ſulphureous acid* forms with it a SULPHITE, or SULPHURATED SULPHITE of TIN.——*Fourcroy*, 1800.

Water is ſufficient to precipitate this oxidated metal. *Mr. Monnet* has obtained cryſtals, the SULPHITE of TIN, which reſemble fine needles, interlacing each other.

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 into a crucible. On diſtillation it boils up, and fills the receiver with a white vapour, ſmelling like nitric acid.

By adding a ſolution of gold to the ſolution of tin in the nitric acid, a beautiful purple precipitate falls.

Tin is diſſolved by the *muriatic acid*, cold or heated, a fetid gas being diſengaged. 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 oxy-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 an OXYGENATED MURIATE of TIN.

It is diſſolved by the *oxy-muriatic acid* with vehemence, and when the acid is highly concentrated, a magma is obtained, reſembling pitch, which hardens in time.

It is diſſolved in the common *aqua fortis*, prepared with ſalt-petre of the firſt boiling, for the compoſition for ſcarlet dye, from *cochinelle*. 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.

Tin and its oxides are diſſolved, but the latter more freely, by the cauſtic alkalies. It is likewiſe ſlightly ſoluble in the *vegetable acids*; but the *carbonic acid* does not appear to act on it at all.

It has no known union with *nitrogen*, *hydrogen*, or *carbon*. *Charcoal* renders it refractory, and with *phoſphorus* it forms a brittle PHOSPHURET.——*Fourcroy*, 1800.

Combined 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 *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 ammoniac; the bottom of the matraſs being ignited, the ſulphuret ſublimes; and if the heat is 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 oxidated by the muriatic acid of the muriate of ammoniac; and the hydrogen, diſengaged from the water of cryſtallization of this ſalt, combining with ſulphur and caloric, forms a ſulphurated 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 ammoniac, 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 pot-aſh being dried, and put into a retort, with half its weight of ſulphur, and a quarter of the muriate of ammoniac, 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 amalgam 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 ounces 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*.

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

One part of tin and one of zinc being melted together, and mixed with two 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 Printer's *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, form 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: Three parts of ſand, one of chalk, and three of borax; or three of glaſs, one of borax, a fourth 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 oxidation, and the tin is rubbed over its ſurface.

If care be taken to prevent oxidation, 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.——*Fourcroy*, 1800.

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 flame of a blue colour, mixed with green. M. de Laſſone conſiders it as a kind of metallic phoſphorus.

From its ſtrong attraction for oxygen in a red heat, it decompoſes water: much hydrogen gas being diſengaged, but mixed with carbon; derived from the zinc.

Zinc is diſſolved by all the acids.

Sulphuric acid, diluted, diſſolves it in the cold, and produces much pure hydrogen gas; a black powder, which is plumbago, from the admixture 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 is not much altered by expoſure to air, when pure; but its acid eſcapes, at a degree of heat, leſs than is required by the ſulphate of iron.

This ſulphate uniting with the alkaline ſulphates, forms triple ſalts, from which may be precipitated, a white oxide ſoluble in pot-aſh and ſoda.——*Fourcroy*, 1800.

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

The *muriatic acid* attacks zinc, with efferveſcence: hydrogen gas is produced, and an *irreducible oxide of zinc* is depoſited in black flocks. The ſolution thickens by evaporation, without cryſtallizing, a concentrated acid eſcapes, and the MURIATE of ZINC will itſelf ſublime by diſtillation.

Of all known bodies, *Girtanner* ſays, zinc unites moſt readily to *oxygen*. It takes it from almoſt every other body, which renders it uſeful in detecting the ſmalleſt quantities of oxygen. It was chiefly by means of zinc that I have been enabled to ſeparate the oxygen of the muriatic acid from its baſe.——*Ann. de Ch.* Cah. 100.

The zinc of commerce, Prouſt remarks, contains alſo iron, lead, and copper, which precipitate in an oxided ſtate in a black powder, during the ſolution of zinc in the acids. In whatever acid it is diſſolved, he obſerves, it conſtantly abſorbs the ſame portion of oxygen. In the muriatic and ſulphuric acid, where it is perfectly oxided, the iron is at its *minimum* of oxidation, and therefore does not change by the addition of the gallic acid, which it will however do by expoſure to the air, or by the addition of a few drops of oxy-muriatic or nitric acid. Thus alſo the carbonate becomes yellow on expoſure to the air, the iron paſſing readily to its *maximum* of oxidation.

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 the zinc; leaving the fluid on the ſolution two or three days, that if any manganeſe have been precipitated, it may be re-diſſolved by the acid, the zinc precipitating in its place. The ſulphate of zinc thus purified will furniſh the fine WHITE OXIDE of ZINC ſo deſirable by painters.——*Ann. de Chim.* Cah. 103.

The *pure alkalies*, boiled on zinc, obtain a yellow colour, and diſſolve part of the metal; and added to a ſolution of zinc in ſulphuric acid they throw down a white oxide, with a conſiderable increaſe of weight beyond that of the metal.

It detonates ſtrongly if mixed with *nitrate of pot-aſh*, and thrown into an ignited crucible. The *muriate of ammoniac* is decompoſed by it, ſimply by trituration.

Sulphur cannot be combined with zinc by fuſion, but is ſaid by *Dehne* and *Guyton* to combine with the oxide.

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, milor*, 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 acetite 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 a white, brilliant ſemi-metal. Sp. gr. 6,860. volatile and difficult of fuſion; but when melted, it emits a white fume, called *argentine ſnow*, or *flowers of antimony*, being a SUBLIMED OXIDE of ANTIMONY, in brilliant priſmatic acicules. The metal whilſt cooling ſlowly, cryſtallizes in octahedra, and generally aſſumes a ſtellular form, on its ſurface. It is very ſlightly changed by expoſure to air. When combined with *ſulphur* in the earth, or artificially, it forms a SULPHURET of ANTIMONY ; this, when native, is an *ore of antimony*, commonly called *crude antimony*, or improperly, antimony.

Crude antimony, reduced to powder and expoſed in a ſhallow veſſel to a ſlow heat, gradually loſes its ſulphur ; and the oxygen of the atmoſphere uniting with the antimony, converts it to a GREY or imperfect OXIDE. This being urged by a more violent heat, becomes a reddiſh, and partly a tranſparent *glaſs of antimony*, VITREOUS OXIDE of ANTIMONY, which when corrected by being blended with wax, forms the CERATED GLASS of ANTIMONY.

Tin, *copper*, *ſilver*, or *iron*, being fuſed with crude antimony, 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 from the ſulphuret, or crude antimony, by detonating three parts of crude tartar, two of crude antimony, 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 ſulphurated alkali, combined with imperfect antimonial oxide, and which, on ſolution in water, lets fall a brown precipitate, an *hydrogenated ſulphuret of antimony*, named the SULPHURATED OXIDE of ANTIMONY, and formerly *Kermes mineral.* But, if an acid be added, the precipitate is of a fainter, and at laſt, of an orange colour. This laſt precipitate is alſo called the ſulphurated oxide of antimony, and was formerly termed the *golden ſulphur of antimony*. It differs from the former precipitate, in containing a greater proportion of the hydrogenated ſulphur.

Antimony is completely diſſolved in the dry way by alkaline ſulphuret; thus equal parts of fixed alkali being melted with crude antimony, a ſulphuret is formed containing antimony, being the 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.* On being boiled with water, HYDROGENATED SULPHURATED OXIDE is precipitated.

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.*

One part of pot-aſh being melted with five of crude antimony, 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.

All tbe acids, except the *carbonic*, diſſolve the imperfect oxide of this metal. The ſulphuric, nitric, oxy-muriatic, and nitro-muriatic acids alone attack reguline antimony.

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, as well as a ſmall quantity of SULPHATE of ANTIMONY, which is very deliqueſcent, and eaſily decompoſed

It decompoſes the *nitric acid* with great facility, part of the antimony is oxidated, forming the *bezoar mineral*, and a portion is diſſolved, forming a NITRATE of ANTIMONY, decompoſable by heat, and very deliqueſcent.

The *muriatic acid* acts on it only by a long digeſtion. The *nitro-muriatic acid* is its moſt convenient ſolvent. The ſolution has no colour. *The oxy-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 a butyraceous matter, the SUBLIMED MURIATE of ANTIMONY, or *butter of antimony*. The acid, as in the corroſive muriate of mercury, being in an oxygenated ſtate. The ſublimed muriate of antimony becomes fluid by a very gentle heat, and is thus eaſily poured from one veſſel to another. It ſometimes cryſtallizes in hexahedral priſms with dihedral ſummits, two ſides of the priſms being inclined. Diluted with water, a white oxide, of antimony falls, which has been called *powder of Algaroth*, or *mercurius vitæ*.

Wine and the *acetous acid* diſſolve it.

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 tartrite 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.

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.

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

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 *ſulphate of alumine*, and 1 of *muriate of ammoniac*, 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 the 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 re-diſſolved and cryſtallized, as the ſilica will entirely ſeparate towards the end of the evaporation.——*Ann. de Ch.* 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, and, next to tin, is the moſt fuſible of all metallic bodies. It tarniſhes, but does not ruſt in the air.

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 parallelipepids, united by their ends, at right angles.

Sulphuric acid being boiled on it, the biſmuth is partly diſſolved, forming the SULPHATE of BISMUTH, which is very deliqueſcent.

The *nitric acid* is ſpeedily decompoſed by biſmuth; nitrous gas is ſeparated, whilſt the oxygen combines with the ſemi-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.

The *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. 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 ſulphurous 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 bluiſh grey; and if tarniſhed, to red, Sp. gr. 7,645. When very pure it is malleable, in ſome degree, in a red heat. Even when pureſt it is magnetic, and 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. After fuſion its ſurface frequently aſſumes a reticular form. It calcines with more difficulty, as it is more pure; its oxide being of ſo deep a blue, as to appear black.

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*, *microcoſmic ſalt*, in a ſtrong heat it tinges them blue. In fuſion, it will not mix with *biſmuth*, *lead*, or *ſilver*; but with *biſmuth* it unites by the mediation of *nickel*; but it does not amalgamate with quickſilver. With *arſenic* it burns with a bluiſh or white flame.

With concentrated *ſulphuric acid*, it unites and yields reddiſh cryſtals, with quadrilateral columns, with dihedral ſummits, the SULPHATE of COBALT.

It unites with the *nitric acid* readily, and with effervеſcence; 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 *ammoniac*; 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 ammoniac 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*.

It was employed to give a blue colour to glaſs, long before it was ſuppoſed to contain a ſemi-metal.

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 three-fourths of sand. This oxide fused with three parts of sand and one 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 liquid AMMONIURET of COBALT: by evaporation to one-fourth he procured two substances, the one of which precipitates of a yellow colour, the other remaining dissolved, and giving to the water a red colour. The yellow substance is a pure oxide of cobalt, and dissolved in *ammonia* forms a pure AMMONIURET of COBALT. The colour of this is yellow and sometimes rose-red: the acids do not decompose it, but the muriatic acid discolours it; and the prussiate of pot-ash renders it grey, and produces a precipitate of the same colour. The sulphur of pot-ash gives it a deep colour, approaching to black, and SULPHURET of COBALT is precipitated. Borate of soda is decomposed by it, and BORATE of COBALT precipitated. From the red solution, filtered from the yellow oxide, he obtained an acid which he calls the COBALTIC ACID. This acid he obtained in a concrete form, of a red or yellow colour, and sometimes colourless; without smell, and of a sharp, and not unpleasant taste. It reddens turnsole, is soluble in water, and decomposes sulphurets of alkali. It precipitates ammoniuret of copper of a light green, and that of zinc of a clear white, and the sulphuret of copper of the same colour as the ammoniuret; nitrate of silver it precipitates white, as well as the nitro-muriate of tin; the nitrate of mercury of a light straw colour; the acetite of lead, white; lime-water, a white coagulum; tincture of galls, yellow; and it precipitates the acetites and muriates of barytes, but does not affect the solutions of gold and platina. It is separable by alcohol from its solution in water. Used as a sympathetic ink it changes brown, not green or blue. With soda it forms a salt of irregular crystals; with pot-ash, square crystals; and with ammonia, a salt soluble in its acid; and with baryt, an opake, difficultly crystallizable salt.——*Ann. de Chim.* XXXIII.

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 one part of smalt with six of soda.

NICKEL is a metallic substance of a greyish white, when pure; but shaded with red or yellow, when impure. Sp. gr. 9.000. It is difficultly purified. When purest it is magnetic, and hence has been deemed to contain iron, even when it exhibits no other sign of its containing any, but Mr. Kirwan thinks without sufficient reason. 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.

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 them, but in excess re-dissolves them, the solution being blue; even metallic nickel yields to ammonia. It is not precipitable by zinc, though in some measure by iron, but does not amalgamate with iron.

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 *perfect* OXIDE being black. It is in no degree malleable. Sp. gr. 7.000.——*Hielm.*

By heat it is converted into a black oxide, and, if strongly urged, affords a glass of a yellowish brown. This metal is less fusible than crude iron, and unites by fusion, with all the metals, except mercury. The oxide of manganese affords a prodigious quantity of oxygen gas; and with charcoal, the carbonic acid.——Kept in fusion, with *phosphate of soda*, upon charcoal, a transparent glass is formed, which curiously changes from the colour of a ruby 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.

From its affinity with oxygen it decomposes 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 oxidation, 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 oxygenated, but being volatile, the oxygen flies off, and the muriatic acid continues to dissolve the oxide thus rendered imperfect.

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 hespatic 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 *chamelion minæralis*, 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 perhaps that of any other metal.

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 oxidation.

If a very slight portion be used to glass discoloured by coally particles or iron, it renders it colourless; it is hence called *glassmaker's soap.*

It is also employed to give a *black glazing to pottery-ware.*

URANITE, or the metal of uranochre, of the *pitchblende*, and of the *chalcolite*, or *green mica*, discovered by Klaproth, in 1790, is of a dark steel or iron grey; internally browner. Sp. gr. 6,444. It is soluble in nitrous acid; it does not appear that other acids have been tried. It is infusible alone before the blow-pipe; but with micromcosmic salt, or concrete phosphoric acid, it becomes a grass green glass; and with soda or borax only a grey opake scoriaceous bead. Its oxyde 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 *nitrous* and *nitro-muriatic acids*, greenish yellow crystals. The precipitate thrown down from these two last mentioned ſolutions, by sulphurated ammoniac, is of a brownish yellow; by *tincture of galls*, the superfluous acid being saturated, of a chocolate brown; by *Pruſſian alkali*, 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*, whitish yellow; much of which is re-diſsolved by the carbonic acid gas ſet looſe. By *pure ammoniac*, lemon yellow. By *carbonated ammoniac*, dark yellow. But these solutions are precipitable neither by *iron* or *zinc*. This oxide is inſoluble in alkalies, either in the moist or dry way; which fully distinguishes it from tungſtenic oxide, which it resembles in colour.

* * *

TELLURITE, or SYLVANITE. *Klaproth*, although he firſt appears to have clearly aſcertained the exiſtence of this metal, modeſtly gives the honour of the diſcovery of it to *Muller*, and even to *Bergman*. Mr. *Kirwan* firſt called it ſylvanite, but Mr. *Klaproth* denominated it tellurium. He diſcovered it whilſt analyſing the gold ore from *Fatzebay*, in Transylvania.

It is one of 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 SULPHURIZED OXIDE of SYLVANITE.

Its oxids 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.——*Dr. Pearſon's Nomenclature*, 1799.

TITANITE 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 MENACHANITE, a ſubſtance firſt noticed by Mr. M'Gregor, in the valley of *Menachan*, in Cornwall, in ſmall black grains reſembling gunpowder. Mr. *Kirwan* pointed out the reſemblance between this ſubſtance and titanite.

The oxide of this metal, which is of a whitiſh yellow, requires to be diſoxidated 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-red and then of amethyſtine hue. *Zinc* thus produces firſt a violet, and then a deep indigo blue.——*Gren*.

The ſolutions of titanite yield ALKALINE CARBONATES, and in white flocks by the addition of alkalies.

The pruſſic acid precipitates it of a green colour according to *Klaproth*, but according to *Lowitz* of a dirty yellowiſh brown.

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, of a whitiſh grey, ſhining, and very brittle; obtained by Vauquelin from the mineral, called *Siberian red lead.*

He obtained the CHROMIC ACID from this mineral by the following proceſſes:

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 oxygenates it, paſſing itſelf to a green oxide——*Journal des Mines.* XXXIV. 1798.

Before the blow-pipe Chrome does not fuſe, but becomes oxided; 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 CHROMIATE of LEAD. It also forms CHROMIATES 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 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 re-agent 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. 8,310. It is brittle and not soluble in water. 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.* In close vessels, it sublimes without alteration, and crystallizes in trihedral pyramids, or octahedrons, of a brilliance resembling steel.

This substance, which in general is called arsenic, is of a glittering whiteness, sometimes of a vitreous appearance; exciting an acrid taste on the tongue, and subliming with the same smell and smoke as the arsenic itself. It may be reduced to the metallic state by treating it with oils, soaps, or charcoals, in close vessels.

Arsenic 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 is less volatile than the metal itself. If sublimed by a strong fire in closed vessels, it becomes transparent like glass. The oxide 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 very feebly; 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 ATSENIC, or *bute of arsenic.*

The *nitric acid*, and the *oxygenated muriatic acid* distilled from the oxide of arsenic, are decomposed; from the former, nitrous gas passes over abundantly, and from the latter, ordinary muriatic acid; their superabundant oxygen being seized by the arsenical oxide, which is thereby changed to a more perfect *oxide* called the ACID of ARSENIC. This acid is also obtained from the residue of the distillation of equal parts of nitrate of pot-ash and oxide of arsenic, which yields a red, and almost incoercible nitric acid.

This residue is capable of being crystallized in tetrahedral prisms, terminated by four-sided pyramids, this arseniate of pot-ash, the neutral arsenical salt of *Macquer* being mixed with half its quantity of sulphuric acid, and urged by a strong fire, a white mass is left in the retort, which attracts humidity, and is *pure arsenical acid.* The nitrate of ammoniac with the oxide of arsenic, also, being distilled, the arseniate of ammoniac remains, from which the alkali being driven by a fire long kept up, the residue is a vitreous, deliquescent mass, the acid of arsenic.

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 arsenical acid remains.

The ACID of ARSENIC may possess the concrete form, but deliquesces and resolves into a fluid. It is fixed in the fire, but heated in contact with a coally substance, it is decomposed, the oxygen exhaling in fumes. It is also reduced by passing hydrogen gas through it.——*Pelletier*.

At 12° it requires only two-thirds of its weight of water to dissolve it: and when thus dissolved, it may be concentrated and again brought to the state of a transparent glass.

In the state of concentration it acts strongly on the crucible, dissolving the alumine.

Pure pot-ash boiled on the oxide of arsenic, becomes brown, gradually thickens, and at last forms a hard, brittle, but deliquescent mass; the ARSENIATE of POT-ASH.

Soda exhibits phenomena nearly similar with this oxide, forming the ARSENIATE of SODA.

Ammonia dissolves the oxide by heat, and yields crystals by spontaneous evaporation, which are the ARSENIATE of AMMONIAC.

Barytes and *magnesia* appear to have a stronger affinity with this acid than the alkalies. *Lime* and *alumine* also decomposes 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.*

MOLYBDENITE.—This semi-metal was obtained by *M. Hielm*, from the sulphurated ore, called *molybdena*, 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 gives no colour to borax.

Molybdena is oxidated in a strong heat. Its white or yellow oxide, manifests evident acid properties, and may be considered as the MOLYBDENIC ACID, being the OXIDE of MOLYBDENITE oxygenated as perfectly as possible.

The most perfect acid is obtained by means of the nitric acid. 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 barytes.

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 MOLYBDATES 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 one part of the metal with four of nitrate of pot-ash, a residue will be left which contains the MOLYBDATE OF POT-ASH.

Molybdena, when not in a metallic state, appears to suffer four degrees of oxygenation, 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, molybdous acid; the last or fourth degree is the yellow acid, or that which is super-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 molybdic acid has suffered a diminution of oxygen.

The *nitric acid* attacks it with effervescence, and converts it into an oxide endued with acid properties, ceasing to act as soon as the super-saturation with oxygen is effected.—*Hatchett. Phil. Trans.* v. 86.

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, *tartarous*, *oxalic*, and *acetic* acids, afford blue solutions of the oxide, the colour shewing 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 oxided as possible, is precipitated by a solution of molybdate of pot-ash, both solutions being well diluted, a beautiful blue precipitate is obtained, which *Richter* calls BLUE CARMINE.

TUNGSTENITE is said to have been obtained in a metallic form from the mineral called *tungsten*, or *ponderous earth*, in which it is united with calcarous earth: and from another mineral called *wolfram*, in which it is combined with iron and manganese. It is supposed to be capable of existing as a REGULUS, externally brown, internally steel grey. Sp. gr. 17,600. Insoluble in the mineral acids, but convertible by the nitric, and nitro-muriatic into a yellow oxide, and likewise by heat, increasing 24 per cent. in weight.

This metal was obtained by Messrs. *Elluyarts;* and lately *Guyton* obtained a button of tungsten, by a heat of 183° Wedgewood in a three blast furnace. No other chymist has yet announced a similar success. It may also exist as a YELLOW OXIDE.

To obtain this, nitric acid is digested with tungsten, which renders it yellow; the powder is then washed and digested with liquid ammonia, by which it is rendered whiter. The ammoniated solution is then poured off, and the residual powder again exposed to the action of nitric acid. It is again extracted by ammonia and so on, until totally decomposed. The nitric acid carries off the lime contained in the ore, and the ammoniac really holds the oxide in solution, which is precipitated by the addition of nitric acid, nitrate of ammoniac being formed, and the oxide is precipitated white. To free it quite from the ammonia either heat must be applied, or it must be boiled with nitric acid. When this is done it assumes a yellow colour.

Ammoniac holds the oxide, therefore, in solution, and is neutralized by it; which circumstance and its changing litmus shews its acid nature. Ammonia by whitening it, distinguishes it from the yellow oxide of uranite.

The neutral salt just mentioned, or *tungstate of ammonia* being dropped into lime-water, throws down a *tungstate of lime*, resembling the native tungsten.

The yellow oxide exposed to the external flame of the blow-pipe, continues yellow; but by the internal, it swells and darkens, but does not melt. This is the reverse of what takes place with manganese, which is coloured by the external, and becomes colourless by the internal flame. The privation of oxygen blackens this substance, and whitens manganese. Alkaline phosphates being added, it loses all colour in the external flame of the blow-pipe, but in the internal, it gives a blue glass, but the addition of an alkali again renders this blue glass colourless. With borax it gives a brownish yellow glass—heated on a burning coal, or in a crucible, it becomes a ſlate blue colour, but does not diſſolve.

Digeſted in the *ſulphuric acid* it is converted into a blue, and in the *nitric* and *muriatic*, into the yellow oxide.

This oxide may be combined with larger or ſmaller portions of oxygen. When imperfectly oxidated, 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 tungſten.

Its union with alkalies, with lime and with metals, even the noble metals, plainly evinces its acid nature, for as a ſimple calx it could not unite with them.——*Kirwan.*

C. Guyton obſerves, that tungſten in the laſt degree of oxygenation 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.

The metals are all excellent conductors of the ELECTRIC FLUID. They alſo poſſeſs the power of producing the evolution, decompoſition, or ſome other unknown change on that fluid, on which thoſe phenomena which belong to GALVANIC ELECTRICITY depend.

Theſe phenomena are produced by two piles compoſed of different metals, alternately placed, one for inſtance *zinc*, another *ſilver*, with pieces of leather interpoſed between each metallic diſk, moiſtened with a ſolution of muriate of ammoniac; water even will anſwer, but in a leſs degree. From each of theſe two piles a wire being paſſed, ſeveral curious phenomena reſult. When an animal is placed between the wires, and thus connects the two piles, a ſhock, ſimilar to that from a charged electric jar is felt; when placed on each ſide of the tongue a pricking ſenſation and ſomewhat of an acid taſte is experienced; when the head forms part of the circuit, the wires being placed in the ears, a crackling ſound is heard; a flaſh of light appears if the eyes are brought in its courſe; and exceſſive pain is felt if its influence is directed on a ſurface where the ſkin is removed. When the wires from the two piles are brought within leſs than two inches of each other, but not in contact, and under water, the water appears to ſuffer a decompoſition, hydrogen gas being ſeparated by the wire coming from the pile of ſilver, whilſt pure oxygen is obtained from the wire of the zinc pile, the wire itſelf ſuffering oxidation. Theſe extraordinary effects were firſt noticed by *Volta.* Numerous experiments with different metals, &c. are recited in *Ni-*

cholſon's Philoſophical Journal, by the learned editors, Mr. Carliſle, Mr. Cruickſhank, Mr. Davy, and Major Haldane; no ſatisfactory theory has however yet been publiſhed reſpecting theſe curious reſults from the apparent combination of electric and chemical powers.

BITUMINOUS SUBSTANCES.

NAPHTHA is a white or yellowiſh white ſubſtance, fluid as water, feels greaſy, has a penetrating ſmell, and burns with a light flame, leaving ſcarcely any reſiduum. It is inſoluble in ſpirits of wine, paſſes over entirely in diſtillation, and is thickened, but not inflamed by nitrous 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 pitch.

ASPHALTUM, or MINERAL PITCH, is produced by a ſtill farther exſiccation. There are three varieties deſcribed of this ſubſtance, depending chiefly on the degree of ſolidity they poſſeſs. 1. *Cohæſive*, MINERAL PITCH. 2. *Semi-compact*, MALTHA. 3. *Compact*, ASPHALT.

JET is a ſubſtance of a full black, harder, and leſs brittle than aſphalt; and according to *Wiedenman*, 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 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.

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, hydrogen, carbon, 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, hydrogen and carbon, conſtitute the vegetable oils and roſins; and the ſame with ſome nitrogen, form the oils and greaſe of animals.

Organiſed 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 peatmoſſes, 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 ammoniac 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.*

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 ammoniac, and an empyreumatic oil in the form of *TAR*. If this be performed in a proper oven, the coal being piled in the manner of wood for charring, it 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 ſlightly 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 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 dram of oil of amber, with a proper quantity of cauſtic ſolution of ammoniac, a compound of a milky colour is formed, called EAU DE LUCE.

Among the ſtrata of *braunkohle* (bovey coal) in Saxony, is found a foſſil of a honey yellow colour, and of an octahedral form; ſoft, brittle, and reducible to a greyiſh powder: it is called MELLILITHUS, or *Honey-ſtone*. It was ſuppoſed by ſome to be a gypſum impregnated with petroleum; and by Burn it was thought to be a kind of amber. But by the analyſis of Mr. Klaproth, 100 parts appear to contain, beſides the water of cryſtallization, 16 of alumine, and 46 of a peculiar acid.

This acid, which he 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 acetous acid, though leſs than that of mineral acids. ——*Crell's Journal*, 1800.

OF STONES.

CALCAREOUS EARTHS are characteriſed 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 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 *tungſtenic acid*, TUNGSTEN.

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* forms the SILICI-MURITE; with *lime* and ſome *iron*, CALCI-MURITE; 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 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.

From its admixture with *ſilecious 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 TRIPOLI; from its union with phoſphoric acid, PHOSPHOLITE; with *ſilex*, *iron*, 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, TOAD-STONE, BASALT, CALP, ARGILLITE, SLATES, and NOVACULITE.

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 clay 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. From its mixtures with various proportions of *iron*, *lime*, and *alumine*, reſult the AMETHYST, TOPAZ, SAPPHIRE, HYACINTH, GARNET, CHRYSOBERYL, and 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 SHORL. With *alumine, lime* and *iron*, it forms the TOURMALIN and the PREHNITE; and with the addition of *manganeſe*, THUMERSTONE. Combined with *alumine, lime* and *water*, it forms the ZEOLITES; and with *barytes* in the place of *lime*, the STAUROLITE; with *alumine*, *blue ſulphur of iron*, *ſulphate and carbonate of lime*, LAPIS LAZULI; with *nickel, iron, alumine*, and *lime*, CHRYSOPRASE; with *alumine* and *lime*, VESUVIAN; with *alumine* only, SHORLITE; and with *alumine* and *pot-aſh*, LEUCITE. If this laſt combination alſo hold *oxide of iron* and *manganeſe*, RUBELLITE is the reſult; but if *iron* only is added, OPALS, SEMI-OPALS, and PITCH-STONE. From the addition of *lime* to the combination juſt mentioned, proceeds HYALITE. From the various intermixtures of *alumine*, and a ſmall portion of *iron*, alſo proceed CHALCEDONY with its varieties, CORNELIAN, CAT'S-EYE, ONYX, MOCHA, AGATE, CUCHOLONG, and the SARDONYX; and by the farther addition of a ſmall portion of *lime*, FLINT, HORN-STONE, PETRO-SILEX or CHERT, JASPER, EGYPTIAN PEBBLE, PORCELANITE, 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.

STRONTIAN 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 ſtone of this genus, is the ſtone called ZIRCON, or JARGON of Ceylon.

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.

The RUBY appears, by the analyſis of Vauquelin, to be a ſaline ſubſtance, compoſed of two baſes, *alumine, magneſia,* and the *chromic acid.* The difference of colour between the ruby and the emerald, both of which he has diſcovered owe their colour to this acid, he attributes to the different degree of oxidation 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.*

The DIAMOND, though conſidered as a precious ſtone, has long been known to be of an inflammable ſubſtance, and is now believed to be the ſubſtance called *carbon,* exiſting in its moſt ſimple ſtate, and in a cryſtallized form.

A mineral ſubſtance brought from Sydney Cove, was ſuppoſed to contain a new ſpecies of earth, which was therefore termed SYDNEIAN EARTH; but Mr. Hatchett having analyſed this ſubſtance, ſays, " I do not heſitate to aſſert this mineral does not contain any primitive earth or ſubſtance, poſſeſſing the properties aſcribed to it, and conſequently that the *Sydneian genus,* in future, muſt be omitted in the mineral ſyſtem."——*Phil. Tranſ.* 1798.

The ſtone called the CORUNDUM STONE, and from its hardneſs, ADAMANTINE SPAR, was alſo ſuppoſed to contain a new earth, which was therefore termed CORUNDA. Mr. Klaproth's firſt analyſis of this mineral, gave ſilex 31,5. Iron and nickel 00,05, and *adamantine earth,* 68. But by a ſubſequent analyſis, by Mr. Klaproth, of this mineral, he found that it contained alumine, from 84 to 89. Silex 5,5. to 6,5. Oxide of iron from 1,2 to 7,5, and *no new earth of any kind.*

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 *garnites*, GRANITINE; *quartz*, *mica* and *garnet* compoſe the ſtone called NORKA or 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 GRUN-STEIN, *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. SHISTOSE MICA is compoſed of *quartz* and *mica*, and is of a ſhiſtoſe or ſlaty texture, but contains more mica than gneiſs. PORPHYRY is any ſtone which in a *ſiliceous*, *argillaceous*, *muriatic*, 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 *trap*, *mullen*, *krag*, &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. Sometimes theſe are cryſtallized, as in the SANDSTONE of FONTAINBLEAU. 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 no 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 and TUFAS, 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 Mitchell*, 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 were 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* accounts 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.*

It is however obſerved by Mr. *Spallanzani*, 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.*

OF THE PRIMEVAL STATE OF THE EARTH,

AND ITS SUBSEQUENT CHANGES.

Mr. Kirwan ſuppoſes the ſuperficial parts of the globe to have been originally in a ſoft liquid ſtate, proceeding from ſolution in water heated at leaſt to 33°, and poſſibly much higher. This menſtruum muſt have held in ſolution all the different *earths*, the *metallic*, and *ſemi-metallic*, the *ſaline*, and the *inflammable* ſubſtances; being a more *complex men-*

ſtruum than has ever ſince exiſted. In this fluid, its ſolid contents coaleſced and cryſtallized, according to the laws of elective attraction; *quartz, felſpar,* and *mica,* conſtituting *granite, gneiſs,* &c. he ſuppoſes to be firſt depoſited, with various *metallic ſubſtances*, particularly *iron*. In other tracts, according to the predominant proportion of the ingredients, were formed *ſiliceous ſhiſtus, porphyries, jaſpers,* &c. with *argillites, hornblende, ſlates, ſerpentines,* and other *primeval ſtones*; and the metallic ſubſtances meeting and combining with ſulphur, formed the *pyritous* ſubſtances and *ſulphurated ores*. With the ſulphur alſo *petrol* would combine and enter into combination. By this cryſtallization of theſe immenſe maſſes, a prodigious quantity of heat muſt have been generated, and increaſed by the decompoſition of the water, intercepted in the precipitated ferruginous particles, and by the diſengagement of inflammable air, even to incandeſcence; the oxygen uniting with the inflammable air, and burſting into flame. This ſtupendous conflagration, ſupported alſo by the ſulphurated, carbonic and bituminous ſubſtances, muſt have rent and ſplit, to an unknown extent, the ſolid baſis on which the chaotic fluid reſted. From the heated chaotic fluid muſt have been extricated the *oxygen* and *mephitic* airs, which gradually formed the atmoſphere. From the union of oxygen with the ignited carbon, proceeded the *carbonic acid*, or in Mr. *Kirwan's* words, the *fixed air*, the abſorption of which, as the chaotic fluid cooled, occaſioned the cryſtallization and depoſition of the *calcareous earth*.* The immenſe maſſes, concreted and depoſited by the combination and cryſtallization of the ſeveral earths on the nucleus of the globe, formed the *primitive mountains*. The formation of *plains* took place from the ſubſequent depoſition in the internals of diſtant mountains, of matters leſs diſpoſed to cryſtallize; ſuch were argillaceous and ferruginous particles, and ſuch particles of other earths, as were too diſtant from each other's ſphere of attraction to concrete into cryſtals. The level of the antient ocean being lowered to the depth of 8500 or 9000 feet, then and not before, it began to be peopled by fiſh. That the *creation of fiſh* was ſubſequent to the emerſion of the tracts juſt mentioned, he thinks, is proved, by no marine ſhells

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* The formation of fixed air being ſubſequent to the formation of the primeval ſtones, he thinks, appears from the calcareous earth being found in the compoſition of primeval ſtones, in a cauſtic ſtate.

or petrifactions being found in tracts elevated above the height of 9000 feet, and reciprocally, of the mountains containing petrifactions, none reaches to the height of 8600 feet. After this elevated tract of the globe had been uncovered by the retreat of the ſea to its bed, there is no reaſon to believe it remained long diveſted of *vegetables*, or unpeopled by *animals*; being in every reſpect fitted to receive them. This retreat of the ſea, from the lower parts of our preſent continent, was not effected, he ſuppoſes, until the lapſe of ſeveral centuries; this, he thinks, is proved by the vaſt accumulated heaps of foſſil ſhells, in inland ſituations, and the diſcovery of trees and vegetables in great depths, of our modern continents; and from the appearance of ſtratified mountains formed by gradual depoſition; and thus entombing fiſh, ſhells, wood, &c. The retreat of the ſea continued probably until a few centuries before the deluge, which he conceives to have originated in and proceeded from the great ſouthern ocean below the equator, and thence to have ruſhed on the northern hemiſphere, ſpread over the arctic region, and then to have deſcended ſouthwards. During this elemental conflict, he ſuppoſes the carbonic and bituminous matter muſt have run into maſſes no longer ſuſpenſible in water, and have formed *ſtrata of coal*; the calces of iron, gradually reduced by the contact of bitumen and precipitated with the argillaceous and ſiliceous particles, forming *baſaltic maſſes*, which ſplit into columns by deſiccation. The eruption of fixed or oxygen air would form cavities in which, by ſubſequent infiltration, *calcedonies*, *zeolytes*, *olivins*, *ſpars*, &c. might be formed.

This ſyſtem, Mr. *Kirwan* ſays, agrees with the geological facts related by Moſes, not only in ſubſtance but in the order of their ſucceſſion.——*Geological Eſſays*, 1799.

It is remarked by Mr. Jameſon, that in the Shetland Iſlands, the eaſt ſide is low, but the weſt, lofty, rugged, and broken, and many of the mountains are more ſteep on the weſt, than on the eaſt ſide. Upon examining other parts of Scotland, England, Norway, &c. ſimilar phenomena preſent themſelves.—The *rivers* alſo generally run from weſt to eaſt.—*Hills*, he remarks, all run in the longeſt direction of the iſlands in which they are placed.——*Mineralogy of the Shetland Iſlands*.

OF VEGETABLE SUBSTANCES.

VEGETABLE SUBSTANCES appear to derive their chief nouriſhment from *water*, which on its reception into the plant 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 vegetable acids, &c. and partly expelled by tranſpiration through the pores of the plant: its ſeparation is evidently accelerated by the action of light; ſince during night plants chiefly give out carbonic acid gas.

The *air* is uſeful in vegetation, not only as a vehicle for water, caloric and light, but from its yielding oxygen, which enters into the plant itſelf, and which alſo combines with the carbon and hydrogen it meets with on the ſurface of the plants; furniſhing alſo a portion of carbonic acid, from which nouriſhment is derived in a high degree. The *carbonic acid* thus abſorbed is decompoſed, its *carbon* is depoſited in the plant, aiding the formation of the vegetable fibre, whilſt its oxygen is tranſpired. Thus alſo *carbonated hydrogen* promotes vegetation. M. *Sauſſure* finds that plants, like animals, form carbonic acid, with the aſſiſtance of the oxygen of the atmoſphere, the acid being often decompoſed as faſt as it is formed. *Light*, he obſerves, promotes vegetation by decompoſing the acid; and therefore that proportion of the acid which favours vegetation during the influence of the ſun, injures it during the night. 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 des Chemie, Jan.* 1800.

Nitrogen gas, ſo unfriendly to man, appears to be rapidly abſorbed by vegetables.

Light is certainly neceſſary to vegetable life, it ſerving as a ſtimulus, and being alſo a powerful agent in decompoſing the various nutritive principles; and particularly in ſeparating the oxygen gas from the ſubſtances imbibed, whilſt their baſes become fixed in the plant.

Light has been ſuppoſed to occaſion the green colour of vegetables, plants growing in the dark being white, when they are ſaid to be *etiolated.* But *Von Humboldt* finding plants green which have grown in the dark, but in inflammable or mephitic gaſes, attributes the verdure of plants to hydrogen and azote in certain proportions.——*Experiments by V. Humboldt.*

A ſenſible production of *heat* is diſcoverable in vegetables, ſo as ſometimes to exceed 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.

I. The SAP is that fluid which is formed by the elaboration of the various ſubſtances which are taken up as *pabulæ* by the plant.

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 the elm, the beech, the ſervice, the birch, and the mulberry-trees appear to differ conſiderably in their compoſition; but in general they contain in much water, gum, ſugar, extractive matter, tannin, carbonic acid, acetous acid, and ſalts with baſis of pot-aſh.——*Fourcroy,* 1800.

II. MUCILAGE is a viſcious matter, which 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.

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 a conſiderable quantity 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 what is termed the pyromucous acid.

Its formation ſeems almoſt independent of light.

Mucilage may be changed into *oxalic* acid by the nitric, and into the *citric*, by the *muriatic acid.*——*Vauquelin.*

III. GUM exudes from different parts, but chiefly from the trunks and branches of trees. It is generally ſuppoſed to be only inſpiſſated mucilage.

It 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.——*Cruikſhank.*

IV. OILS. 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 degrees of diminution of heat, 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.

By diſtillation they afford phlegm, an acid, conſequently oxygen, a fluid, or light oil, much hydro-carbonate gas, with carbonic acid gas, and a coally reſidue which affords no alkali. The volatile oils afford more hydrogen gas, and the fixed more carbonic acid gas; this laſt depending on the mucilage.

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 oxidation 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.

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.

The proceſs by which oil is rendered drying, ſhows 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 Chemie*, 1800.

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. The *muriatic* forms a ſaponaceous maſs with them, and the *oxy-muriatic* thickens them. Theſe maſſes have been called *acid ſoaps*.

The alkalies alſo combine with the fixed oils, and form SOAPS, by which oils are rendered miſcible with water.

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.

Sir *John Dalrymple* propoſed to uſe the muſcular fibres of fiſh, in a certain proportion with tallow, to make hard ſoap, and to ſubſtitute it for oil, in the manufacture of ſoft ſoap. But by experiments made to determine the value of this propoſal, it appears, that in making hard ſoap, the greater part of the fiſhy matter was uſeleſs, being nearly in a gelatinous ſtate; and that it ſeparates from the tallow, ſo that the fiſh and tallow will not combine. In attempting to make ſoft ſoap, the precariouſneſs of the reſult, and its affording little or no ſaving, renders it unworthy of attention.——*R. Jameſon. Nicholſon's Journal*, 1799.

By mixing oil with lime-water, an acid ſolution of lime, ſolutions of the ſulphates of magneſia, or of alumine, or of the muriate of baryt, an EARTHY SOAP, either *magneſian*, *aluminous*, *barytie*, &c. is formed.

The fat oils perfectly diſſolve *ſulphur*, and form a reddiſh balſam, of a diſagreeable odour, called BALSAM of SULPHUR. They alſo diſſolve *phoſphorus*.

2. *Volatile* or *eſſential oils* are ſoluble in alcohol. 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.

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 oxy-muriatic acids, are ſoon deprived of their oxygen by the ethereal oils, which are thereby converted to reſins.

If two parts of oil of turpentine, and one 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 *ſulphur*. They contain much *hydrogen*.

V. CAMPHOR is a white concrete cryſtalline ſubſtance, which, though chiefly obtained from a ſpecies of laurel, is ſaid to exiſt in all odoriferous vegetables. It has a ſtrong ſmell and taſte, is ſoluble in alcohol, 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 not 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. It is capable of cryſtallization either by ſublimation, or precipitation. It appears to be a volatile oil, rendered concrete by carbon; and, treated with nitric acid, yields its peculiar acid.

Romieu has 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.*

Prevoſt and *Venturi* have remarked the curious appearances obſervable from the floating of camphor and other odorant bodies on water, under different circumſtances.——*Annales de Chimie*, XIX.

It appears that theſe phenomena proceed from jets of eſſential oil thrown out with rapidity from theſe bodies, which make them move on the water.——*Brugnatelli.*

VI. RESINS appear to be oils rendered concrete by their combination with oxygen. They appear to be volatile oils oxygenated and in part diſ-hydrogenated——*Fourcroy*, 1800.

They are inflammable, and yield much ſoot, during their combuſtion; are ſoluble in alcohol and in oils, but not in water. They are generally leſs ſweet than the balſams, and afford more volatile oil, but no acid by diſtillation. Among the reſins may be placed *maſtich*, *ſandarach*, &c.

Bouillon la Grange obſerves that SENA contains, beſides extractive matter and a gum, both reſolvable into calcareous earths, and ſimilar ſubſtances, a ſubſtance only wanting a portion of oxygen to make it a perfect reſin. This it acquires by boiling and then becomes draſtic. Hence he recommends the cold infuſion, and not mixing it with acids or any other ſubſtance which may ſupply it with oxygen.——*Ann. de Chi.* XXIII.

TAR is ſeparated from pine, and Scotch firs, in *tar furnaces*, and when inſpiſſated it becomes BLACK PITCH. The TURPENTINES appear to be reſins containing volatile oil.

VII. 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.

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 *birdlime*. Reſins diſſolved in fixed oils form the fat or *oily varniſh*; in volatile oils the *eſſential varniſh*; and in alcohol the *ſpirit varniſh*.

VIII. CAOUTCHOUC, called the *elaſtic gum*, may alſo be placed here. The *nitric ether* diſſolves this gum. 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. A mixture of volatile oil and alcohol forms a varniſh which dries more ſpeedily. Linſeed oil alſo, by long digeſting on the oxides of lead, affords a pellicle of conſiderable firmneſs; tranſparent, wonderfully elaſtic and extenſible, and burning like elaſtic gum. A pound of this oil, ſpread on a ſtone and expoſed to the air for ſix or ſeven months, acquired almoſt all the properties of elaſtic gum.——*Chaptal.*

IX. BALSAMS are ſubſtances containing a principle which does not exiſt in reſins, and which combining with oxygen, forms an 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.

X. 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 is obtained *potatoe flour, caſſava, ſago,* &c. 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. There are alſo *coloured fæcula,* ſuch as *indigo.*

XI. VEGETABLE GLUTEN. This has been called the *vegeto-animal ſubſtance,* from its properties reſembling thoſe of animal ſubſtances. It is more particularly obtained from the gramineous vegetables. 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.

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 ammoniac, and ſhews in ſeveral inſtances 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 a ſtate is produced reſembling that of cheeſe.

Cold water does not attack this glutinous part; but if it be boiled with this fluid, it loſes its extenſibility and 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.

The *nitric acid* diſſolves it, with activity, emitting at firſt the 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 oxalic acid in cryſtals.

The *ſulphuric* and *muriatic acids* likewiſe diſſolve it, and ſalts with baſe of ammonia, may be obtained from the combinations.

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.

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*. This 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 leſs quantity in the flour of other corn, but is a conſtituent part of many other plants, particularly of the *fungi*. Its principles appear to be carbon, hydrogen, nitrogen, phoſphorus, 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*.

XII. SUGAR is a true eſſential ſalt, of a peculiar nature, a conſtituent part of vegetables; it may be extracted from a number of plants, as the maple, birch, 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 would prevent 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 bullocks blood, which latter, coagulating by heat, involves and ſeparates moſt of the foreign matters it contains, thus producing its clarification, when it is 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, being truncated on two ſides, it is then called *ſugar candy*.

It may be converted by the *nitric acid* into the oxalic, and by fermentation into acetic acid.

The juice of the ſugar maple *(acer ſaccharinum)* yields it very plentifully.

The carrot, and the *beta cycla altiſs*, yield ſugar in conſiderable quantity. The water remaining after obtaining ſtarch, alſo contains a large quantity of ſugar.——*Profeſſor Jacquin and Dr. Peſchiere.*

MANNA, which is ſugar under another form, is ſecreted 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.

From the ingenious inquiries of Mr. Cruikſhank, it appears that, 1. ſugar is a pure vegetable oxide, conſiſting of carbon, hydrogen, and oxygen. 2. Sugar of milk differs only in containing more oxygen, and much leſs carbon. 3. Gum differs alſo in containing lime and azote. 4. Vegetable farina cannot be converted into ſaccharine matter, without the joint action of oxygen and water, the firſt being abſorbed, the latter decompoſed. 5. Sugar deprived of its oxygen, loſes its characteriſtic properties, appears ſomewhat like a gum, and is no longer ſuſceptible of the vinous fermentation. 6. Neither vegetable nor animal mucilage, in their pure ſtate, are ſuſceptible of this proceſs.——*Experiments on Sugar. W. Cruikſhank.*

XIII. 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 it in a floculent form. 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.

XIV. 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. We can decompoſe them all, but cannot compound any one.——*Gren.*

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 ſaturate the chalk employed, is to 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 may be freed from the remaining gypſum. Its cryſtals are octahedral priſms, truncated on their ſolid angles. It ſeems to be one of the ſtrongeſt of the vegetable acids; it is not converted by the nitric acid into the oxalic acid. It acts on ſeveral metallic ſubſtances by the aid of water, and forms CITRATES with the *alkalies* and *earths.*

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.

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.

2. The MALIC ACID may be extracted from the juice of unripe fruits, particularly of apples, by ſaturating the juice with chalk, and adding a ſolution of acetite of lead; the acetous 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 ammoniac, and alſo a light flocky precipitate, with acetite 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 oxygenated by degrees, it at laſt contributes, in ſome plants, to form the oxalic acid.

3. The GALLIC ACID, which is alſo yielded by many barks, roots, fruits, &c. may be thus obtained. 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 falls down in proportion as the infuſion evaporates. Theſe precipitates being collected, and diſſolved in boiling water, form a liquid 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 by ſublimation.

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 ſpirits of wine diſſolves its own weight of this acid; but cold ſpirits 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.

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 *iron*, of a *black* colour.

The baſis of INK is iron thus precipitated. *Prouſt* conſiders ink as a ſolution of gallate and tannate of iron in ſulphuric acid; and prefers ink made by a ſolution of iron itſelf in infuſion of galls. The juice of walnuts (green) preſent the ſame appearances on digeſtion with iron. It is only the red oxide of iron, (oxidated *ad maximum*) that forms the ink with the galls; but whichever ſulphate is employed, when the ink is ſpread on paper it blackens, from the oxygen it abſorbs. Sulphurated 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.

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, half an ounce of acetite of copper firſt moiſtened and pounded into a paſte, 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.—*Deſormeaux, Phil. Mag.*

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 ſulphur of ammonia or of the pruſſiate of pot-aſh, 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 oxymuriatic acid, indigo and the oxide of manganeſe may be added.

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.

To obtain the tanning principle in the readieſt manner, a ſaturated ſolution of carbonate of pot-ash is to be poured in a very ſtrong infuſion of galls, when the tannin is precipitated in whitiſh yellow flocks; which muſt be waſhed with a very ſmall quantity of cold water. The quantity remaining in ſolution may be precipitated by inſpiſſation. The whole precipitate being ſpread thin, dries in a ſtove and aſſumes a reſinous form, of an acid bitter taſte, ſoluble in hot water and in alcohol, and by diſtillation yields a ſaline liquor, in which the ſmell of ammoniac is diſtinguiſhable. This ſolution holds *tannin*, which volatilizes unchanged, and which blackens the red oxide of iron, but does not become green with alkalies. The foregoing precipitate appears to be formed by the ſalt, which is added, having a greater affinity for the water than the *tannin* has; at the ſame time, that the carbonate of alkali ſaturates the gallic acid, which has the property of holding the *tannin* in ſolution. The aqueous ſolution of *tannin* lathers like ſoap water, and being poured into a ſolution of glue, it directly converts it into a magma, which poſſeſſes the elaſtic properties of the gluten of wheat. As all ſaline ſubſtances will precipitate the tannin, and as the animal fluids contain ſalts; it is not to be inferred from a precipitation on a mixture with infuſion of *tannin* that theſe contain glue. It is the *preſerving principle of tanned leather*.

By its action on animal ſubſtances it renders them ſoft, ſupple, and laſting, diminiſhes their attraction for water, and prevents their becoming the food of inſects.——*Prouſt. Ann, de Chim.* C. 103.

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.*

The green ſulphate of iron is not altered by the tanning principle, any more than by the acid of galls. But the red ſulphate is precipitated by the tanning principle, in a ſomewhat tarniſhed blue depoſition, different from that by the acid of galls. Beſides, the GALLATE of IRON is ſoluble in acids, but the TANNATE of IRON is decompoſed by theſe ſalts.——*Prouſt.*

4. The BENZOIC ACID is obtained by boiling 4 parts of benzoic with 1 of lime, and 4 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, it muſt be diſſolved, filtered, and gently evaporated. It may be alſo obtained by *ſublimation*, in the form of *flowers of Benjamin*.

It reddens the infuſion of violets, effervefces with the alkaline carbonates, and unites with earths, alkalies, and metals, forming BENZOATES. A ſimilar acid is obtained from *balſam of Tolu* and *ſtorax*.

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.

Diſtilled with ſulphuric acid, and the black oxide of manganeſe, it is decompoſed, and becomes acetic acid.

5. ACID of TARTAR is obtained from TARTAR, or the TARTAREOUS ACIDULE, which is pot-aſh ſuperſaturated with tartareous acid, and 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. Expoſed to heat it yields oil, phlegm, carbonic acid, and hydro-carbonate gas, and leaves in its aſhes a conſiderable quantity of vegetable alkali.

PURIFIED ACIDULOUS TARTRITE of POTASH, 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 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 9 ounces of ſulphuric acid, and 5 ounces of water to this tartrite, and digeſting them together for twelve hours, the tartarous 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 hydro-carbonate, 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.

This acid is very ſharp, but has no action on *platina*, *gold*, *ſilver*, or *antimony*, and ſcarcely any ſenſible action on *copper*, *lead*, and *tin*; but it diſſolves their *oxides*. It acts on *iron* with a conſiderable degree of effervefcence. With the *earths* it alſo combines very freely.

Boiled with the *ſulphuric* acid, the *tartarous* is for the moſt part *converted into acetic acid*.——*Gren*.

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*, a *triple ſalt* is formed.

The addition of *ſoda* to the *acidule* forms the TARTRITE of SODA, formerly called *ſal rochelle*, or *ſel de ſeignette*, which cryſtallizes in tetrahedral, rhomboidal priſms.

The TARTRITE of AMMONIAC forms cryſtals of tetrahedral priſms with obliquely truncated ſummits.——*Gren.*

The cryſtals of tartar are rendered more ſoluble by the addition of *borax*.

The tendency of the tartarous 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 tartarous, decompoſe the neutral tartrite of pot-aſh, and ſeparate from it, not the tartarous acid, but the acidulous tartrite, the conſequence of the tartarous 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.——*Gren.*

6. 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 from the juice of the *oxalis acetoſella*. 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 alſo forms triple ſalts with the alkalies, earths, and ſome of the metals.

The OXALIC ACID obtained from the oxalic acidule, by depriving it of the pot-aſh it contains, has a penetrating ſour taſte, it effervеſces in the air, is ſoluble in twice its weight of cold, and half its weight of hot water.

It forms OXALATES with the *alkalies*, making, with *pot-aſh*, the oxalic acidule, or the ſalt of ſorrel of the ſhops. 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*.

It combines with *alumine*, *magneſia*, and *barytes*. 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.

Brugnatelli ſays that the oxalic acid cannot be depended on as a re-agent on lime, ſince he diſcovered that, in ſeveral inſtances, the preſence of lime was aſcertained by other known re-agents, when the oxalic failed.——*Ann. de Chim.* No. 86.

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 tartarous and the oxalic are converted into the acetic acid.——*Gren.*

7. 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 ammoniac, which are very ſparingly ſoluble in water. With *pot-aſh* it forms cryſtals in regular hexagons; with *ſoda*, irregular cryſtals; with *ammoniac*, 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 whoſe planes are parallel, and in ſome reſpects reſembling baſaltes.

It burns without leaving any reſidue, 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.*

8. SUBERIC ACID, obtained, as its name imports, from *cork*, 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*, *ammoniac*, *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.*

To explain the action of SULPHURIC ACID on *dry vegetable ſubſtances*, Fourcroy obſerves, that on putting *a ſtraw* in this acid a black powder is precipitated, and the acid weakened without being decompoſed. The acid, he ſuppoſes, decompoſes the ſtraw, by attracting ſome of its water of compoſition, thus deſtroying the mutual attraction of its component parts. A portion of the carbon is precipitated unchanged, and another of it is combined with the hydrogen, and a part of the oxygen of the vegetable ſubſtance, to form the acetous acid, which is found after the proceſs to be combined with the ſulphuric acid, while the remaining hydrogen and oxygen form the water with which the mineral acid appears to be diluted.——*Ann. de Chim.* XXIII.

ACIDS *obtained by the* ACTION of FIRE, or EMPYREUMATIC ACIDS.

9. PYRO-TARTAROUS ACID is yielded by dry diſtillation, by the *tartarous acidule*. Its ſaline combinations are called PYRO-TARTRITES.

10. PYRO-MUCILAGINOUS ACID is obtained by dry diſtillation from *inſipid*, *ſaccharine*, *gummy*, or *farinaceous* mucilages. It renders the ſkin of a red colour, and forms PYRO-MUCITES with the *earths* and *alkalies*, with *lead*, *copper*, *tin*, and *iron*.

The acid thus obtained *Gren* believes to be only a mixture of acetic and oxalic, and does not think it deſerves to be conſidered as a peculiar acid.

11. PYRO-LIGNOUS ACID is obtained by dry diſtillation from *wood*, and particularly from *beech*, *birch*, and *box*. With earthy and alkaline baſes it forms PYROLIGNITES.

Gren ſuppoſes theſe acids to be *products* of the operation, not *educts* which have actually exiſted in the ſubſtance.

From the experiments of *Vauquelin* and *Fourcroy*, it appears that the three empyreumatic acids are merely the acetous acid impregnated with empyreumatic oil, of which it appears to be an actual diſſolvent.——*Ann. de Chim.* 1800.

12. The ACETOUS ACID is the reſult of what is termed the acetous fermentation, of which it will be neceſſary firſt to ſpeak.

FERMENTATION of VEGETABLE SUBSTANCES.

FERMENTATION takes place, accompanied by a decompoſition, when the various parts of vegetables are diffuſed in water, and the action of this fluid 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.

When the *ſaccharine principle* predominates in the ſubſtances employed, the product is a *ſpirituous liquor*, and the proceſs is termed, the *ſpirituous fermentation*; but when *mucilage* is moſt abundant, the liquor ſoon manifeſts *an acid*, the proceſs by which it is formed being termed the *acetous fermentation*; and if gluten be prevalent, *ammoniac* will be diſcovered in the product, and the proceſs will be the *putreſcent fermentation*. No ſubſtances but thoſe which conſiſt ſimply of carbon, hydrogen and oxygen are ſuſceptible of the vinous fermentation. It appears that nitrogen and lime combined with the carbon, in gum, prevents the vinous, and conſequently the acetous fermentation.

SPIRITUOUS FERMENTATION is employed for making *wine*, *cider*, *beer*, *perry*, &c. Thus the *muſt* or *juice of grapes*, at about 70° F. ſoon becomes turbid, and agitated through its whole maſs, ſeparating carbonic acid gas, and a frothy ſubſtance called *yeaſt*. This proceſs ceaſing, the liquor becomes clear and bright, and has obtained a vinous odour and taſte, with certain intoxicating powers; the *lees of the wine* ſettling to the bottom. Even after this an *imperceptible fermentation* goes on which occaſions the difference between *new* and *old* WINE.—During theſe fermentations *tartar* is depoſited on the ſides of the veſſels. If the fermentation be impeded, whilſt at its height, by the excluſion of air, as in bottling, the wine on the firſt opportunity lets the impriſoned gas, formed after its ſecluſion from the air, eſcape rapidly, as in the ſparkling *Champaigne wines, cider, perry*, &c.

Flour is likewiſe diſpoſed to fermentation, eſpecially if the grain be firſt *malted*, 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 about 2-3ds of its length, the farther germination is then ſtopped by drying in a kiln, or airy lofts. When dried in the latter way it is called *air dried malt*, and in the former *kiln-malt*. BEER is made from malt by infuſing ground malt in boiling water in a *maſh-tub*, it being then called *maſh*, and the infuſion drained off is called *ſweet-wort*. To give it a pleaſant flavour, it is then boiled with *hops*, then the decoction is ſpeedily cooled to 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*. Alcohol is produced by a re-diſtillation or *rectification*. 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, appears to be formed by an intimate union of much hydrogen with carbon. Mr. *Lavoiſier* obtained eighteen ounces of water by burning one pound of alcohol.

Alcohol may be freed from its redundant water, not only by diſtillation, but by the addition of fixed alkali, which attracts the water, in which it becomes diſſolved, the alcohol ſwimming at the top, and containing a ſmall portion of the alkali.

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.

It 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*, *eſſential oils*, and *ſoap*, but does not diſſolve *fat oils*, *animal fat*, *ſulphur*, *pruſſian blue* or *phoſphorus*.

ETHER, or *naphtha*, is formed by diſtilling equal parts of ſulphuric acid and alcohol, the oxygen of the acid combining with the hydrogen and carbon of the alcohol. If the diſtillation be continued beyond the production of the ether, a yellow oil, called SWEET OIL of WINE, is produced, which is heavier and leſs volatile than the ether.

Ether is exceedingly light and volatile, and of a peculiar ſmell; is ſparingly ſoluble in water, and burns with a bright flame.

Fourcroy and *Vauquelin* attribute the formation of ether to the attraction of the ſulphuric acid for the water of the alcohol.

Van Mons ſays, that a *muriatic ether* may be compoſed by one operation, if you diſtil, at a boiling heat, a mixture of alcohol and oxy-muriate of pot-aſh in the proportion of 1,00 to 0,25.

By ſimply mixing the ſulphuric and muriatic ethers, inſtantaneous evaporation takes place, and the abſorption of caloric is ſo rapid as 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 Trootſwyk*, and *Lawrenberg*, have 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 have called the *carbonated oily hydrogenous gas:* which on being mixed with oxygenated muriatic acid gas, manifeſts 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 *manganeſian 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, and which ſinks in water, comes over. This has been called *oil of ſalt*; perhaps it reſembles the oil juſt ſpoken of 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 ſettles, 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 may be concentrated by diſtillation, or by freezing, when it forms the ACETOUS ACID, which united with *pot-aſh*, forms the ACETITE of POT-ASH, alſo called improperly, *terra foliata tartari*; with *ſoda*, the ACETITE of SODA; and with *ammoniac*, the AMMONIACAL ACETITE, generally known by the name of *Mindererus*'s *ſpirit*.

ACETIC ACID, alſo called *radical vinegar*, has been ſuppoſed to be formed by introducing a ſtill larger quantity of oxygen, than it in general contains, into the acetous acid. To do this, the acetous acid is combined with ſome of the metallic oxides, and expoſed to diſtillation, when the higher acid is obtained. Or half its weight of *ſulphuric acid* may be mixed with *acetite of ſoda* and diſtilled. It is moſt probable that the difference ariſes only from the proportion of water the acids contain.

Acetic acid, as it is termed, is very acrid and volatile, emitting, when heated, an inflammable vapour, and forming with alkalies and earths, ſalts different from thoſe formed by common vinegar, and which are diſtinguiſhed by the term ACETATES. It will alſo form ether with alcohol.

The formation of vinegar appears to be the reſult of the combination of oxygen with carbon and hydrogen, *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.

The converſion into the acetous acid appears to depend on four circumſtances. 1ſt. The decompoſing action of fire by diſtillation, by which the conſtituent parts of the ſubſtance are ſo combined as to form the acetous acid, water and carbonic acid gas being alſo formed at the ſame time, with charcoal, which is pecipitated. 2dly. The action of ſtrong mineral acids, by which water and carbonic acid alſo are formed, and charcoal depoſited. This acetification appears to be the laſt ſtep of vegetable acidification; ſince if 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 with the putrid decompoſition. It takes place in animal fluids, particularly in urine.——*Ann. de Chim.* Cah. 104.

Scheele has formed vinegar by decompoſing the nitric acid on ſugar and mucilage.

In the making of *bread*, the vinous and acetous fermentation take place; the former ſoon yielding to the latter, the flour kneaded into *dough* with water, having acquired this ſtate, is called *leaven*, and if added to more dough it haſtens its fermentation. But if baked before ſourneſs is diſcoverable good bread is formed. Yeaſt is alſo 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.

XIV. 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 *ammoniac*. 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 is, in fact, a neutral ſalt, containing carbonic acid; and which, as is the caſe with the boracic acid, in borax, is chemically, not merely mechanicanically, ſuper-ſaturated with its alkaline baſis.——*Crell's Journal*, 1800.

XV. 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 DYING, conſiſts in transferring the colouring principle of one body to another, ſo that it ſhall be durably fixed.

Colours are all formed in 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 dying, 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 dying 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*, which either by imparting oxygen or otherways, alters its ſubſtance, and 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.

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.

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 *archil*, *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 mordants are chiefly of an acid nature, ſuch as the ſulphate of alumine, acidulous tartrite of pot-aſh, ſolution of tin in nitro-muriatic and oxy-muriatic acid, gallic acid, ſulphate of copper, of iron, and of zinc, acetite of copper, arſenic, &c.

Blue, red, and yellow, are the fundamental colours, by combining theſe, *on the ſtuffs*, rarely in the bath, the various hues are obtained.

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 oxygenated muriatic acid produces the effect with ſo much facility, that all former proceſſes muſt yield to it.

The oxy-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 thus made.

Sulphur 4 pounds, flaked lime 24 pounds, and water 16 gallons boiled half an hour in an iron veſſel, the liquor ſtrained off and 16 gallons more of water poured on the dregs and alſo ſtrained off; the two ſolutions being mixed together and poured into 33 gallons more water, makes a liquor of a proper ſtandard in which cloth may be ſteeped in the proceſs of bleaching, the ſulphuret ſerving as a ſubſtitute for pot-aſh for condenſing the oxy-muriatic gas.——*Eſſay on Bleaching, &c. Wm. Higgins.*

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 ſulphate of alumine and the muriate of tin are the two ſalts which are moſt efficacious for theſe purpoſes. 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 dying cotton.

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.*

The juice of aloes produces a lively violet, highly proper for works in miniature, and which may ſerve either cold or warm, for dying ſilk, from the lighteſt to the darkeſt ſhade. ——*Fabroni. Ann. de Chim.* XXV.

INDIGO is a fæcula obtained from the indigo plant, by ſteeping it in water and allowing its fermentation, the coloured fæcula falling in a blue flocculent ſediment. WOAD 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.

ARNATTO is prepared from the pulp of the ſeed capſules of a tree growing in Guiana.

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.

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.

Guyton ſuppoſes the red colour of fruits to be owing to the re-action 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 tungſten, he thinks, is ſuperior to all others, in forming cakes for painters.——*La Decade Philoſ.* 1798.

XVI. 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.

XVII. WAX of BEES is merely the pollen very little altered.

There appears to exiſt in the very texture of ſome parts of various vegetables, a matter analogous to wax.

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 oil 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.

Ammoniac 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.*

XVIII. HONEY, or the nectar of flowers, is contained chiefly in the piſtil or female organs. It appears to be a ſolution of ſugar in the mucilage.

XIX. 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. Its character is inſolubility in water, and almoſt every other menſtruum; even the concurrence of air and water alters it very difficultly, and it ſo abſolutely reſiſts every kind of fermentation, as to be almoſt indeſtructible, but by inſects. It contains the greateſt quantity of carbon of any vegetable ſubſtance.

XX. 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.

XXI. CHARCOAL is an *oxide of carbon*, obtained from wood by the proceſs termed *charring*, which is 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. *Iron*, *mangane\ſe*, and even *gold*, have been found in the aſhes of plants. *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. Journal.*

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 ammoniac, 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.

Distillation occaſions a ſeparation of the principles of vegetables; all vegetables yielding nearly the ſame, viz. an *oil*, an *acid water*, a *concrete ſalt*, *carbonic acid*, and *carbonated hydrogen gaſes*, and *charcoal*.

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, and becomes heated, and as it is reduced to a magma, a gas is diſengaged, which is a mixture of *nitrogen*, *hydrogen*, and *carbonic acid*; *ammoniacal gas* is alſo emitted. 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 reſidue of vegetable decompoſition may be conſidered as the great agent and means by which nature repairs the continual loſſes the mineral kingdom undergoes, diamonds, quartz, cryſtals, ſpars, bog-ores, &c. being formed in this matrix.

If this decompoſition is 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 may accompany the diſengagement of *hydrogen*, and of *phoſphorus*.

Peat, or quick moss, appears to be vegetable matter deprived of its *hydrogen*; 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 of the Shetland Iſles*.

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.

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.

Beſides the manures already mentioned, *charcoal* itſelf, and *ſoap-boiler's waſte* have been ſucceſsfully uſed.

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 taking 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.

The oxygenated 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 *pure* earth, either ſilica, lime, or alumine thus abſorbs oxygen. 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.

OF ANIMAL SUBSTANCES.

THE conſtituent parts of animal bodies conſiſt of but a ſmall number of radical principles; their various natures chiefly reſulting from the different proportion in which theſe are combined. Theſe radicals appear to be *nitrogen*, *carbon*, *hydrogen*, *phoſphorus*, *oxygen*, and *lime*.

1. 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, whilſt circulating through the veins, differs in intenſity of colour and degree of conſiſtence, from 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, which is the character of lymph: it eaſily putrifies, and then affords much carbonate of ammoniac. Diſtilled on a water bath, it yields an inſipid phlegm, neither acid nor alkaline, but very readily putrifying; the reſidue being tranſparent like horn, and no longer ſoluble in water, but yielding, by farther diſtillation, an alkaline phlegm, carbonate of ammoniac, and a fetid blackiſh oil, more or leſs thick: the remaining coal is very voluminous and difficult to incinerate. The aſhes afford muriate and carbonate of ſoda, and phoſphate of lime. Being poured into boiling water, it directly coagulates, a part communicates a milky colour to the water, and poſſeſſes, according to *Bucquet*, all the properties of milk.

The COAGULABLE LYMPH, beſides being the principle 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. 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.——*Gren.*

The COAGULUM of the blood, likewiſe contains much lymph, which may be carried off by waſhing. The colouring part, which contains much iron, may be carried off by the ſame proceſs. When the coagulum has been thus waſhed, a white fibrous ſubſtance is left called FIBRIN, or the *fibrous part* of the blood. It is void of ſmell, and being diſtilled in a water bath it yields an inſipid phlegm, eaſily ſuſceptible of putrefaction. The reſiduum ſoon becomes dry, by a gentle heat; and if expoſed to a conſiderable heat, it ſhrinks up like parchment; if diſtilled, it affords the ſame reſults as the coagulable lymph, but the coal is leſs voluminous and lighter than that of lymph. The *alkalies* diſſolve it, if aided by a boiling heat, and the *acids* combine with it.

The blood contains much iron. 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 oxidation 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, and 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.

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.

II. 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.

III. 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.

IV. 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.

LACTIC ACID, or the ACID of MILK, is thus obtained. Sour milk being evaporated to one eighth, the cheeſy matter ſeparated by the filter, 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 nitrous acid from twelve ounces of ſugar of milk, *Scheele* obtained five drams of oxalic acid in long cryſtals, and ſeven drams and a half of the ACID of SUGAR of MILK, in a white powder.

The SACCHO-LACTIC ACID is combuſtible, and does not leave any aſhes behind; 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 SACCHO-LACTATES with the *alkalies* and *earths*; thoſe with the earths being inſoluble, and that with *ammoniac* having a ſouriſh taſte. On the *metals* it does not act, but with their calces it forms ſalts of very difficult ſolubility.

The ſerum of milk may, by ſeveral proceſſes, be made to paſs into the vinous fermentations. Six ſpoonsful 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. *Ammoniac* 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.*

V. FAT is a condenſed in flammable 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 oil and phlegm; the phlegm is reddiſh, has an acid taſte, effervеſces 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, thus obtained, has been concentrated by various proceſſes by Mr. Crell. Alkalies, it is known, form a ſoap with animal fat; by heating this ſoap with a ſolution of alum, he ſeparated the oil and obtained the SEBATE of POT-ASH, by evaporation. The ſulphuric acid, afterwards diſtilled from this ſalt, decompoſed it, and the ſebacic acid was ſeparated.

This acid exiſts ready formed in the fat, ſince earths and alkalies diſengage it.

Mr. Crell alſo obtained it by diſtillation from the butter of cocoa, and from ſpermaceti.

It ſeems to approach to the nature of the muriatic acid, in ſome reſpects, but not in others. Mr. Crell thinks its place ſhould be between the mineral and vegetable acids. It forms a cryſtallizable ſalt with the *oxide of gold*, as it does likewiſe with that of platina. It unites with *mercury* and with *ſilver*, yielding the latter to the muriatic acid, but not the former: it takes both from the ſulphuric. It alſo takes *lead* from the nitric and acetous acids, and *tin* from the nitro-muriatic. It attacks neither *bismuth*, *cobalt*, nor *nickel*, nor decompoſes the *ſulphates of copper*, *of iron*, or *of zinc*, nor the *nitrates of arſenic*, *manganeſe*, *zinc*, &c. but reduces the *oxide of arſenic*. It unites with the *carbonates of lime* and *alkali*, with efferveſcence, and forms ſalts very ſimilar to the acetites of the ſame baſis. Crell formed with it a SEBACIC ETHER.

The ſebacic acid treated with the *nitric acid*, may be converted into the oxalic, and acetic acid.

From the foregoing analyſis, 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 analyſes, 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.

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. The *ſulphuric* acid diſſolves it. The *nitric* and *muriatic* have no action on it. *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*.

VI. 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. Diſtilled on a water bath, it yields a phlegm which is neither acid nor alkaline, but ſoon putrifies; this phlegm, and the bile itſelf, ſometimes, it is ſaid, emits a ſmell like that of muſk. The reſidue of this diſtillation is a dry extract, which attracts the humidity of the atmoſphere, and is tenacious, pitchy, and ſoluble in water. By more violent heat it yields ammonia, an empyreumatic animal oil, concrete alkali, and hydrogen.—The coal is not difficult of incineration, and contains iron, carbonate of ſoda, and phoſphate of lime. 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. Bile is ſoluble in alcohol, by which the albuminous principle, which renders bile coagulable, and haſtens its putrefaction, is alſo ſeparated. The bile appears therefore to be a combination of ſoda with a matter of the nature of reſins, and a lymphatic ſubſtance, which renders it ſuſceptible of prutrefaction and coagulation. 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.

When the bile becomes thick in the gall-bladder, it forms the concretions called *biliary calculi*; concreted, it is ſuppoſed, by the abſorption of oxygen. Theſe are ſoluble in general, in ardent ſpirit; and when the ſolution is left to itſelf for a certain time, brilliant and light particles are ſeen in it, which appear to have an analogy with the ſalt of benzoin, and with thoſe which are found in the human calculi. There appear to be two ſorts of biliary calculi, the one opake, conſiſting of the condenſed bile, with a ſubſtance ſimilar to wax or ſpermaceti, and formed in concentric ſtrata; the other compoſed of cryſtalline plates, ſimilar to mica or talc, formed by the cryſtals juſt deſcribed.

VII. The SOFT AND WHITE parts of animals. The tendons, cartilages, ligaments, and ſkin of animals, contain a mucous ſubſtance, very ſoluble in water, but not in alcohol; known by the name of GELATIN or *animal jelly*. It is obtained merely by boiling any of the foregoing ſubſtances in water: it has in general no ſmell, and is inſipid to the taſte. By diſtillation this jelly yields an inſipid and inodorous phlegm, which eaſily putrifies; by a ſtronger heat it ſwells, becomes black, and emits a ſtrong odour, with white acrid fumes: an alkaline phlegm, an empyreumatic oil, and a little carbonate of ammoniac paſſes over; and a ſpongy coal remains, difficult of incineration, and which contains muriate of ſoda and phoſphate of lime.

As it putrifies, a large quantity of nitrogen, hydrogen, and carbonic acid gas, is emitted. 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 more 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. *Gilders' ſize* is made by boiling eel-ſkin with a ſmall quantity of lime in water, to which ſome whites of egg 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 ſinew, 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 a cake of glue, after ſteeping three or four days to ſwell much, without being diſſolved. Gelatin is ſoluble in acids; thus dry mucilage, dry ſize, and dry glue, are progreſſively diſſolved in nitric acid, according to the degree of viſcidity by which they are diſtinguiſhed.

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 yielding 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 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 *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 ſtag's horn, bone, ivory, &c. but when carbonate of lime is the hardening ſubſtance, as in ſhells, madrepores, and millepores, no gelatin can be diſcovered.

Scales of fiſh, and the *ſpicula of the ſhark*'s *ſkin*, appear to be true boney ſubſtances, containing much phoſphate of lime, with a greater proportion of the membranaceous part than in common bone.

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.——*Philoſ. Tranſ.* 1800.

The SKINS of ANIMALS, after waſhing, fleſhing, and cleaning from the hair, are impregnated with the tanning principle, with which they form a compound inſoluble in water, and poſſeſſing other uſeful qualities; this ſubſtance is termed *leather*.

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 Chi. de Crell.* 1799.

VIII. The MUSCULAR or FLESHY PARTS afford, by diſtillation, water, alkaline phlegm, empyreumatic oil, nitrogen gas, carbonate of ammoniac, and a coal which yields a ſmall quantity of fixed alkali and febrifuge ſalt. *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 ammoniac, mixed with the phoſphate of lime. The moſt abundant part of muſcles, and that which conſtitutes their predominating character, is the *fibrous matter*. This is diſtinguiſhed by its inſolubility in water, and by its yielding more nitrogen gas, by the nitric acid, than other animal ſubſtances. It alſo yields the oxalic and the malic acid. It putrifies readily, when moiſtened; and affords much concrete ammoniac by diſtillation. Of the other matters contained in fleſh, the lymph, and fat part, have been already ſpoken of; and the albumen has been lately the ſubject of ſome ingenious experiments of Mr. Hatchett.

ALBUMEN, that tenacious fluid contained in the blood, and compoſing the chief part of the white of eggs, which, when dry, is ſemitranſparent, like horn; 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 thoſe of pure *albumen*, in every reſpect; 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.

Fourcroy found the muſcular parts of bodies, which had been interred in the *Cemeterie des Innocens,* converted into a ſubſtance reſembling ſpermaceti.——*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 reſembling 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. Tranſ.* 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. Tranſ.* 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, and the mixture becomes 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 ſaturnine 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 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 aërial fluids extricated from the muſcular fibres of animals by putrefaction, conſiſt of carbonic acid and animal hepatic gas, mixed with a very ſmall proportion of phlogiſticated air. From the green leaves of a cabbage, I obtained, the doctor ſays, an aërial fluid, which, in moſt of its properties, reſembled animal hepatic air.——*Phil. Tranſ.* 1790.

Vauquelin found that ammonia was produced by the action of ſulphuric acid on animal ſubſtances. Mr. *Jameſon* found that the muſcular fibre of fiſh, treated with pure alkali, yielded ammonia, eſpecially with long boiling and the addition of tallow; a carbonaceous matter ſubſiding, not acted upon by alkalies. Thus the muſcular fibre appears to be completely decompoſed, its hydrogen and nitrogen forming ammonia, and the carbonaceous matter being left behind.—*Jameſon's Experiments.*

IX. 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 *(Halle)*. The crude urine preſents very different phenomena, becoming ſoon covered with mouldineſs, like the expreſſed juice of vegetables.

By diſtillation, the urine yields a phlegm which ſoon putrifies, and which affords ammonia by its putrefaction. At the ſame time, a ſubſtance is precipitated of an earthy appearance, but which is, in reality, a peculiar ſaline ſubſtance. This ſalt forms the ſediment of urine, which ſeparates by the cold, or by evaporation, even in the urine of perſons in perfect health.

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 phoſphate of ſoda and of ammoniac, and is uſed as a flux to the earths.

From accurate experiments it appears that thirty-ſix ounces of urine yields a reſiduum from an ounce to an ounce and a half, which conſiſts of the following ingredients in nearly theſe relative proportions.

	Drams.	Grains.
Muriatic ſalts	1	0
Phoſphoric ſalts	3	50
Lithic or Uric acid and phoſphate of lime, with exceſs of acid	0	25
Animal extractive matter	3	40

The ſalts are the muriates of pot-aſh and of ſoda; the phoſphates of ſoda, of lime, and of ammonia, with the lithic and phoſphoric acids.——*Cruikſhank.*

Urine, when firſt voided, contains an exceſs of phoſphoric acid, and thereby holds in ſolution more or leſs of phoſphate of lime. It ſoon runs into the putrefactive ſtate, accompanied with the extrication of much ammonia. The ammonia is diſengaged from urine, likewiſe, by the fixed alkalies and lime, which decompoſe the phoſphate of ammoniac; and acids diminiſh its ſmell by combining with and fixing the ammonia, which is the principal cauſe of its odour. The urine of animals which feed on vegetables does not appear to contain phoſphoric acid, but an acid of a vegetable nature, which ſeems to reſemble the benzoic.——*Rouelle and Fourcroy.*

Recent human urine contains ten conſtant ingredients; muriate of ſoda, muriate of ammoniac, acid phoſphate of lime, phoſphate of magneſia, phoſphate of ſoda, phoſphate of ammonia, uric acid, benzoic acid, jelly, albumine, and the ſpecific matter of urine, called *urée*, to which matter the urine owes its odour, colour, and ſavour, its alterability into ammonia, carbonic and acetic acids, &c. with the property of becoming by putreſcent fermentation, a fluid ſo different from what it is when firſt voided, as to contain nine new ingredients. Theſe are, 1. Ammonia in exceſs. 2. Phoſphoric acid ſaturated by this alkali. 3. Phoſphate of magneſia, converted into ammoniaco-magneſian phoſphate. 4. Urate of ammonia. 5. Acetous acid, united to ammonia. 6. Benzoic acid with ammonia. 7. Muriate of ſoda, changed in its cryſtallization from the cube to the octaëdron. 8. Muriate of ammoniac, changed from the octaëdron to the cube. 9. Carbonate of ammoniac.

The urée is obtained by diſtillation from a brown liquor formed, by adding at different times, four times their weight of alcohol, on the cryſtals yielded by inſpiſſated urine.——*Ann. de Chim.* 93.

According to *Fourcroy*, the analyſis of urine diſcovers that it contains the phoſphoric, uric, and benzoic acids, in a free ſtate, the phoſphates of lime, of ſoda, of magneſia, and of ammoniac, and a peculiar cryſtalline matter in the form of an extract, which is the moſt abundant of all the matters it contains; and which poſſeſſes the very ſingular property of changing to carbonate of ammoniac by the action of fire, and alſo of changing the cubic cryſtals of the muriate of ſoda into octahedra, and the octahedra of the muriate of ammoniac into cubes. This animal matter, named UREE, is an excrementitious ſubſtance ſurcharged with nitrogen, and it is by it that the body rids itſelf of the ſuperfluous part of this animalizing principle. The urine ſuffers a ſpontaneous decompoſition, thereby undergoing very conſiderable alterations, its ſalts being changed and multiplied, and the acetous and carbonic acids, with ammoniac formed. Beſides the ammoniaco-magneſia phoſphate, and the phoſphate of ammonia, the carbonate of ammoniac is produced in a conſiderable quantity, and is eaſily obtained by diſtillation.——*Tab. Syn. de Fourcroy*, 1800.

PHOSPHORUS is thus obtained from *URINE*. Ten pounds of urine evaporated to the conſiſtence of honey, the muriate of lead, remaining after the diſtillation of four pounds of minium, two of muriate of ammoniac, and half a pound of charcoal, are to be mixed together, and dried in an iron pot, until reduced to a black powder, which is to be deprived of its volatile alkali, fetid oil, and muriate of ammoniac, by diſtillation; the reſidue containing the phoſphorus, which it will yield, by diſtillation in a good earthen retort. In this proceſs the muriate of lead is employed, to decompoſe the phoſphate of ſoda, which is not decompoſable by charcoal, and to form the phoſphate of lead, which affords the phoſphorus.——*Margraaf.*

Phoſphorus is of a fleſh colour, of the conſiſtence of wax, and at firſt tranſparent, but becoming white, and, in the ſun, yellow. In the air it emits a white fume, and is luminous in the dark. It is ſoluble in oils, more eſpecially in volatile oils, which then become luminous: the oil of cloves is uſed for this purpoſe, and every time the bottle is opened a phoſphoric 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.

A very thin ſlice of phoſphorus being placed on an anvil with a gros of the cryſtals of nitrate of ſilver, and ſmartly ſtruck with a hammer, a moſt terrible detonation was produced, the edge of the hammer was turned up, and the anvil ſhaken and marked with ſtreaks of ſilver. The lapis infernalis and all the metallic nitrates being thus treated, violent detonations were produced. The experiment alſo ſucceeded with the common nitrate of pot-aſh, but the hammer was required to be heated.——*Brugnatelli.*

Van Mons repeated theſe experiments with ſucceſs, and found the oxides of gold, ſilver, and mercury, by fire, to occupy the firſt rank among fulminating ſubſtances. He alſo diſcovered that two grains and a half of oxygenated muriate of ammoniac, with four grains of phoſphorus, being gently cruſhed on the anvil, a moſt terrible detonation enſued, which alarmed the houſe; and the concuſſion was ſo violent as to force the hammer out of his hand.——*Ann. de Chim.* 1797.

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.

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.*

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.

Brugnatelli remarks, that phoſphorus diſſolves without light in oxygen gas, which becomes luminous by adding any mephitic gas. It diſſolves alſo in hydrogen, and is then ſeparated by oxygen. It ſeparates the oxygen from the oxy-muriatic acid, and becomes itſelf an acid, but does not diſſolve in pure carbonic acid. When the temperature is a little raiſed, and ſome pure air is added, it ſhines better than in atmoſpheric air. Water ſuſpends little atoms of phoſphorus only. Atmoſpheric air diſſolves it at the moment of burning, and becomes phoſphoreſcent.——*Ann. de Chim.* XXIII.

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 ſubſtance, to enable them to attract oxygen.

Girtanner conjectures phoſphorus to be hydrogen in its pureſt ſtate.

The PHOSPHORIC ACID is formed by the combination of oxygen with the phoſphorus during combuſtion. This acid thus obtained is, however, imperfect, not being ſaturated with oxygen; but the phoſphorus is more completely decompoſed by the ſlower combuſtion, or combination with oxygen, which takes place at the common temperature of the atmoſphere; fluid acid of phoſphorus is thus obtained, ſtill however retaining a ſmall quantity of undecompoſed phoſphorus, of which it may be cleared by digeſting alcohol upon it.

By digeſting *nitric acid* upon phoſphorus, nitrous gas is ſeparated and the oxygen unites to the phoſphorus, forming *phoſphoric acid*. If the acid be highly concentrated, the phoſphorus burns at the ſurface. The water in which phoſphorus is kept, contracts acidity in time, the water yielding its oxygen to the phoſphorus. This acid, when pure, is clear, inodòrous, and not corroſive; it may be concentrated to dryneſs, when its ſpecific gravity, compared with water, is as 3. 1. It is very fixed. If after concentration it is put in a crucible, on hot coals, it boils, a green flame appears, and the maſs is converted into a white tranſparent ſubſtance ſoluble in water.

The PHOSPHATE of POT-ASH forms a very ſoluble ſalt, in tetrahedral cryſtals, terminating in tetrahedral pyramids; is acid, ſwells on hot coals, is difficult of fuſion, and decompoſable by lime water.

PHOSPHATE of SODA forms in rhomboidal cryſtals which effloreſce in the air. 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.

PHOSPHATE of AMMONIA forms in tetrahedral cryſtals, readily ſoluble in water. It is alſo fuſible, when it parts with its ammoniac.

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

PHOSPHATE of BARYT is taſteleſs and inſoluble, and convertible by fire into a glaſs.

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

PHOSPHATE of LIME is white, friable, inſipid, opake, and inſoluble in water.

Phoſphate of 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.

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 glaſs.

X. The CALCULUS of the BLADDER is chiefly formed of a peculiar concrete acid, which is ſlightly ſoluble in boiling water, and is depoſited in cryſtals, as the ſolution cools.

The URIC ACID, or *acid of calculi*, formerly called the *lithic acid*, is concrete, ſparingly ſoluble in water, and is decompoſed, and partly ſublimed by diſtillation: it decompoſes the *nitric acid*, unites with *earths*, *alkalies and metallic oxides*, and yields its baſes to the weakeſt *vegetable acids*, not excepting the *carbonic*.

Mr. *Lane* aſcertained by careful experiments that there exiſts a great difference in different calculi, ſome being diſſolved in the lixivium ſaponarium, and others being ſcarcely altered; ſome retaining their form, whilſt others were nearly evaporated by a red heat. Different parts of the ſame calculus varying conſiderably in theſe reſpects.——*Phil. Tranſ.* 1791.

It has been aſcertained that the calculus, 1ſt. Is diſſolved by the *ſulphuric acid*, with heat. 2. Is not acted on by the *muriatic acid*. 3. Is diſſolved by the *nitric acid*, with effervеſcence and the diſengagement of the nitrous gas and carbonic acid: the ſolution is red, contains a diſengaged acid, tinges the ſkin of a red colour, and is not precipitated by the muriate of barytes, nor rendered turbid by the oxalic acid. 4. Is not acted on by the *carbonate of pot-aſh*, but is diſſolved by the *cauſtic alkali*, as well as the *volatile alkali*. 5. Is diſſolved in *lime-water* in the quantity of 5,37 in 1000 grains, and may be precipitated by acids. 6. Contains a ſmall quantity of *ammoniac*. 7. The coally reſiduum of combuſtion indicates an animal ſubſtance of the nature of jelly.——*Scheele.*

This illuſtrious chemiſt has alſo proved that all urine, even that of infants, holds a ſmall quantity of the matter of calculus in ſolution, and that the brick coloured depoſition from the urine in fevers, is of the nature of calculi, but he did not find that it contained a particle of calcareous earth. By pouring the ſulphuric acid into the nitrous ſolution of the calculus, a true ſulphate of lime was obtained; although the lime did not exceed the 200th part of the entire weight.

This chemiſt alſo detected a white ſpongy ſubſtance, not ſoluble in water, ſpirit of wine, acids, or alkalies, nor in the nitric acid, even in the ſtate of aſhes; but the quantity was too ſmall to be thoroughly examined.

The matter obtained from calculi, by ſolution in lye of cauſtic fixed alkali, and precipitation by acids, has been ſuppoſed to be an acid ſimilar to that obtained by ſublimation, and which has been termed LITHIC ACID. Dr. *Pearſon* obtained this precipitate, in the proportion of at leaſt one half of the matter of the calculi; and aſſerts that this precipitate does not belong to the genus of acids; that it is not the ſame thing as the *ſublimate of Scheele,* nor is to be referred to the animal mucilages; but that it belongs to the genus of *animal oxides.* Its peculiar and ſpecific diſtinguiſhing properties being imputreſcibility, facility of cryſtallization, inſolubility in cold water, and that moſt remarkable property of all others, of producing a *pink* or *red matter,* on evaporation of its ſolution in nitric acid. Of 300 grains of calculus 175 were this peculiar *animal oxide,* 96 were *phoſphate of lime,* 29 were *ammoniac* and probably united with it, *phoſphoric acid, water,* and *common mucilage of urine.*

The term *lithic,* being, the doctor ſays, a groſs ſolecifm, he propoſes, as more appropriate, the term OURIC or URIC. This oxide he would therefore term the URIC OXIDE.

From 100 grains of an urinary concretion he obtained only 18 grains of the acid ſublimate of *Scheele,* and doubts whether the lithic acid of *Scheele* exiſts as a conſtituent of urinary concretions, or is compounded, in conſequence of a new arrangement of the elementary matters of the concretion, by the agency of fire. The doctor did not find the uric oxide in the urinary concretions of any phytivorous animal.——*Phil. Tranſ.* 1797.

Fourcroy aſſerts that *Scheele* did not give the name of lithic acid to the ſublimate of the calculus, as Dr. *Pearſon* aſſerts, and that the peculiar animal oxide of Dr. *Pearſon* is really *Scheele's* acid (the lithic acid). *Fourcroy* approves of the adoption of the name *ouric acid*, eſpecially as Dr. *Pearſon* has found the ſame acid in athritic concretions, and it has not yet been found, but in man. *Ann. de Chim.* XXVII.

Although the cauſes of diſeaſe, theſe concretions are the natural products of urine, which generally contains almoſt all the materials of which they are compoſed. Theſe may be formed by

1. *Uric acid*, which cryſtallizes in ſtriated layers, is inſoluble in cold water, and but ſlightly ſoluble in hot, it weakly reddens turnſole, is inſipid, inodorous, ſoluble in cauſtic alkali; when pure, of a fawn colour, and becoming of a pink red by the addition of nitric acid.

2. *Phoſphate of lime*, this will be found to concrete in earthy layers reſembling chalk, to be ſoluble, without effervеſcence, in nitric acid; precipitable by all the alkalies; by the ſulphuric acid in a ſulphate of lime, and by the oxalic acid is an oxalate of lime.

3. *Ammoniaco-magneſian phoſphate*, forms in ſemitranſparent, ſpathoſe, hard layers, ſuſceptible of poliſh, or in cryſtals, very ſoluble in all the acids, yielding an ammoniacal vapour by the addition of fixed alkalies, which deprive it of the phoſphoric acids. It is often mixed with the phoſphate of lime, and frequently covers a kernel of uric acid or oxalate of lime.

4. *Oxalate of lime* forms the harder, mulberry form, calculi, which are very denſe and capable of receiving a fine poliſh, are externally of a ſooty brown colour, internally of a dirty grey, having numerous tubercles on their ſurface, are inſoluble in water, very difficultly ſoluble in the nitric acid, and not affected by alkalies, leaving, after the action of the fire, which burns the animal matter, a reſidue of quick-lime.

Beſides theſe four ſubſtances, which are united to a gelatinous or albuminous animal matter, *ſilica* is ſometimes, but very rarely, found in the human urinary calculi.——*Tabl. Synopt. de Fourcroy.* 1800.

Dr. *Pearſon* found the uric acid in *arthritic* concretions: Mr. *Tennant* diſcovered in them a combination of that acid and ſoda. *Fourcroy* and *Vauquelin* confirm this analyſis, finding them to conſiſt of urate of ſoda, with a conſiderable quantity of animal matter.

XI. The PRUSSIC ACID, or *colouring matter of pruſſian blue*, is produced by expoſing the horns, hoofs, or dried blood of animals, with an equal quantity of fixed alkali, to a red heat. The alkali united with the acid thus formed, yields a ſalt in tetrahedral plates, or priſms, with tetrahedral ſummits, which is called PRUSSIATE of POT-ASH, or of SODA, according to which alkali has been employed. Theſe pruſſiates of alkali precipitate all *metals* from their ſolution; the alkali uniting with the acid which held the metal in ſolution, whilſt the pruſſic acid unites with the metallic oxide, and communicates to it a peculiar colour. Thus *gold* is precipitated of a *yellow*; *lead* of a *white*; *copper* of a *browniſh red*; and *iron* of a *dark blue*, being a PRUSSSIATE of IRON, or the ſubſtance called *pruſſian-blue*.

The pruſſic acid may be again ſeparated from pruſſiate of iron, by digeſtion with pure alkali, the pruſſiate of alkali, being again formed, and the iron left in a brown oxide. Thus may a fully ſaturated pruſſiate of pot aſh be obtained; but ſtill this is not a pure pruſſiate, but contains ſome iron or rather pruſſian blue, which it depoſits on the addition of an acid, and therefore it is not an accurate teſt of the quantity of iron contained in any ſolution.

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 it gives it 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. It has an acid taſte and ſuffocating ſmell; but except its capacity of combining with alkalies and metals, it manifeſts no conſpicuous acid properties.

By digeſtion of pruſſiate of iron with ammonia, the PRUSSIATE of AMMONIA is obtained, and, in the ſame manner, is PRUSSIATE of LIME obtained with lime water. This acid is found alſo in the mineral kingdom, combined with iron; it alſo exiſts in vegetables. The pruſſic colouring principle has been obtained by paſſing ammoniacal gas through charcoal.——*Clouet.*

Prouſt deſcribes pruſſian blue to be an oxide, whoſe baſis contains 48-100 of oxygen. Berthollet believes its baſis to be compoſed of hydrogen, nitrogen, and carbon; but its conſtituent parts are not yet known.

XII. 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.*

XIII. 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 Dipple*; 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 coally 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.

XIV. 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 mild ammoniac, 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 farther 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.

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. 103.

XV. 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 remaining 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

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* Becher, 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.

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 appearing 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.

XVI. 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 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 of 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 boney 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. Hatchet, 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 extemities of the chain. Bones of fiſh appear to contain more of the cartilaginous ſubſtance, and leſs of the phoſphate of lime, then is commonly found in the bones of quadrupeds.

XVII. CARTILAGE, and ſuch HORNS as are diſtinctly ſeparate from bone, as are thoſe of the *ox*, the *ram*, *chamois*, alſo *tortoiſe-ſhell*, contain phoſphate of lime, but in two ſmall a quantity to be conſidered as one of their conſtituent principles. 500 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.

XVIII. MADREPORE 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 cartilagnous 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 *gorgoniæ*, 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.

XIX. SYNOVIA appears to contain lymph, 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.

XX. TEARS are ſecreted by the lachrymal glands, and are chiefly compoſed of a peculiar kind of mucilage, common ſalt, phoſphate of lime, phoſphate of ſoda, and ſoda, in a free and apparently cauſtic ſtate.——*Jacquin.*

XXI. **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.

XXII. **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 boney nature.——*Fourcroy.*

XXIII. **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 mucus will not.

XXIV. **Semen**, its conſtituent parts appear to be water, animal mucilage, phoſphate and muriate of ſoda, cauſtic ſoda, and phoſphate of lime: the latter cryſtallizes during evaporation in the air, and the ſoda attracting carbonic acid will be rendered a carbonate of ſoda. It has a peculiar ſmell, and acrid taſte, and changes violets green. When freſh, it is 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.

XXV. **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.

XXVI. **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 fœtuſſes 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, ammoniac, pruſſic acid, and 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 ammoniac 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.

XXVII. 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 ammoniac 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 ammoniac 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 effervеſces with alkaline carbonates. It has a ſtronger attraction to the oxides of mercury and lead, reſpectively, than the acetous 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.

XXVIII. 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 is 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 barytes, pot-aſh, ſoda, lime, magneſia, ammoniac, zinc, manganeſe, iron, lead, tin, cobalt, copper, nickel, biſmuth, ſilver, alumine, eſſential oils, water. *(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 *ſilkworm*. The acid is extracted by digeſting the ſubject of experiment in alcohol, which diſſolves the acid, and precipitates the foreign animal matters.

XXIX. 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 is of the ſame nature as the ſerum of blood: heat coagulates it, ſo do acids and alcohol. By diſtillation it affords a phlegm, which eaſily putrifies, then carbonate of ammoniac and empyreumatic oil came over, a coal remaining in the retort which yields ſoda and phoſphate of lime. 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.

XXX. The **HAIR, WOOL,** and **BRISTLES** of animals differ both from the bones and white animal ſoft parts, containing leſs jelly, fat, and lymph.

XXXI. **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.

XXXII. **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.

XXXIII. **CONCRETIONS,** ſuch as are found in the pineal gland, are in general boney, with an exceſs 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.

XXXIV. **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 either 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.

XXXV. **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.

XXXVI. **COCHINEAL.** Theſe inſects are more eſpecially uſed in dying; 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.

XXXVII. 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.

XXXVIII. 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 Lacſha, 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 Lacſha, 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 cinera*, or on a new ſpecies called by the Gentoos *conda corinda*.——*Dr. W. Roxburgh, Phil. Tranſ.* 1790.

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 phoſphorated and carbonated 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 produce 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.

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

Muria. 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. Silv.
——Arſenic
——Antim.
——Iron

Fixed Alkal.

Barytes
Strontia
Lime
Magneſia
Phoſphorus
Fat Oil
Vol. Alkali.
Æther
Hydrog. G.?

In Fire.

Fixed Alkal.
Oxygen
Iron
Copper
Tin
Lead
Silver
Cobalt?

Nickel?
Biſmuth
Antimony
Q. Silver
Arſenic
Uranite?
Molybdena
Sylvanite

4.
SAL. SULPHURETS.
In Water.

Oxygen

Ox. of Gold
Silver
Q. Silv.
Arſenic
Antimony
Biſmuth
Copper
Tin
Lead
Ox. of Nikel
Cobalt
Mangan.
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
Aceto. Acids
Fixed Alkali
Sulphur
Ox. of Lead

7.
BARYTES.
In Water.

Sulphuric
Oxalic
Succinic
Fluoric
Phoſphoric
Lacteo-Sac.
Molybdic
Mitric
Muriatic
Suberic
Sebacic
Citric
Tartarous
Arſenic Aci.
Formic
Lactic
Benzoic
Acetous
Boracic
Sulphureous
Nitrous
Carbonic
Pruſſic Acids
Fix. Alkali ?
Lime ?
Water
Fat Oil
Sulphur
In Fire.
Phoſphoric
Boracic
Arſenic
Sulphuric
Succinic
Fluoric
Nitric
Muriatic
Sebacic
Formic
Lactic
Benzoic
Aceto. Acids
Fixed Alkali
Sulphur
Ox. of Lead

8.
STRONTIA.
In Water.

Sulphuric
Oxalic
Tartarous
Fluor
Nitric
Muriatic
Succinic
Phoſphoric
Acetous
Arſenic
Boracic
Carbonic
Other Acids?
Fix. Alkalies
Water
Fat Oil
Sulphur
In Fire.
Not aſcertai.

9.
LIME.
In Water.

Oxalic
Sulphuric
Tartaric
Succinic
Phoſphoric
Lacteo-ſach.
Nitric
Muriatic
Suberic
Sebacic
Fluoric
Arſenic
Formic
Lactic
Citric
Benzoic
Acetous
Boracic
Sulphureous
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
Aceto. 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
Sulphureous
Carbonic
Pruſſic Acids
Sulphur
In Fire.
Phoſphoric
Boracic
Arſenic
Sulphuric
Succinic
Fluoric
Nitric
Muriatic
Sebacic
Formic
Lactic
Benzoic
Aceto. 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-ſacchar. Acids
Boracic
Sulphurous
Nitro. Acids
Carbonic A.
Pruſſic A.
Water
Fat Oil
Sulphur
Met. Oxides
In Fire.
Phoſphoric
Boracic
Arſenic
Sulphuric

Succinic
Fluoric
Nitric
Muriatic
Sebacic
Formic
Lactic
Benzoic
Aceto. 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 decompoſ. by Sulphuric Acid
Silica

15.
SULPHURIC ACID.
In Water.

Barytes
Strontia
Pot-Aſh
Soda
Lime
Magneſia
Ammonia
Alumine
Jargonia?
Metallic Oxides, 20 ſpecies Order in which precipitated

Water
Alcohol

In Fire.

Pot-Aſh
Soda
Barytes
Strontia
Lime
Magneſia
Jargonia
Met. Oxides
Ammonia
Alumine

16.
SULPHUREOUS ACID.
In Water.

Barytes
Strontia
Lime
Pot-Aſh
Soda
Magneſia
Ammonia
Alumine
Jargonia
Met. Oxides
Water
Alcohol

17. 18. 19. 20. 21.
NITROUS, NITRIC, MURIATIC, OXY-MURIATIC, NITRO-MURIATIC ACIDS.
In Water.

Pot-Aſh
Soda
Barytes
Strontia
Lime
Magneſia
Ammoniac
Alumine

Met. Oxides

Water
Alcohol

In Fire.

Barytes
Strontia
Pot-Aſh
Soda
Magneſia
Met. Oxides
Ammonia
Alumine

22.
FLUORIC ACID.
In Water.

Lime
Barytes
Strontia
Magneſia
Pot-Aſh
Soda
Ammonia
Alumine
Met. Oxides

Silica
Water
Alcohol

In Fire.

Lime
Baryt
Strontia
Magneſia
Pot-Aſh
Soda
Met. Oxides
Ammonia
Alumine

23.
BORACIC ACID.
In Water.

Lime
Barytes
Strontia
Magneſia
Pot-Aſh
Soda
Ammonia
Alumine

Met. Oxides

Water
Alcohol

In Fire.

Lime
Baryt
Strontia
Magneſia
Pot-Aſh
Soda
Met. Oxides
Ammoniac
Alumine

24. 25.
OXALIC AND TARTAREOUS ACIDS.
In Water.

Lime
Barytes
Strontia
Magneſia
Pot-Aſh
Soda
Ammonia
Alumine
Met. Oxides
Water
Alcohol

26.
CITRIC ACID.
In Water.

Lime
Barytes
Strontia
Magneſia
Pot-Aſh
Soda
Ammonia

Alumine
Met. Oxides

Water
Alcohol

27.
BENZOIC ACID.
In Water.

W. Oxide of Arſenic
Pot-aſh
Soda
Ammonia
Barytes
Lime
Magneſia
Alumine
Tromſdorf

In Fire.

Lime
Barytes
Strontia
Magneſia
Pot-Aſh
Soda
Met. Oxides
Ammonia
Alumine

28.
SUCCINIC ACID.

Barytes
Lime
Magneſia
Pot-Aſh
Soda
Ammonia
Alumine
Met. Oxides
Water
Alcohol

In Fire.

Barytes
Strontia
Lime
Magneſia
Pot-Aſh
Soda
Met. Oxides
Ammonia
Alumine

29.
LACTEO SACCHARINE ACID.
In Water.

Lime
Barytes
Magneſia
Pot-Aſh
Soda
Ammonia

Alumine
Met. Oxides

Water
Alcohol

In Fire.

Lime
Barytes
Strontia
Magneſia
Pot-Aſh
Soda
Met. Oxides
Ammonia
Alumine

30. 31. 32.
ACETOUS, LACTIC, and FORMIC ACIDS.
In Water.

Barytes
Pot-Aſh
Soda
Strontia
Ammonia
Lime
Magneſia
Alumine
Met. Oxides

Water
Alcohol

In Fire.

Barytes
Strontia
Pot-Aſh
Soda
Lime
Magneſia
Met. Oxides
Ammonia
Alumine

33. 34.
SEBACIC AND PHOSPHORIC ACIDS.
In Water.

Lime
Barytes
Strontia
Magneſia
Pot-Aſh
Soda
Ammonia
Alumine
Met. Oxides
Water
Alcohol

In Fire.

Lime
Barytes
Strontia
Magneſia
Pot-Aſh
Soda
Met. Oxides
Ammonia
Alumine

35.
PRUSSIC ACID.
In Water.

Alkalies
Barytes
Strontia
Lime
Henry

36.
CARBONIC ACID.
In Water.

Barytes
Strontia
Lime
Fix. Alkalies
Magneſia
Ammonia
Alumine
Met. Oxides

Water
Alcohol

37.
ARSENIC ACID.
In Water.

Lime
Barytes
Strontia
Magneſia
Pot-Aſh
Soda
Ammonia
Alumine
Met. Oxides
Water
Alcohol

In Fire.

Lime
Barytes
Strontia
Magneſia
Pot-Aſh
Soda
Met. Oxides

Ammonia
Alumine

38.
CHROMIC ACID.
In Water.

Fixed Alkali
Ox. of Lead
do. of Copper

39.
MOLYBDENIC ACID.

Sulphur
Fix. Alkalies
Abſ. Earths
Met. Oxides

40.
TUNGSTENIC ACID.

Lime
Barytes
Magneſia
Alkalies
Alumine
Elluyarts

41.
OXIDE OF ARSENIC.
In Water.

Muria. 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 Muri. Acids
Pruſſic A.

Oxy-Muria.

Nitro-Muri.

TITANITE
In Fire.

43.
OXIDE OF URANITE.

Sulphuric
Nitro-Muri.
Muriatic
Nitric
Phoſphoric
Acetous
Gallic
Pruſſic
Carbo. Acids
Sulphur

Water

URANITE.
In Fire.

44.
OXIDE OF SYLVANITE
In Water.

Nitrous
Nitro-Muri.
Sulphu. 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
Tartarous
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.
Tartarous
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
Carbo. 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
Tartarous
Phoſphoric
Citric
Succinic
Fluoric
Arſenic
Formic
Lactic

Acetous
Boracic
Pruſſic

Carbo. 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

Carbo. 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

Tartarous
Muriatic
Sulphuric
Oxalic
Arſenic
Phoſphoric
Nitric
Succinic
Fluoric
Sachlactic
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
Fluor
Citric
Formic
Acetous
Lactic
Boracic
Pruſſic
Carbo. 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

Carbo. 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
Carbo. 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
Carbo. 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
Succi. 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-Muri.
Nitric
Sulphuric
Arſenic
Fluoric
Tartaric
Phoſphoric
Sebacic
Pruſſic Acids

Fix. 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

Caoutchouc

61. VOLATILE OIL.	62. FIXED OIL.
Æther	Barytes
Alcohol	Strontia
Fixed Oil	Lime
Fixed Alkali	Met. Oxides
Sulphur	Alumine
Phoſphorus	Volatile Oil
	Fixed Alkali
	Vola. Alkali
	Sulphur
	Phoſphorus.

A judicious critique has lately appeared in a periodical publication on the foregoing table. The differences between Dr. Pearſon and the Reviewer, proceed partly from diſcoveries made ſince the publication of the table, partly from the affinities being aſſumed from the experiments of different chemiſts, and partly from differenee of judgment in matters of opinion. Thoſe alterations which ſubſequent diſcoveries ſeem to have rendered neceſſary, the liberty has been taken of introducing in the table. The other remarks are here ſubjoined, as an intereſting and uſeful adjunct to the table.

REMARKS ON

DR. PEARSON's TABLE OF AFFINITIES.

Column 1. *Caloric.*—Why is *ammonia* put after alcohol? Its gaſeous ſtate is permanent, at a much lower temperature than alcohol vapour.—Why does glaſs precede mercury? ſurely it does not boil ſo ſoon. This column appears to us improper, and calculated to miſlead. The only poſſible method of judging of the affinities of different bodies for caloric, is to aſcertain the temperature at which they change their ſtate, and to rank them inverſely at that temperature. According to that rule, *alcohol* ought to follow the three gaſes, *oxygen*, *hydrogen*, and *azot*.

Column 2. *Oxygen.*—Iron decompoſes water, even at the temperature of the atmoſphere, and ought therefore to precede hydrogen; but lead, and moſt other metals do not, hydrogen is, therefore, by far too low in the ſcale. Why is ſulphuric acid inſerted? No diſtinction is made between metals and their firſt oxides; yet their affinities for oxygen are very different. *Iron*, for inſtance, decompoſes water, but the *green oxide of iron* does not.

Column 15. *Sulphuric acids.*—The order in which they precipitate each other is not that of the affinities of metallic oxides for acids. This Prouſt has ſufficiently demonſtrated. The reaſon is evident, every ſuch precipitation is an inſtance of the action of *compound affinity*.

In *columns* 17, 18, 19, we would wiſh to know, why barytes is placed below the alkalies.

Columns 20, 21.—*Oxymuriatic and nitromuriatic acids*. The affinities of theſe acids, according to Lavoiſier, are very different from what they are here repreſented to be. *Column* 22, 23.—According to Lavoiſier, alumina ought to be placed after the metallic oxides. *Column* 26. *Citric acid.*—Lavoiſier places alumina after the oxides.

Column 28. *Succinic acid.*—Guyton places magneſia after the alkalies.

Column 33. *Sebacic acid.*—Guyton places the affinities of this column as follows. Barytes, pot-aſh, ſoda, lime, magneſia, ammonia, alumina, jargonia.

Column 36. *Carbonic acid*—Dr. Hope places lime before ſtrontian.

Column 53. *Oxide of lead.*—The order of phoſphoric and muriatic acids aſſigned here, holds only above the temperature of 245°; below that temperature muriatic acid has the ſtrongeſt affinity.

Column 62. *Fixed oils.*—Berthollet has arranged the affinities of this column as follows. Lime, barytes, fixed alkalies, magneſia, ammonia, oxides of mercury, other oxides, alumina. The Author of the article Chemiſtry, in the Supplement to the Encyclopædia Britannica, has added the following table, which, however, is unconnected with the firſt. Nitric acid, muriatic, ſulphureous, ſulphuric, acetous, ſulphur, phoſphorus.

A column might have been added for *pyromucous acid*, the affinities of bodies for which are, according to Guyton, as follows—Potaſs, ſoda, barytes, lime, magneſia, ammonia, alumina, jargonia, oxides of metals. The affinities of *pyrolignous acid* are, according to the ſame philoſopher, as follows. Lime, barytes, potaſs, ſoda, magneſia, ammonia, metallic oxides, alumina. A column, too, might have been added for *jargonia*. The affinities are vegetable acids, ſulphuric acid, muriatic, nitric.

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.	Stront.	Lime.	Mag.
Sulphuric	121,48	78,32	26,05	200,	138,	70,	57,92
Nitrous	117,7	73,43	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,

Vide p. 15.

APPENDIX.

Engraved for J. Humphreys.

Akin. del.

Tanner

Economical Laboratory, of James Woodhouse, M. D.

REFERENCES

TO Dr. WOODHOUSE's

ECONOMICAL APPARATUS.

FIG. 1.

A is a ſtand, made of tin, eleven inches high, conſiſting of a flat bottom, from which proceeds three upright pieces, of the ſame metal, one inch broad, which are ſoldered to the top, in which there is a round aperture, three inches in diameter, to receive the bottom of a retort, or oil flaſk. B is a hydroſtatic lamp, with Argand's apparatus. C a retort, luted to a receiver D, which is ſupported by a frame of wood E.

FIG. 2.

A is a cylindrical veſſel of tin, eleven inches high, and twenty-one in circumference, open at *a*, ſo as to admit the hydroſtatic lamp, with a round aperture in the top, three inches in diameter, and ſeveral ſmall holes o o o ſurrounding it. B is a circular caſe, ſix inches high, formed of two pieces of the ſame metal, which include a lining of charcoal, in fine powder, one inch thick, at the top and on the ſides. The lower part has an opening five inches in diameter, and in the middle of the upper part, there is an aperture, to receive the neck of an oil flaſk. C is a flaſk, from which proceeds the tube D, which enters the bottle E.

In uſing this apparatus, the flaſk, containing the ſubject of the operation, muſt be placed on the cylindrical body A. The caſe B, is then to be put over the flaſk, and the tube D, which enters a perforated cork, joined to it with a ſtrip of paper, covered with a paſte, made of flour and water.

The charcoal, with which the caſe B is lined, is a bad conductor of heat, hence, it is accumulated round the flaſk, and thus prevented from flying off, into the air.

FIG. 3.

A is a ſeparate ſection of the caſe lined with coal, and the oil flaſk, on the neck of which, the head of an alembic B, made of tin or copper, four and a half inches high, is placed. C the neck of this veſſel, nine inches long, enters an oil flaſk D.

To uſe this apparatus, the flaſk muſt be put on the top of the cylindrical body A fig. 2. The veſſel lined with coal, is then to be placed over the flaſk, and the head of the alembic fixed to its neck. E the part over the top of the head of the alembic, may be filled with cold water.

This economical apparatus may be uſed;

Firſt. In obtaining the gaſes from certain ſubſtances, which require the application of heat; as oxigenous air, from manganeſe or red lead and the ſulphuric acid; or ammoniacal gas, from lime and ſal ammoniac; or oxigenated muriatic gas from manganeſe and the marine acid, &c.

Secondly. In making ammoniac, and the liquid and concrete carbonate of ammoniac; in uniting ſulphur with pot aſh, ſoda and lime; to compoſe ſulphur of pot-aſh, ſoda and lime; to form fulminating mercury, and the pruſſiates of lime, pot-aſh, &c.

Thirdly. In procuring ſeveral of the acids, as the nitric, muriatic, ox-muriatic, oxalic, fluoric, acetic, &c.

Fourthly. In diſtilling water, ſpirits, and alcohol, &c. and uniting the ſulphuric acid and alcohol, to form ether, &c.

Fifthly. In the drying of powders, and in evaporating water, and ſome of the acids, from ſaline ſolutions. A tin, copper, glaſs, or queens-ware ſaucer, may be placed on the top of the ſtands, Fig. 1 or 2, for this purpoſe.

Sixthly. In making experiments upon all kinds of dyeing drugs, and

Seventhly. In analyſing earths and the ores of metals, in the humid way.

This apparatus is preferable to that of *Guyton*, in many reſpects.

Firſt. It is leſs expenſive. The lamp of Guyton, is one of the worſt of the kind, for a Chemical Laboratory. There is no occaſion for a number of ſcrews, to elevate or depreſs the retort or lamp, for a great or low heat may be made, merely by raiſing or lowering the wick.

Secondly. It would be no very eaſy matter, to place an oil flaſk on the ring of *Guyton's* apparatus, ſo as to connect a long tube with it, to obtain oxigenated muriatic acid gas, ammoniacal gas, &c. And in the winter ſeaſon, the cold air, acting on the belly of the veſſel placed there, would deprive it of a portion of heat, and if the ore of a metal was boiled with an acid, in an oil flaſk, it would keep jumping from the ring.

When the caſe lined with coal is placed over a flaſk, the heat is accumulated round it, and the veſſel is kept ſteady in one poſition. Retorts are alſo procured with difficulty, at this time, even in the great cities of the United States. It is of great conſequence then to procure a ſubſtitute for them. The head of the copper or tin alembic, fig. 3, fixed on an oil flaſk, and its neck communicating with another, form a diſtilling apparatus, which may be uſed, in a great many chemical operations.

Theſe obſervations are the reſult of experience.

For the method of procuring the gaſes, acids, &c. vide, the common elementary treatiſes on Chemiſtry.

An Account of the principal Objections *to the* Antiphlogistic System *of* Chemistry:

By JAMES WOODHOUSE, M.D.
Professor of Chemistry in the University of Pennsylvania, &c.

IN the year 1796, the celebrated Dr. JOSEPH PRIESTLEY published a pamphlet, entitled, *Considerations on the Doctrine of Phlogiston, and the Decomposition of Water*, in which he brought forward various objections to the Antiphlogistic System of Chemistry, which was at that time, almost universally adopted.

Monsieur ADET, then Minister Plenipotentiary from the Republic of France, to the United States, and Dr. JOHN MACLEAN, Professor of Mathematics and Natural Philosophy, in Princeton College, New Jersey, wrote Answers to this work. These Gentlemen respectively proved themselves, to be accurately acquainted with the reigning opinions of the times; and the latter displayed great acuteness of remark in his performance.

Professor MITCHILL, of New York, made an ingenious attempt, to reconcile the contending parties.*

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* Medical Repository, vol. i. p. 54. first edition.

I also had the honor of replying to Dr. PRIESTLEY, in an *Experimental Essay*, printed in the fourth volume, of the American Philosophical Transactions, and in *Three Letters*, published in that truly valuable work, the Medical Repository, of New York.

After these various publications, the Doctor, having seen no reason to abandon any of his opinions, wrote another Pamphlet, which he called, *The Doctrine of Phlogiston established, and that of the Composition of Water refuted.*

Having been for several years, considering this subject, I have been obliged to give up certain parts of the new theory, and it is my intention to relate some striking objections to it, to which no satisfactory answer, has as yet, been made.

SECTION I.

Of the AIRS *produced, by transmitting the steam of water over charcoal, exposed to a red heat.*

If pure charcoal, broken into moderately small parts, is exposed to a red heat, in a copper, glass, or earthen tube, and the steam of water is passed over it, carbonated hydrogenous, and carbonic acid gas will be obtained.

LAVOISIER particularly mentions this experiment, and considers it as one of the principal proofs of the decomposition of water, which is supposed to be formed, of eighty-five parts, by weight, of oxygen, and fifteen of hydrogen.† It is said, that the oxygen of the water unites to part of the coal, and makes the carbonic acid, while its hydrogen escapes, dissolves another part of the coal, and gives rise to the carbonated hydrogen gas.

Dr. PRIESTLEY has objected to this explanation, and has clearly proved, that if the coal receive but a small portion of water at a time, inflammable air, without any mixture of fixed air, will be produced. The Doctor calls to his assistance, the aid of Mr. WATT, who says, " it has been observed by Dr. " PRIESTLEY, and confirmed by my experience, " that when much water passes in the form of " steam, over hot coal, there is much fixed air " formed; but little or none, when the water is " admitted so sparingly, that no steam reaches the " refrigeratory."

The Doctor supposes, that the reason why more fixed air is produced when the supply of water is copious, is because more water is necessary to the constitution of fixed air, than to that of inflammable air.

In order to acquire accurate information, concerning the proportion of the inflammable and fixed air in this process, the steam of water was transmitted by means of an Eolipile over one ounce of red hot coal, in a copper tube. Portions of the gases having been examined, for the space of two hours, by throwing a measure of the airs up over lime-water, in an eudiometer, it was found, that the fixed air was generally thirty in every hundred parts, of the airs obtained.

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† *Lavoisier's* Elements of Chemistry, p. 135.

Four ounces of charcoal, taken promiscuously from a heap, were then exposed to a red heat, in an earthen retort, when six hundred and twenty-two ounce measures of inflammable and fixed air were generated.

The 1st 10 oz. measures, was the atmospheric air of the veſſel.

		fixed air	inflammable.
2d	4	contained 30	70
3d	4	20	80
4th	4	15	85
5th	360	10	90
6th	70	2	98
7th	170	0	100
	622		

The same coal, taken from the retort, wetted with water, and committed to it again, gave eighty one ounce measures of inflammable and fixed air.

The 1st 10 oz. measures, was the air of the vessel.

		fixed air.	inflamma.
2d	12	contained 30	70
3d	40	25	75
4th	6	20	80
5th	13	0	100
	81		

The same coal, wetted a third time with water, yielded one hundred and eighty-one ounce measures of inflammable and fixed air.

The 1st 10 oz. measures, the air of the vessel.

		fixed air.	inflammable.
2d	4	contained 30	70
3d	44	26	74
4th	37	25	75
5th	62	20	80
6th	12	8	92
7th	4	1	99
8th	4	0	100
	181		

According to these experiments, Lavoisier must have possessed very inaccurate information, concerning the gases produced by exposing moistened charcoal to heat, and the inference of Dr. Priestley is just.

As water is composed of eighty-five parts of oxygen and fifteen of hydrogen, the eighty-five parts of the former, ought constantly to unite with the coal, and form fixed air, and the proportions of the inflammable and fixed air should invariably be the same; or where two parts in bulk of the inflammable air are found, there should be one part of oxygen, united to the coal, in the form of fixed air; but this is not the case, for when the airs are made from coal, the first portions are generally seventy inflammable, and thirty fixed; and the last are all inflammable, without any mixture of fixed air, provided the heat is kept up, a sufficient length of time.

SECTION II.

Of the Gases *obtained by exposing metallic calces and coal to a red heat.*

According to the new Theory of Chemistry, a metal is a simple body, and it is converted into a calx, by an union with oxygen, the base of vital air.

Coal is also considered as a simple substance, and it is said, when it is added to a metallic calx, and exposed to a sufficient degree of heat, that the metal will be revived, by the coal uniting with the oxygen of the calx, and thus producing fixed air.

This theory is generally adopted, although it is not warranted by experiment, for upon exposing metallic calces and coal to heat, carbonic acid gas is not produced, but carbonated inflammable air, mixed with fixed air, the proportion of which diminishes to the end of the process.

Dr. PRIESTLEY exposed the scales of iron, which he calls finery cinder, previously made red hot, to a high degree of heat, with coal which contained no water. Carbonated inflammable and fixed air were generated, and the iron was revived.

According to the Antiphlogistic theory, the agents in this process, were iron, oxygen and coal, and nothing but carbonic acid gas, should have been produced.

Supposing that water had been concerned in this experiment, I made an attempt to exclude it from each of the substances, previous to their mixture, in the following manner.

One ounce of the scales of iron, and the same quantity of charcoal were reduced to a very fine powder, and exposed separately, in covered crucibles, in an air furnace, well supplied with fuel, for five hours. They were then taken out of the fire, and mixed while red hot, in a red hot iron mortar, were triturated with a red hot iron pestle, formed of an iron ramrod, were poured upon a red hot sheet of iron, and instantly put into a red hot gun barrel, which was fixed in one of Lewis's black lead furnaces, and which communicated with the worm of a refrigeratory, a part of an hydropneumatic apparatus. Immediately after luting one end of the gun barrel to the worm, one hundred and forty-two ounce measures of carbonated inflammable air, came over in torrents, every portion of which was mixed with carbonic acid gas. The iron was revived.

Here the effects of water were seen, as much as if it had been added to the coal, or had been transmitted over it, in the form of steam.

As the coal had ceased to yield air, before it was mixed with the finery cinder, and as no air can be obtained from this substance without water, a conclusion was drawn, that this fluid existed in the scales of iron, and could not be driven off from them, by means of heat.

An hypothesis was formed, that the finery cinder supplied the coal with water, which was decomposed; its oxygen was supposed to unite with the coal and generate the fixed air, while its hydrogen escaped, dissolved part of the coal, and made the carbonated inflammable air.

This explanation appeared to be very plausible, but it has been overturned, by subsequent experiments, which are related in the first section.

Inflammable and fixed air are also procured, by mixing coal, with the calces of zinc, iron, copper, lead, manganese, tin, and bismuth, as will be shewn by the following experiments.

Half an ounce of the oxide of zinc, precipitated from a solution of white vitriol by caustic pot-ash, was washed in water, until it would not give a milky colour to muriated barytes, and was exposed to a red heat half an hour, and then mixed with two drachms of coal, which had ceased to yield air, in an earthen retort, when it gave eighty-six ounce measures of carbonated inflammable and fixed air.

The 1st 10 oz. measures, was the atmospheric air of the vessel.

		fixed air.	inflammable.
2d	4	contained 75	25
3d	4	40	60
4th	4	15	85
5th	4	10	90
6th	4	2	98
7th	56	0	100
	86		

The same result happened, from using the flowers of zinc and coal, The metal in both experiments, was completely revived, and was found adhering to the neck of the retort, which was broken to obtain it. Very frequently, upon exposing the flowers of zinc and coal to heat, inflammable air, without any mixture of fixed air, will be obtained.

Two drachms of the oxide of iron, made from a solution of green vitriol, by caustic pot-ash, and which had been half an hour exposed to a red heat, and one drachm of coal, gave two hundred and sixty-nine ounce measures of inflammable and fixed air. The metal was revived.

The 1st 4 oz. measures, was the atmospheric air of the vessel.

		fixed air.	inflammable.
2d	4	contained 65	35
3d	4	60	40
4th	4	42	58
5th	4	30	70
6th	5	25	75
7th	200	20	80
8th	44	15	85
	269		

Half an ounce of the oxide of copper, from blue vitriol by caustic pot-ash, which was exposed half an hour to a red heat, and one drachm of coal, yielded one hundred and six ounce measures of inflammable and fixed air.

The 1st 4 oz. measures, was the air of the vessel.

		fixed air.	inflammable.
2d	36	contained 100	0
3d	10	74	26
4th	10	20	80
5th	8	12	88
6th	20	10	90
7th	18	5	95
	106		

Half an ounce of minium, and one drachm of coal, gave twenty-six ounce measures of inflammable and fixed air.

The 1st 4 oz. measures was the air of the vessel.

		fixedair	inflam.
2d	10	contained 100	0
3d	8	45	55
4th	4	15	85
	26		

Half an ounce of white lead, and one drachm of coal, afforded fifty-three ounce measures of inflammable and fixed air.

The 1st 4 oz. measures, was the air of the vessel.

		fixed air.	inflammable.
2d	4	contained 80	20
3d	18	95	5
4th	4	85	15
5th	9	70	30
6th	8	20	80
7th	6	10	90
	53		

Half an ounce of the black oxide of manganese, and one drachm of coal, gave fifty-five ounce measures of inflammable and fixed air.

The 1st 4 oz. measures was the atmospheric air of the vessel.

			fixed air.	inflammable
2d	4	contained	80	20
3d	26		95	5
4th	8		85	15
5th	10		30	70
6th	3		25	75
	55			

Half an ounce of the white oxide of tin, and one drachm of coal gave seventy-four ounce measures of inflammable and fixed air.

The 1st 4 oz. measures was the air of the vessel.

			fixed air.	inflamma.
2d	12	contained	50	50
3d	10		45	55
4th	26		20	80
5th	22		15	85
	74			

Half an ounce of the white oxide of bismuth, precipitated from a solution of bismuth, in the nitric acid by water, and one drachm of coal, gave thirty-eight ounce measures of inflammable and fixed air.

The 1st 4 oz. measures, was the air of the vessel.

			fixed air.	inflamma.
2d	10	contained	30	70
3d	9		15	85
4th	10		8	92
5th	5		5	95
	38			

All these calces, except bismuth and zinc, afford more fixed air than can be procured from coal and water, which is a proof, that they contain oxygen. Water appears to be a principal agent in producing part of the inflammable and fixed air, for these gases are procured, in proportion to the quantity of this fluid, in the calces. If oxygen was the sole agent, no inflammable air could be obtained.

The flowers or white oxide of zinc, frequently affording inflammable and no fixed air, when subjected to heat with coal, cannot be accounted for by the new doctrine.

Mr. W. CRUIKSHANK of Woolwich, Great Britain, having attentively perused the pamphlet of Dr. PRIESTLEY, was struck with the nature and quantity of the gases, procured from the scales of iron and charcoal. He repeated many of the experiments here detailed, and met with similar results. He supposes that the oxygen of the metallic calces exists in the carbonated inflammable air, which he calls the gaseous oxide of carbon, and thinks it bears the same relation to carbonic acid gas, as nitrous air does to nitric acid.

He thinks that none of the hydro-carbonates at present known, are similar in their properties to the gaseous oxides of carbon, being much lighter, and yielding a far less proportion of carbonic acid, when combined with oxygen.§

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§ *Nicholson's* Chemical Journal, for April 1801.

Dr. Woodhouse's

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