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H. J.

APPENDIX

OR

SUPPLEMENT

TO

DR. D. MONRO'S TREATISE

ON

MEDICAL AND PHARMACEUTICAL

CHYMISTRY,

AND THE

MATERIA MEDICA.

CONTAINING

I. An Account of ſome Articles omitted.
II. A Sketch of the New Syſtem of Chymiſtry.
III. Application of it to the former Parts of this Work.
IV. And a general Index to the four Volumes.

MAKING

VOL. IV.

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ADVERTISEMENT TO THE READER.

THE intention of the Author in publiſhing this Appendix being only to ſupply ſome defects of the former volumes, and to give the reader a general idea of the new ſyſtem and its application to the chymical part of the foregoing work, and not to write a treatiſe on the elements of univerſal chymiſtry, he has not entered at large into the diſcuſſion of the arguments uſed in ſupport of the different opinions; neither has he deſcribed the numerous proceſſes performed to prove the different facts mentioned, or the inſtruments and machines employed in performing theſe proceſſes; and therefore muſt refer thoſe who wiſh to be particularly informed of theſe circumſtances, to the elaborate works of the Hon. H. Cavendiſh, Dr. Prieſtley, Mr. Kirwan, M. Lavoiſier, M. Fourcroy, M. Morveau, M. Metherie, and of other able

able and ingenious chymical philoſophers, which have been publiſhed either in the works of the different learned ſocieties of Europe, or in ſeparate volumes.

N. B. *As this Appendix was not all publiſhed at one time, it is neceſſary to mention that the Table of Contents of the firſt fifty pages are to be found before page* 1; *and the Table of Contents of the Continuation (or remaining part) of the Appendix in page* 51, *&c.*

THE CONTINUATION

OF THE

APPENDIX

TO

Dr. D. MONRO's TREATISE

ON

MEDICAL AND PHARMACEUTICAL CHYMISTRY,

AND THE

MATERIA MEDICA;

WHICH TREATS

1st, Of the Doctrine of Phlogiston, and the New Theory of Chymistry. 2d, Of the Analysis of Animal and Vegetable Substances. 3d, Of the Application of the New Theory to the former Parts of the Work.

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PART II.

PART III.

INTRO-

INTRODUCTION.

AFTER the Author's Treatiſe on Medical and Pharmaceutical Chymiſtry had been printed in the year 1787, the French Nomenclature, containing a plan of a new ſyſtem of chymiſtry, arrived in this country. At firſt, moſt of the ingenious men, converſant in pneumatical chymiſtry, who had long ſupported the doctrine of phlogiſton, ſuſpected that miſtakes had been committed, in performing many of the experiments brought in ſupport of the new doctrine, and that falſe concluſions had been drawn from others; and therefore the Author, in his Preface, took no further notice of this French work, than in mentioning, that it promiſed to add great improvements to chymiſtry; thinking that it would not be right in him to enter into the deſcription of a ſyſtem, the principles of which were not eſtabliſhed, and were even ſuſpected by many ingenious and able men to be erroneous; particularly as at that time it had not been carried ſo far, as to point out to us any new or better method of preparing chymical medicines, than thoſe already recommended, or to add one new remedy to thoſe now in uſe.

But ſince that period, many diſcoveries have been made by the authors of the new ſyſtem, which ſhould ſeem to eſtabliſh it on a firmer baſis, to enable us to make a more accurate analyſis of bodies than formerly, and to lead to the diſcovery of many chymical preparations, which may prove efficacious remedies in the cure of diſeaſes; for theſe reaſons the Author thinks it now right to add to his former work ſuch a ſketch of the new ſyſtem, as may give a general idea of it, and enable thoſe who wiſh to proſecute the ſtudy of medical chymiſtry, to read with more eaſe and pleaſure the elaborate works of our more modern chymiſts; and, likewiſe, to add a table, in which the changes produced by chymical operations on ſome of the principal ſubſtances, which are the objects of the foregoing work, are to be accounted for by the new theory.

The new doctrine is certainly beautiful, and at preſent appears in many points to be juſt; but whether the whole ſyſtem laid down by Monſieur Lavoiſier and his aſſociates, will ſtand the teſt of experiment, in its full extent, is as yet uncertain; for the objects of fire, light, aërial fluids, &c. are ſo very ſubtile, that many of them cannot be confined in veſſels; ſo that it is not at all improbable but that many miſtakes may have been committed, and falſe concluſions been drawn from the reſult of ſome of the experiments which have been made: time however will correct theſe errors, if the new doctrine is well founded; and if otherwiſe, it will ſap its foundation.

The operations performed for eſtabliſhing this new ſyſtem have already led to the diſcovery of a number of preparations, particularly of the ſaline claſs, which have properties different from thoſe before known; thus the ſame acid has different properties, according as its acidifiable baſis is more or leſs impregnated with the baſis of pure air, called oxigene, by our modern French chymiſts; and the neutral ſalts, made with the ſame acids and alkaline ſubſtances, differ likewiſe from one another, if the degree of oxigenation be different in the acids employed: thus the neutral ſalt, made with the vegetable alkali and the common muriatic acid, differs very much from that made with the ſame alkali in a cauſtic ſtate, and the muriatic acid highly oxigenated, *i. e.* impregnated with pure air: the taſte of this laſt ſalt differs from that of the former, and it detonates when laid on the red hot coal, more ſtrongly than nitre, which the other does not. However, as the ſalts, and other preparations, made by the inventors of the new theory, have not hitherto been uſed as medicines, ſo as to aſcertain their particular virtues, properties, and doſes, they cannot properly be conſidered as ſubſtances belonging to the materia medica, and therefore no further notice will be taken of them at preſent.

It having been ſuggeſted lately to the Author, that ſome of the experiments made by Mr. Eller (the account of which he had quoted from the Berlin Memoirs for the year 1750), relative to the generation of heat during the time of the ſolution of Glauber's and other ſalts in water, were ſuſpected to be erroneous, he repeated ſome of them; and found that Glauber's and Epſom ſalts, if diſſolved in their cryſtallized ſtate, generate cold inſtead of heat; but if they be firſt reduced to a powder, and then dried, ſo as to free them from the water of their cryſtallization, in the manner recommended by Mr. Eller, that they then generate heat, and raiſe the quickſilver of the thermometer in the time of their ſolution in water. By miſtake, the words dried and powdered had been forgot to be put before ſome of the ſalts mentioned in page 185 and beginning of page 186 of vol. i. of the foregoing work.

In repeating theſe experiments of Mr. Eller's a very particular circumſtance occurred, which the Author was at firſt at a loſs how to account for.—Having cauſed an ounce of true Glauber's ſalt, and as much green vitriol, to be well dried, ſeparately, and freed of all the water of their cryſtallization, he put three ounces of New River water, which had paſſed through a filtrating ſtone, into a large tea-cup; and having placed in it a pocket thermometer, graduated according to Fahrenheit's ſcale, he obſerved to what height the quickſilver roſe; after which he added by degrees the green vitriol, dried to whiteneſs and powdered, while he kept ſtirring about the water, and a heat was immediately generated, which raiſed the quickſilver of the thermometer above ſeven degrees. Having let the thermometer remain in the water for ten minutes, to ſee if the quickſilver would riſe higher, which it did not, he, at the end of that period, attempted to remove it, but found it firmly fixed in the cup, which ſurpriſed him; and, on pouring out the water to know the cauſe, he found the ball of the thermometer fixed firmly in a browniſh coloured ſaline cake, which

had

had formed in the bottom of the tea-cup, in the ſame manner as a piece of ſtick would have been, which had been put into water, and the water afterwards allowed to freeze, by ſetting it in the open air, in the time of a hard froſt.

The ſame thing happened when the dried Glauber's ſalt was treated in the ſame manner; heat was generated on being mixed with water, and a ſaline cake was formed in the bottom of the tea-cup. In both theſe caſes, the quantity of water was more than would have diſſolved the ounce of each of theſe ſalts in their cryſtallized form. Dried Glauber's ſalts, during its ſolution, raiſed the thermometer 6 degrees; dried green vitriol 7 degrees; dried Epſom ſalt 14; and part of all of them coagulated, and ſunk to the bottom of the cup, without diſſolving.

This is a circumſtance which I have not obſerved to have been taken notice of by chymical authors, but deſerves to be attended to, and experiments to be made to aſcertain the reaſon why theſe ſalts, when dried, ſhould generate heat when mixed with water, and why part of theſe dried ſalts ſhould coagulate and not be diſſolved in the water, in the ſame manner as they are when they are in a cryſtalline ſtate.—The cauſe of their becoming ſolid may probably be the ſame as that aſſigned by Monſieur Adet, in the Annales de Chymie, tom. i. p. 17, for the muriate of tin becoming ſo, on its being mixed with water; which, he ſays, is in conſequence of that law which forces all bodies to condenſe; when, during their combinations, they are robbed of the matter of heat *(du colorique)* which holds them in a certain ſtate of dilatation.

Crude ſal ammoniac in powder, which had been deprived of moſt of its water, by being firſt reduced to a fine powder, and then kept ſtirring in an earthen pan over the fire, on being mixed with a cup full of New River water, in which I had placed a pocket thermometer, diſſolved readily, without forming any cake; and generated ſuch a degree of cold as lowered the quickſilver of the thermometer above ſixteen degrees.—In the Philoſophical

phical Transact. vol. lxxvii. for the year 1787, art. 26, p. 202, Mr. Walker of Oxford tells us, that he found, as Boerhaave had done before him, that sal ammoniac, as well as nitre, well dried in a crucible, and reduced to a fine powder, will produce a greater degree of cold, than if they had not received this treatment.—Do not these experiments confirm M. Adet's doctrine? For when no heat is generated, that is, where the salt to be dissolved does not part with its latent heat, it does not become solid, but dissolves readily. Hitherto we do not know why some salts generate cold, and some heat, during the time of their solution; nay, that the same salts, under different circumstances, should at one time generate heat, and at another cold: in the one case the water should seem to attract the heat from the salt; in the other, the salt should seem to attract it from the water; however, this is only mere conjecture. These phenomena concerning salts are objects which well deserve the attention of chymical philosophers, and ought to be prosecuted with care.

The

The few experiments I have made incline me to believe, that Mr. Eller's experiments, which I have quoted in vol. i. p. 185, from the Memoirs of the Academy of Berlin for the year 1750, will be found to be accurate, if performed in the manner recommended by him.

OF

OF THE

DOCTRINE OF PHLOGISTON,

AND OF THE

NEW THEORY OF CHYMISTRY.

PART I.

(This firſt part ſhould have followed the accounts of Elective Attractions and Solution, between pages 14 and 15 of vol. i. had the account of the New Theory been publiſhed before it was printed.)

HAVING mentioned theſe few things relative to elective attractions and ſolution, it may ſeem neceſſary to ſay ſomething concerning the nature of fire and of light, and of their different modifications; and likewiſe to take notice of air and other aëriform

aëriform fluids, which have of late so much engaged the attention of chymists.

The analysis of bodies, made by very modern chymists, begins where that of former times used to end; for, till within these very few years, an analysis was thought to be completed, when, by distillation and other processes, a body was divided into water, salts, oils, and earth, which were supposed to be its constituent parts; and little regard was, at that time, paid to those particles which separated in form of vapour or of air: but the industry of the present times has shewn, that many material parts of bodies had escaped in these forms; and that the other products obtained were themselves compounds, which, by means of certain processes, could be still further divided into different aërial fluids, which could be separated from each other, so as to examine their particular natures, and to form a better judgment of the primitive or elementary principles of the body analyzed.

Of FIRE.

IT is very difficult to define exactly what fire is, though it is one of the moſt common objects which preſents itſelf to our ſenſes, and its operations are amongſt the moſt curious and extenſive of any in nature.—It is ſo very ſubtile as to penetrate through the pores of every terreſtrial object we are acquainted with.

When certain ſubſtances are ſubjected to its influence in cloſe veſſels, which prevent any communication with the external air, it disjoins their component particles, and renders many of them volatile, but without exciting flame, or conſuming them to aſhes. But when it is united to the ſame bodies, ſo ſituated as to be expoſed to a current of atmoſpheric air, it moves with velocity, excites flame, and acts with ſuch force as to deſtroy, in a ſhort time, the union of all their conſtituent parts, and to diſſipate them in the air, in form of ſmoak or vapour; leaving nothing behind, but a pittance of an earthy and ſaline matter, called the aſhes. The vulgar

vulgar commonly believe, that, during this operation, the fire consumes and annihilates all the other parts of bodies except the ashes ; but the burning of combustible matters under vessels fitted to receive the vapour or steam that comes from them, during the time of their conflagration, shews that the force of fire only renders them volatile, and disperses through the atmosphere, in various forms, those particles which were supposed by the generality of mankind to be consumed and annihilated.

Every one acknowledges that matter to be fire, which, when united to combustible matters, renders them red hot, emits heat, flame and light, and dissipates or seems to consume such matters in the open air. It exists more or less in every known body, and in every climate ; for a flint, struck with force against a plate of steel, instantly throws out fire, which melts the abraded particles of the flint and steel into glass ; and if the spark of fire, thus thrown out, be received upon tinder, or any other very combustible matter placed upon a large quantity of dried wood, a prodigious quantity of fire will ſoon be collected, and ſeemingly conſume the wood with the greateſt violence, even in the coldeſt regions under the Pole, particularly if it be expoſed to a current of air.

It is of ſo volatile and ſubtile a nature, that no perſon hitherto has been able to confine and to collect it in veſſels, ſo as to aſcertain its intimate nature; and therefore we are obliged to content ourſelves with the examination of the effects it produces.

Chymiſts have long been divided in their opinions concerning the nature of fire and of heat; ſome ſuppoſing them to be the ſame; others, that heat is only the effect of fire. And they have been likewiſe divided in their opinions, whether light be a diſtinct body, or only a modification of fire.

Hitherto we are certainly ignorant of the particular nature of fire, heat, and light; from what we daily ſee, we are fully convinced, that they are the principal inſtruments which nature employs in carrying on moſt of her operations, and that they

they are the great efficient caufes of the production of all animated and inanimated bodies, and of the various changes which they daily undergo, although we are ignorant of the particular manner in which they are brought about.

From an attentive obfervation of the effects produced on bodies, fubjected to the influence of fire, chymifts are convinced that it is the great agent by which moft chymical operations are carried on, and they have fuppofed that *rarefaction*, and *light*, are only effects of it.

1. *Heat* is either fire itfelf, or is an effect produced by the immediate application of fire; and it is always more or lefs intenfe in proportion as the matter of fire, actuated by air, is more or lefs concentrated, and the body fubjected to its influence is more or lefs denfe.—And from obfervation it appears that the quantity of fire, or matter of heat combined with bodies, determines the form or ftate in which they exift, for the time being; whether in that of a folid, or of a fluid, or of an air or vapour; for in a *folid ftate*, bodies contain

leſs heat than in a *fluid*, and in a fluid leſs than in an aërial form. Thus, for example, ice is colder than water in its natural ſtate*, and water than its ſteam or vapour: and the ſame holds true with reſpect to oils, bitumens, ſulphur, metals, and all other bodies; though it requires different degrees of heat to keep different bodies in theſe different ſtates. Hogs-lard melts eaſily, and is kept in a fluid ſtate with a

* I have ſaid in a natural ſtate, becauſe Dr. Black, the Honourable Mr. Cavendiſh, and lately Dr. Blagden, have ſhewn that, by means of art, water under different circumſtances may be cooled without congealing, even to ten or eleven degrees below what is commonly looked upon as the freezing point. In vol. lxxviii. of the Philoſ. Tranſ. for the year 1778, p. 125, art. 10. Dr. Blagden has given an account of a number of ingenious experiments which he made relative to this ſubject, by ſetting a glaſs tumbler, with water variouſly impregnated, in a frigorific mixture made with ſnow or ice, and common ſalt. Amongſt other experiments, he mentions that pure water, which had been boiled, ſunk the thermometer to twenty-one before it congealed, but that muddy water congealed at thirty-two. The Doctor very candidly ſays, that he had not been able to account for the phenomena which occurred, and that the ſubject ſtill remains in great obſcurity.

very gentle heat; though it requires the heat of a reverberatory furnace to melt iron, and to keep it in that ſtate.

As heat is one of the great inſtruments employed in performing chymical experiments, and the great agent in forwarding fermentation, vegetation, and many other operations of nature; and as different degrees of it are required for anſwering theſe various purpoſes; chymiſts have been aſſiduous in finding out means for aſcertaining the exact degree of it, in any given body or place. In general they meaſure the degrees of heat, under that of boiling water, by means of thermometers; and the degrees above that, by certain appearances produced on particular ſubſtances by certain degrees of heat applied to them.

There are at preſent two thermometers which are moſt commonly uſed; the one invented by *Fahrenheit*, the other by Monſ. *Reaumur*. 1. That of Fahrenheit, where the freezing point is placed at 32°. 2. And that of Reaumur, where the freezing point is placed at 0; and one degree is equal to $2\frac{1}{4}$ of that of Fahrenheit's: in both you begin

begin to count the degrees, upwards and downwards, from theſe points; though in common, when you reckon upwards by Fahrenheit's ſcale, the 32 degrees below the freezing point are included; and hence, when you reduce the degrees of Monſieur Reaumur's thermometer to thoſe of Fahrenheit, you muſt multiply them by $2\frac{1}{4}$, and add the 32° which are below the freezing point in Fahrenheit's.

M. Fourcroy mentions five degrees of heat, or ſtations on the ſcale of the thermometer, below that of boiling water, and five above it; which are neceſſary to be attended to, in performing chymical operations. Theſe are:

To the Heat of boiling Water.

1. The firſt degree raiſes the quickſilver in Reaumur's thermometer from 5 to 8, in Fahrenheit's from $42\frac{1}{4}$ to 50. This degree, he ſays, favours putrefaction, vegetation, and ſlow evaporation.

2. The ſecond degree is at 15 in Reaumur's, and at $66\frac{1}{2}$ in Fahrenheit's. This

keeps up putrefaction, and excites the vinous fermentation in saccharine liquors.

3. The third degree extends from 25 to 30 in Reaumur's, or from 86½ to 99½ in Fahrenheit's. This, he says, establishes the acetous fermentation, and favours the drying and flowering of plants.

4. The fourth degree raises the quicksilver in Reaumur's to 45, in Fahrenheit's to 133. This disorganizes animal substances, volatilizes essential oils, &c.

5. The fifth degree, which is that of boiling water, he says, may be marked from 80 to 85 in Reaumur's, or in Fahrenheit's from 212 to 223¼.

Above the Heat of boiling Water.

1st Degree reddens glass, burns organized bodies, and melts sulphur.

2d Degree melts soft metals, such as lead, tin, bismuth, and fusible glass.

3d Degree melts metals of a middle hardness, such as zinc, regulus of antimony, silver, and gold.

4th Degree bakes porcelain or china

ware; melts refractory metals, ſuch as cobalt, braſs, and iron.

5th Degree, which is the ſtrongeſt of all, is the burning glaſs, that calcines, burns, and vitrifies in an inſtant all the bodies which are ſuſceptible of thoſe changes.

2. *Rarefaction.* The ſecond modification or effect of fire which I mentioned, was that of rarefaction; or that effect of heat by which the component particles of bodies, ſubjected to its influence, are ſeparated from each other, and the bulk or ſize of the bodies is increaſed. M. Lavoiſier obſerves, that although ſome ſubſtances may ſeem to contract; yet that, upon an accurate examination of the particular circumſtances in which they are placed, it will be found that rarefaction has taken place, for that is a general and a conſtant rule of nature.

3. *Light* is ſo connected with fire, that moſt chymiſts formerly looked upon it as one of its attributes; but the late M. Macquer and others have conſidered it as a diſtinct matter, and have accounted for a number of phenomena, from its effects

upon other bodies: but as it is too ſubtile a matter to be confined in veſſels, and to try chymical experiments with, nothing certain has hitherto been, or probably ever will be, determined relative to its particular nature.

Of the Doctrine of PHLOGISTON, *or Matter of* FIRE.

TOWARDS the end of the laſt century, Dr. Becher, phyſician to the Electors of Mentz and Bavaria, a moſt ingenious man, and one of the beſt chymiſts of his age, on examining into the nature of inflammable bodies, concluded, that the matter of fire, which he called *phlogiſton*, was a particular ſort of earth, that ſubſiſted more or leſs in every body; and was the cauſe of many of the changes which they underwent. In the year 1723, Dr. Stahl, one of his diſciples, publiſhed at Nuremberg a book called *Fundamenta Chemiæ*, in which he illuſtrates the doc-

trine

trine of his maſter. He ſays that, while phlogiſton (or the matter of heat) remains at reſt in the bodies to which it is united, it does not excite light or heat, nor produce any viſible or remarkable change in their properties, further than in rendering them ſuſceptible of being acted upon, and ſet in motion, on fire being applied to them; that it is the cauſe of material coheſion, nutrition, colour, ſmell, volatility, ductility, malleability, and other properties of bodies; for that all theſe qualities periſh when phlogiſton is taken away, and return when it is reſtored: and that moſt of the changes which bodies undergo, when ſubjected to certain chymical proceſſes, are brought about by a quantity of phlogiſton being added to, or ſubtracted from them; which has been termed the *phlogiſticating* and the *dephlogiſticating* of bodies. Thus he ſuppoſed ſulphur to be a body compounded of an *acid* and *phlogiſton*; and ſays that, when it is burnt in an open veſſel, theſe two principles riſe in form of vapour or phlegm, and ſeparate from each other; and if a proper veſſel for collecting and condensing this vapour be put over the sulphur while burning, a fluid acid, called the sulphureous or vitriolic, will be collected; while the other principle, called phlogiston, which is of so subtile a nature as not to be confined in vessels, will make its escape; and that this acid may be again restored to the state of sulphur, by uniting with it a fresh quantity of phlogiston, either by distilling, or subjecting to the action of the fire in a crucible, the acid itself, or substances containing it, along with charcoal, or other bodies containing phlogiston. In like manner if metals, which he alleges are made up of a certain earth and phlogiston, be deprived of their phlogistic matter, either by the force of fire, or by being corroded with acids, they are reduced to the state of calces; but if the phlogiston be restored to these calces, by mixing them in a red-hot crucible with charcoal, or other fluxes containing it, and keeping them there for some time, they resume the form and properties of metals.

This doctrine of Stahl, as it accounted

for many things which before were looked upon as inexplicable, was ſoon univerſally received, and continued to be ſupported till within theſe few years; for, ſo late as the year 1779, Sir T. Bergman, in treating of the uſe of the blow-pipe, ſays that the whole theory of inflammation depends upon that ſubtile principle which goes by the name of phlogiſton; but this, ſo far as is yet known, can never be collected pure and alone, but always requires a ſuitable baſis, to which it muſt be united, in order to become manageable. Scarce any body exiſts entirely deſtitute of it, but a certain accumulation is neceſſary for inflammation; this accumulation takes place in vinous ſpirits, oils, ſulphur, zinc, arſenic, and in all inflammable bodies. And in the year 1782 Mr. Kirwan, in vol. lxxii. of the Philoſophical Tranſactions, alleges, that phlogiſton, like fixed air, exiſts in two ſtates: 1. In a ſolid form, when joined to other bodies: 2. And in an elaſtic aëriform ſtate, when disjoined from them: that in its firſt ſtate it is called *phlogiſton*; in its ſecond, *inflammable air*:

air: and he has made an eſtimate of the quantity of it which is contained in ſeveral different bodies.

Of the Doctrine of AIR.

THIS doctrine of phlogiſton remained uncontroverted for many years, and ſeemed to gain ground daily, till chymiſts began to obſerve more accurately the changes which bodies underwent, when ſubjected to the influence of fire; and, finding that they could not, from it, account for the increaſed weight which moſt bodies acquired by being calcined, nor for other appearances which occurred, they began to ſearch for other cauſes; and at laſt Monſieur Lavoiſier and others, on obſerving with care the circumſtances of combuſtion, and examining the changes which it produced on different bodies, concluded that the matter which brought about thoſe changes was the baſis of pure air, and not phlogiſton, as had been formerly imagined; for that combuſtion is no more than a decompoſition of oxygenous gas, effected by a combuſtible body; and that, during the time in which this is brought about, the baſis of pure air is abſorbed, and the matter of heat (the calorique) and light are diſengaged and ſet at liberty: however, in order to effectuate this, the pure air muſt have more affinity with the combuſtible matter than it has with the matter of heat, the whole muſt be ſet in motion by ſome heated body, and the temperature muſt be of a certain degree, which is different in almoſt every combuſtible ſubſtance.

The following are the principal obſervations and experiments on which they found their opinion.

1. That no body or ſubſtance can burn without air; and that combuſtion is always more or leſs rapid, in proportion to the purity and quantity of the air, and the velocity with which it moves.

2. That during the time of combuſtion there is an abſorption of air; and that many bodies acquire an addition of weight by being ſubjected to this operation.

3. That by calcining metals, in cloſe veſſels, in a given quantity of pure air, they

they become heavier; and the additional weight which they acquire is always equal to the weight which the air, employed in their calcination, has loft, during the time of their combuftion.

4. That if metallic fubftances, thus reduced to the ftate of calces, be put into a clofe veffel, along with proper fluxes or fubftances containing inflammable matter, and be expofed to a great heat, the inflammable matter of thefe fluxes attracts the air which the metallic fubftances had abforbed; by which means they lofe their additional weight, and return to the ftate of metals.

5. That fimilar effects follow, when fulphur is burnt in a ftream of air; for, during the time of its combuftion, it abforbs a quantity of pure air, and thereby acquires additional weight, and becomes vitriolic acid; and that if the vitriolic acid, thus formed, be expofed to a ftrong heat in proper veffels, along with charcoal, or other combuftible matters, which abforb its air, it returns to the ftate of fulphur.

6. That air in which fubftances of any kind

kind have been burnt, always loſes of its weight; and what remains of it ſuffocates animals, is no longer capable of feeding flame, and in ſhort becomes impure or mephitic.

7. That the reſidua of bodies which have been completely burnt, have been found to be fully ſaturated with air; and therefore are no longer capable of abſorbing it, or of feeding flame, but enter into the ſtate of incombuſtibles.

From theſe and a variety of other facts, M. Lavoiſier has endeavoured to prove that it is pure air, and not phlogiſton, which produces many changes that bodies undergo, when ſubjected to certain chymical proceſſes.

Many chymiſts have adopted this new theory entirely, others only in part; while ſome continue ſtill to ſupport the old doctrine of phlogiſton.

Monſieur Fourcroy, who is one of the great ſupporters of the new doctrine, in his third edition of his Leçons Chimiques, ſays that, notwithſtanding the vaſt reſearches, of late years, into the pheno-

mena

mena of combuſtion, the opinion which admits the exiſtence of fire as a principle fixed in bodies, has not yet been overthrown; and its name of *phlogiſton* has been changed to that of *calorique*, or *combined heat*: but that it is not to this matter that the property of combuſtibility is attributed; nor is its preſence, in inflammable bodies, that which determines the inflammability.

Late Arguments in favour of PHLOGISTON, *and of Doctor* PRIESTLEY'*s new Doctrine.*

M. FOURCROY, in his Leçons Chimiques, tells us, that the late M. Macquer thought we ought to combine the new and the old doctrines together; for that metals could not loſe their phlogiſton, and be calcined, without the pure air of the atmoſphere being precipitated, and uniting itſelf to the metals themſelves; and that the metals, when reduced to calces, could not be brought back again to their pure metallic ſtate, until the phlogiſton, added by heat, diſengaged the pure air from them;

them; ſo that theſe two matters, *pure air* and *phlogiſton*, were mutual precipitants of each other.

The Hon. H. Cavendiſh, in vol. lxxiv. of the Philoſophical Tranſactions, p. 152, publiſhed in the year 1784, after having conſidered ſeveral memoirs of M. Lavoiſier, publiſhed in the Memoirs of the Royal Academy of Sciences at Paris, in which he entirely diſcards phlogiſton, and explains thoſe phenomena which have been uſually attributed to the loſs or attraction of that ſubſtance, by the abſorption of pure or vital air, tells us that he has adhered to the doctrine of phlogiſton, becauſe it explains all phenomena, at leaſt, as well as Lavoiſier's new theory.

Dr. Prieſtley, who in vol. lxxiii. of Philoſophical Tranſactions, art. 22, gave an account of a number of experiments and obſervations made in order to ſupport the doctrine of phlogiſton, after having examined the new theory and the facts which have been brought in its favour, and made many experiments relative to theſe ſubjects, ſeems to differ

very

very much from the French academicians, both with respect to the facts themselves, and to the conclusions drawn from them. The academicians have asserted, that the basis of pure air, which they have called oxigene, is a simple substance, and that metals and sulphur are the same: but Dr. Priestley, by a number of experiments which he made, and of which he has given an account in vol. lxxviii. and lxxix. of the Phil. Transf. for the years 1788 and 1789, thinks that he has proved that pure air, and all other airs, are compounds, made up of a large quantity of water, in an aëriform state, united to some particular matter which gives it properties that distinguish it from all other bodies: thus he thinks that inflammable air is a fine aqueous vapour, united to an inflammable matter, which he says may as well be called phlogiston as any thing else; that pure or dephlogisticated air is formed of a fine aqueous vapour, united to the acidifying principle, in the proportion of from 18 or 19 parts of water to one of the acidifying principle; and so forth, with the other airs; water being the proper

basis

baſis of them all, without which none of them can ſubſiſt. He likewiſe ſtill aſſerts that metals and ſulphur are compound bodies, formed of certain baſes united to phlogiſton; and having eſtabliſhed theſe facts, as he imagines, he next accounts for the changes which metals undergo when calcined, and ſulphur when burnt, in the following manner: He ſays, when metals are expoſed to a very ſtrong heat, where there is acceſs to air, that they part with phlogiſton, and abſorb a quantity of that water which formed a conſtituent part of pure air, and not the pure air itſelf; and that this reduced them to the ſtate of calces: and that theſe calces are reduced to the ſtate of metals, if they be expoſed to a great heat along with ſubſtances containing phlogiſton; for under ſuch circumſtances they abſorb a quantity of phlogiſton equal to what they had loſt, and let go the water which they had taken up. Dr. Prieſtley, who made theſe experiments with iron, acknowledges that there is a great difficulty in explaining the reaſons why iron ſhould abſorb water on parting

with

with its phlogiſton; and why it ſhould again part with it, and imbibe phlogiſton, in circumſtances of heat ſo nearly ſimilar to thoſe he has deſcribed. To this he only ſays, that the whole doctrine of affinities, ſo far as it is true, is founded on facts, and theſe are clearly ſuch as he has repreſented; and that a difference of circumſtances, which is not apparent at preſent, may become ſo, when we have given ſufficient attention to them. He ſays that the reduction of finery cynder, and other calces of iron, to a metallic ſtate in inflammable air, is a certain proof that it is the abſorption of this air, containing phlogiſton, which produces this effect; and when the abſorption of this air takes place, and the iron is reduced back to its metallic ſtate, that nothing but water is expelled from it: which ſhews that it was water taken up originally by the iron, during the time of its calcination, which had reduced it to the ſtate of a calx; for the quantity of water obtained was much greater than the inflammable air, employed, was ſuppoſed to contain.

Of

Of WATER *being a Compound Subſtance.*

ACCORDING to the new ſyſtem, water, which has ever been looked upon as an elementary body, is ſaid to be a compound, made up of *pure* and *inflammable* airs; and that in the performance of many experiments it was formed, and in that of others it was decompoſed: and from hence many appearances have been accounted for, which formerly were looked upon as inexplicable. The Hon. Henry Cavendiſh firſt broached this doctrine, from appearances he had obſerved in performing experiments in the years 1781, 82, and 83; and on the 15th of January 1784 he gave in to the Royal Society a particular account of theſe experiments, and of the obſervations he had made, which was publiſhed in the volume for that year.

M. Lavoiſier, in the year 1784, publiſhed two papers, the one dated in April 1784, the other later, in the Memoirs of the Royal Academy of Sciences at Paris for the year 1781, but which were not printed till late in the year 1784; and ſince that period, he, and other academicians have made a number of curious experiments relative to this ſubject; from whence they conclude, that a hundred parts of water contain eighty-five of *pure air*, and fifteen of *inflammable air*; and tell us that they had repeatedly decompounded water, and always found that it yielded the above proportions of theſe two airs; and that, by uniting again theſe two airs in the above proportions, they had obtained a quantity of water equal in weight to that of the two airs employed. After theſe experiments, one ſhould think that no doubt could be entertained relative to the truth of theſe facts. However Dr. Prieſtley, in his late publications in the Philoſophical Tranſactions, has boldly aſſerted that water is an elementary body, as it always has been believed to be; and that neither Mr. Cavendiſh, nor M. Lavoiſier, nor any other perſon, has hitherto either compoſed or decompoſed it; and that what water they had obtained in performing the experiments from which they drew their concluſions, was the water

which

which made up the greater part of the pure and inflammable airs they made uſe of, let looſe by the proceſſes employed for the ſuppoſed formation of water.

A ſeries of accurate experiments, performed by able chymiſts, is the only way in which this controverſy can be determined.

Of the General Principles of the NEW THEORY OF CHYMISTRY, *ſubſtituted in room of* PHLOGISTON.

FOR theſe ſeven or eight years paſt, many of the French academicians have publiſhed, from time to time, Memoirs relative to the ſubjects of their new theory; and at laſt, in the year 1787, four very able and ingenious French chymiſts, Meſſieurs Morveau, Lavoiſier, Bertholet, and Fourcroy, favoured the world with a new nomenclature of chymical ſubſtances, in which they have adopted principles entirely new, changed the names of almoſt every body which is the object of chymiſtry, and arranged them in a particular order, adapted to the new ſyſtem; and ſince then many treatiſes have been publiſhed by different authors on the ſame ſubjects.

Theſe gentlemen begin with mentioning thoſe ſubſtances which they had not been able either to decompoſe, or to form by any combinations which they have attempted. Theſe they have called *ſimple* or *elementary*, though they ſay that it is not at all improbable but that hereafter many of them may be diſcovered to be compounds; but, till then, that they ought to be looked upon as *ſimple bodies:* and theſe they have divided into five claſſes.

CLASS I.

UNDER this firſt claſs they comprehend thoſe *ſimple ſubſtances* or *principles*, which, without ſhewing the leaſt analogy to each other, have however ſomething in common, that makes them approach to the ſtate of ſimplicity, and reſiſt all analyſis; at the ſame time that it renders them active in combination: the five following

following they have brought under this head, *viz.*

1. Light.
2. Matter of Heat.
3. Pure or dephlogiſticated Air.
4. Impure or phlogiſticated Air.
5. Inflammable Air.

Theſe they look upon as the true active elementary bodies, from whoſe various combinations with one another, and with other ſimple ſubſtances, they ſuppoſe all the different changes which they undergo, by natural or artificial proceſſes, are brought about. In order to underſtand their nature, I ſhall conſider each of them ſeparately; but as I have already taken notice of *light* and *fire*, I ſhall at preſent only mention them very ſuperficially.

I. *Of* LIGHT—*Lumiere.*

LIGHT, as I have already obſerved, is a ſubtile fluid, the great fountain of which is the ſun; and it comes from thence to our earth with a velocity of which it is difficult for us to have any conception; for, by a mathematical calculation, it moves at the rate of 240,000 miles in a ſecond of time. It is ſo connected with fire, that it is doubtful whether it be a diſtinct matter of itſelf, or only a modification, or attribute of it. It is too ſubtile a matter to be confined in veſſels, and to be ſubjected to chymical experiments: it is only from a few obſervations made on the effects it produces on terreſtrial ſubſtances; from the manner in which it affects the nerves of our eyes, by which we ſee the objects around us; and from ſome few experiments made relative to the refraction and reflection of its rays coming from the ſun, and their producing different colours, that we conjecture any thing about its nature and properties.

M. Fourcroy obſerves, that it ſeems to obey, as other bodies do, the laws of affinity of compoſition; and M. Lavoiſier ſays that, with regard to light, we know but very little about its combinations, and manner of acting upon bodies; but, from the experiments of M. Bertholet, it ſhould ſeem to have a great affinity with pure air, and is ſuſceptible of combining with

it,

it, and with the matter of heat, to contribute to its transformation into gas.

Experiments made on vegetation ſeem to give reaſon for believing, that it combines itſelf with ſome parts of plants; and that it is this combination which is the cauſe of the green colour of their leaves, and of the different colours of their flowers; and that it contributes to their vigour and their health; for that plants raiſed in houſes where the light is excluded, become languid, and their leaves and flowers have little or no colour: and the want of it is likewiſe obſerved to affect the health of man.

II. *Of the* MATTER OF HEAT, *called* CALORIQUE *by the Academicians.*

THE French academicians, in their new Nomenclature, make uſe of the word *calorique* to ſignify the matter of heat, and to diſtinguiſh it from *chaleur*, heat, which they employ to expreſs the effects produced by it.

I have already mentioned that fire was

ſo ſubtile and ſo volatile a matter, that no perſon had hitherto been able to confine and collect it in veſſels, to examine its particular nature, and that therefore we were obliged to content ourſelves with the examination of the effects it produces—that it ſeems to be one of the great cauſes of the changes which bodies undergo in paſſing from a ſolid to a fluid ſtate, and of their being rendered volatile, and aſſuming the form of a vapour or of a gas ; and that it is one of the great inſtruments of vegetation, of the increaſe, growth, and decay of all the animal and vegetable creation, and probably likewiſe of the mineral.

Chymiſts have given ſuch varieties of names to fire, the matter of heat, the combuſtible principle, and their different properties and modifications, that it is not always eaſy to underſtand their meaning when they ſpeak of them, or of the manner in which they ſuppoſe them to produce their effects.

Monſieur Lavoiſier thinks that burning, or combuſtion, is nothing but the decom-

decompoſition of oxigenous gas, affected by a combuſtible body in the following manner:

Every body capable of combuſtion, or burning, is ſuch as ſtrongly attracts the baſis of pure air (or oxigene); and when ſuch a degree of heat is applied to it as deſtroys the equilibrium of its conſtituent parts, while it is ſo placed as to be expoſed to a current of air, it attracts powerfully the pure air, till it is fully ſaturated with it; and during that time, the matter of heat (or calorique) and light, which are diſengaged and ſet at liberty, fly off, and form that appearance called flame; and the remaining part of the burnt body, which has been fully ſaturated with air, is now no longer capable of abſorbing more, or of burning longer, being reduced to the ſtate of an incombuſtible ſubſtance.

Of the AIR *of the* ATMOSPHERE.

BEFORE conſidering the *pure* or dephlogiſticated, and the *impure* or phlogiſticated airs, as they are called, it is neceſſary to mention a few things relative to the air of the atmoſphere, which is the great magazine of theſe two airs, being made up principally of them.

Its ſpecific weight to that of water has been commonly eſtimated as 850 to 1, but by Mr. Kirwan's account as 816 to 1. It has been ſaid by ſome authors to contain 2, and by others 3 parts of *impure* air to 1 of *pure*: but by M. Lavoiſier's experiments the proportions are a little different; for he ſays that 100 cubic inches of atmoſpheric air yielded him 73 of *impure*, and 27 of *pure* air.

Beſides theſe two airs, the atmoſphere contains a vaſt variety of other matters, and is the great magazine of thoſe particles of bodies which are daily rendered volatile by heat, fermentation, putrefaction, and many other operations of nature, and are capable of remaining in an aërial form in the temperature in which we live; and it is not impoſſible but that particles of every ſort, even of metallic ſubſtances, may be found floating in it: hence we ſhould naturally be led to ſuppoſe that, in analyſing the air of the atmoſphere, ſuch matters

would

would often be met with in it. But in general this is not the caſe; for the quantity of theſe matters being ſmall in proportion to the great body of the air of the atmoſphere, they are preſently diſperſed through this immenſe unbounded ſpace: part of them is decompoſed, and mixed with the general maſs; part of them falls down again inſenſibly to the ground; part of them is attracted by the water of the clouds, and precipitated with rain and dew; part of them goes to form thoſe maſſes of inflammable matter in the clouds, which detonates in the air, and forms thunder and lightning, and ſo forth; ſo that, in analyſing the air of the atmoſphere, little elſe is commonly got but the *pure* and *impure* airs, which we ſhall next conſider; though at times, and in particular places, it is found mixed with various foreign matter.

III. *Of* Pure Air—*Oxigene.*

THIS air is called by a vaſt variety of names. It has been called *pure* and *vital*, from its purity and fitneſs for reſpiration; *dephlogiſticated*, from its being ſuppoſed to be freed of phlogifton; and lately it has been called by the French *oxigene,* from its being believed to be proved to be the true *acidifying principle,* which, with different bafes, forms the different forts of acids; the word *oxigene* being a compound of the two Greek words, οξυς *acid,* and γεινομαι *to engender.*

This air is got pure, or disjoined from all other matters, in feveral ways; but principally by feparating it from other bodies to which it has been combined by art. Dr. Prieftley, who firft took particular notice of it, obtained it by diftilling nitre in an earthen retort glazed both within and without; for, when the retort was made red hot, the nitre was decompofed, and the *pure air* was fet at liberty, and came over into the receiver: and it may be procured by throwing the focus of a burning glafs upon calcined metallic fubftances, fuch as calcined mercury, minium, calcined manganefe, &c. placed under glafs receivers of an air pump, which difengages the pure air from thefe calces.

The

The general properties of this ſort of air are as follow :

I. By Mr. Kirwan's account, 100 cubic inches of pure air weigh 34 grains ; but, by Monſieur Lavoiſier's calculation, 100 cubic inches in the ſtate of gas, with Fahrenheit's thermometer at $54\frac{1}{2}$, and the barometer at 28, weigh 50 grains.

II. It is the only air that is fit for reſpiration, and for the ſupport of animal life ; and it corrects the bad qualities of the impure air with which it is combined, in forming the atmoſphere in which we live.

III. It favours combuſtion, and no ſubſtance will burn without being in contact with it ; and if combuſtible matters are ſet on fire in a confined veſſel or chamber, which contains atmoſpheric air, the fire will go out or be extinguiſhed ſo ſoon as all the pure air is abſorbed or conſumed ; and the briſkneſs with which the fire burns will always be in proportion to the quantity of pure air which comes in contact with the combuſtible ſubſtances, and the velocity with which it moves.

IV. It forms different ſorts of acids by being combined with different ſubſtances, to which the French have given the name of acidifiable baſes.

1. With ſulphur it forms the *ſulphureous* or *vitriolic* acid. It takes about 143 parts of pure air to ſaturate 100 of ſulphur; the exact quantity not fully aſcertained.

M. Bertholet made two experiments to aſcertain the proportion of pure air to ſulphur in the vitriolic acid.—By the firſt, 69 parts of burning ſulphur attracted 31 parts of pure air, and afforded 100 parts of ſulphureous acid. By the ſecond, 72 parts of ſulphur only attracted 28 of pure air.

2. With impure air, called by the French *azote*, it forms the *nitrous acid.* It takes 1 part of the impure to 3 of the pure air. Dr. Prieſtley ſays that he obtained this acid by decompoſing pure and inflammable air with the electric ſpark.

3. With an unknown baſis, it is ſuppoſed to form the *muriatic acid*; though hitherto chymiſts have not been able to

prove

prove its exiſtence in this acid, nor to aſcertain the nature of the baſis with which it is connected; it is only from analogy that it is conjectured that this acid is thus formed.

4. With charcoal it forms *aërial acid.* It takes, by M. Lavoiſier's account, 28 parts of charcoal to 72 of pure air. Dr. Prieſtley, in Phil. Tranſ. vol. lxxix. alleges that he got this acid by decompoſing pure and inflammable airs by means of the electric ſpark.

5. With phoſphorus it forms *phoſphoric acid.* It takes 154 parts of pure air to 100 of phoſphorus.

6. With a baſis, the nature of which is not hitherto aſcertained, it forms *boracic acid*, commonly called ſedative ſalt.

7. With a baſis, the nature of which has not as yet been aſcertained, it forms *acid of amber*, commonly called ſalt of amber.

8. With a baſis, the nature of which has not been aſcertained, it forms a kind of acid, called *fluoric*, or *ſpathic acid.*

9. With a basis, compounded of *inflammable air* and *charcoal*, and sometimes with the addition of *phosphorus*, it forms the *different vegetable acids*; and the difference of the proportion of these component materials, and of the pure air, constitutes the difference between the acids themselves.

10. With a basis, compounded of four simple substances, viz, *inflammable air*, *charcoal*, *phosphorus*, and *impure air*, it forms the different acids of the animal kingdom.

11. With the three following metallic substances, viz. *arsenic*, *molybdene*, and *tungstene*, it forms three particular sorts of acids; *acid of arsenic*, *acid of molybdene*, and *acid of tungstene.*

12. With iron, by a particular encheiresis, it forms a blue matter, which by some people has been called *Prussian acid*; though many have doubted whether it ought to be accounted an acid.

V. By uniting with certain vegetable, mineral, and other substances, a quantity of of pure air, not enough to convert them into acids, but ſufficient to make them approach to their nature, we form thoſe ſubſtances which the French academicians now call *oxides*, and which in Engliſh we have, as yet, no proper name for: the vegetable kingdom furniſhes ſome native ſubſtances of this kind, ſuch as *ſugar*, *gum*, and ſome other vegetable juices; thoſe of the mineral kingdom, to which the academicians have given that name, are moſtly formed by the force of fire: for when certain metallic ſubſtances or earths are calcined in the open air, or in chambers containing this air, a quantity of it is abſorbed, and the metals or earths are reduced to the ſtate of calces, or what the academicians now term *oxides*.

VI. By adding a quantity of this air to certain ſubſtances, reduced to the ſtate of oxides, they are converted into acids: thus the addition of pure air to wine converts it into vinegar.

VII. By uniting this with inflammable air in the proportion of 85 parts of this, to 15 of the inflammable air, it forms water; though Dr. Prieſtley of late doubts of this fact.

IV. *Of* Impure Air, *called by the French* Azote.

THIS air has been called by a variety of names, ſuch as *impure*, *mephitic*, *phlogiſticated*, &c. and the French academicians have of late given it the name of *azote*, from the two Greek words α without, and ζωη life; becauſe it is not fit for reſpiration, but ſuffocates animals who breathe in it.

By the accounts of ſome authors, the air of the atmoſphere contains two parts of this and one of pure air; but by M. Lavoiſier's experiments, 100 ounces of atmoſpheric air contains 73 of this, and 27 of pure air. The different qualities of the air of the atmoſphere, in the places where the obſervations were made, may perhaps have occaſioned this difference in the proportional quantities of thoſe two airs which conſtituted its component parts.

This air may be obtained ſeparate, by placing

placing veſſels containing hepar ſulphuris and lime-water under an exhauſted receiver of an air pump, and then filling the receiver with atmoſpheric air, and letting it ſtand for a fortnight, in which time the hepar ſulphuris, or lime-water, will abſorb all the *pure* from the atmoſpheric air; and the impure air may be drawn off into veſſels proper for receiving it. Or it may be got by diſſolving animal ſubſtances in weak nitrous acid, almoſt cold, in an exhauſted receiver, which will ſet the impure air free, ſo that it may be extracted from thence by means of a pneumatic apparatus.

The principal properties of this ſort of air are theſe:

1. A cubic inch of it does not weigh quite half a grain: M. Lavoiſier ſays that it weighs $\frac{1111}{2500}$ of a grain; M. Kirwan, that 100 cubic inches weigh 30 gr. $\frac{535}{1000}$.

2. It is one of the eſſential principles which conſtitutes animal matter.

3. United to the matter of heat of our atmoſphere, it remains in a ſtate of gas.

4. It is the baſis of the acid of nitre; for

for 1 part of it united to 3 of *pure air*, forms the nitrous acid *.

5. It promotes wonderfully the proceſs of putrefaction.

6. By being joined to inflammable air, it forms the volatile alkali, of which it is a conſtituent part; for no ſubſtances which

* From experiments made by the Hon. H. Cavendiſh, an account of which is given in vols. lxxv. and lxxviii. of the Philoſophical Tranſactions, it appears that what was called the nitrous air is the ſame as this. Dr. Prieſtley, in vol. lxii. of Philoſophical Tranſactions for the year 1772, ſays, that one of the moſt conſpicuous properties of the nitrous air is, the great diminution of any quantity of common air with which it is mixed, attended with a turbid red and deep orange colour, and a conſiderable heat: but it is amazing that a quantity of this kind of air ſhould, as it were, devour a quantity of another kind of air half as large as itſelf, and yet be ſo far from gaining any addition to its bulk, that it is diminiſhed by it. It does not effervеſce with, or diminiſh the bulk of *fixed* or of *inflammable*, or of any other ſort of air, except common air, or air fit for reſpiration: and the Dr. tells us, that, ſo far as he can judge, the diminution of bulk is in proportion to its fitneſs for reſpiration; hence he has eſtabliſhed this diminution of bulk as a teſt for diſtinguiſhing wholeſome air from that which is not ſo, and for knowing the degree of its purity.

do

do not contain impure air, will yield volatile alkali ; and the product of the volatile alkali is, always, in proportion to the quantity which the bodies employed for its production contain of this air.

By Monſieur Bertholet's experiments, the volatile alkali is formed of 807 parts of azote (or impure air), and 193 of inflammable air.

7. Mixed in the proportion of 73 parts to 27 of pure air, it forms atmoſpheric air ; or, according to others, in the proportion of 3 to 1.

8. It enters into the compoſition of Pruſſian blue.

N. B. Notwithſtanding the French academicians have ranked this air among the ſimple ſubſtances, M. Metheric alleges that it is a compound body, formed by the union of pure and inflammable airs ; and Mr. Cavendiſh, in vol. lxxv. of Philoſophical Tranſactions affirm that it is moſtly formed of pure air and phlogiſton.

V. *Of* Inflammable Air—*called by the French* Hydrogene.

INFLAMMABLE air, or gas, is an aëriform fluid which has the appearance of air, but is 10 or 12 times lighter than it. The French have called it hydrogene, from believing it to be one of the component principles of water; this name being derived from the Greek words ὕδωρ water, γείνομαι to engender.

This aërial fluid has long been known, for it often collects in quantity in mines, and proves deſtructive to miners, by its catching fire, and exploding when a lighted candle is unwarily brought into the chambers in which it is lodged; and it riſes through the water of ſome wells in form of a vapour, which catches flame on the approach of a lighted torch.

Its general properties are theſe:

1. It is much lighter than the air of the atmoſphere, and readily unites with the matter of heat. M. Kirwan ſays that 100 cubic inches of this air weigh 2 gr. $\frac{613}{1000}$, and that its weight is to that of common or atmoſpheric

moſpheric air, as $84\frac{3}{10}$ to 1000; and M. Lavoiſier aſſerts, that in the ſtate of gas it is 13 times lighter than atmoſpheric air. Dr. Metheric tells us that this air, as it is firſt got, is ſeldom pure, for it generally carries with it a portion of the ſubſtances from which it is obtained; and hence different parcels of it commonly differ in their ſmell, weight, and other properties: that ſeparated from corrupted animal and vegetable ſubſtances, it is commonly the heavieſt, and only 4 or 5 times lighter than common air; that got from iron, by means of the vitriolic acid, from 8 to 9 times; that from zinc is ſtill lighter; and that from a red hot iron by means of water, the lighteſt of all. Hence chymiſts for ſome time were in doubt whether there was only one, or many ſorts of inflammable air; but M. Fourcroy and other chymiſts aſſure us, that the inflammable air got from different ſubſtances, iron, zinc, water, the marſhes, putrid vegetable and animal ſubſtances, is all of the ſame kind, when freed entirely of foreign matter.

2. It is noxious to animals, who draw

it up into their lungs, and immediately ſuffocates them; but it enters into the compoſition of both vegetable and animal ſubſtances.

3. Iron and zinc both contain a large quantity of this air, which may be ſeparated from them by diſſolving them in the vitriolic acid, diluted with water, under a large glaſs bell, fitted with a pneumatic apparatus; for this air or gas is let looſe as the metals diſſolve, and floats in the cavity of the bell, from which it may be extracted by means of an air pump. Or it may be obtained by putting one of theſe metals into a tubulated retort placed on a ſand heat, and fitted with a tubulated receiver and proper apparatus; then poung the diluted vitriolic acid upon the metal, and diſtilling with a very gentle heat, not exceeding that which will raiſe the quickſilver in Fahrenheit's thermometer to 120 degrees.

The Honourable H. Cavendiſh, in vol. lvi. of Philoſophical Tranſactions, tells us that zinc diſſolves with great rapidity; and, unleſs the acid be very much diluted, it generates a conſiderable heat; that an

ounce

ounce of zinc produced 356 meaſures of inflammable air, and an ounce of iron wire 412. He ſays that tin likewiſe produces this air; but an ounce of tin foil only yielded 202 ounce meaſures.

4. United to pure air, in the proportion of 15 parts to 85 of the pure air, it forms, or is ſuppoſed to form, water; and may be ſeparated again from it, by adding ſome ſubſtance which has a greater affinity with the pure air than with it. Iron made red hot, and put into water under the receiver of an air pump, attracts the pure air, and is converted into a calx or oxide, whilſt the inflammable air, being let looſe, unites with the matter of heat, forms itſelf into a gas, and floats in the receiver above the water, from whence it may be extracted by means of an air pump. Dr. Prieſtley, who now denies that water can be decompoſed, thinks that the inflammable air, thus procured, comes from the iron, and not from decompoſed water.

5. United with charcoal, but without being in the ſtate of gas, it forms, or is ſuppoſed to form, *oil*; which is always more

more or leſs fixed or volatile, according to the proportion of inflammable air or charcoal it contains. The fixed oils expreſſed from vegetables contain an exceſs of charcoal, which ſeparates when they are heated to above the heat of boiling water. The volatile or eſſential oils are formed of a more juſt proportion of charcoal and inflammable air, and are not decompoſed at the degree of heat immediately above that of boiling water; but they, in their united form, combine with the matter of heat, form a gas, and in that ſtate come over when diſtilled.

6. In the form of gas it diſſolves charcoal, phoſphorus, ſulphur, and ſeveral metals; and, united to ſulphur, it forms hepatic air, which is the impregnating matter of moſt of thoſe waters called ſulphureous.

7. It is one of the moſt combuſtible ſubſtances in nature; it obſerves the ſame laws during the time of its burning, as other combuſtible matters do, and will not burn without the contact of pure air. By itſelf it burns ſlowly, but if united with

common

common air, the burning is brisk: if mixed with double its own quantity of atmospheric air, it burns instantly with an explosion; but if it be mixed with double its own weight of pure air, the explosion is much greater. When the inflammable air is perfectly pure, it burns with a flame more or less red; but when it is mixed with foreign matter, it is sometimes blue or yellow.

Such are the five substances which the supporters of the new chymical theory call active elementary principles, from whose various combinations with one another, and with the other substances, which they likewise at present reckon to be simple, they suppose all compound bodies to be formed.

Having taken notice of these three airs, the *pure*, the *impure*, and *inflammable*, which the academicians reckon to be simple or primitive bodies, I shall, before leaving this subject of airs, just name the principal of those which have engaged the attention of modern chymists.

At present chymists call all substances reduced

reduced to the ſtate of permanent aëri-form fluids or vapour by the name of airs; and it is ſuſpected that there is no body whatever that may not be reduced to this ſtate by means of heat; though the means of effecting this change with ſome has not as yet been diſcovered. The diamond, which was long reckoned to be the hardeſt and moſt compact body known, on which heat was ſuppoſed to make no impreſſion, has at laſt, by the application of the focus of the burning glaſs, been found to be one of the moſt volatile, ſubtile ſubſtances in nature, capable of being reſolved into an inviſible vapour, which penetrates through glaſs and porcelain, and leaves not a remnant behind.

The French at preſent generally confine the name of air, either to that of the atmoſphere, or to the *pure* and *impure airs*, of which it is formed, and call by the name of gaſes all other aërial fluids. The Engliſh often call by the name of air every aërial fluid or vapour.

Many believe, and I think not without reaſon, that there is but one primitive air, which

which is that commonly called pure or dephlogisticated; and that all the other aëriform fluids are this air combined with foreign matter: but this is only mere conjecture unsupported by experiment.

The following are the airs principally taken notice of, which are alleged to be compounded as here mentioned:

1. *Atmospheric air*, compounded of pure and impure airs.

2. *Pure air*, called likewise *vital* and *dephlogisticated;* and by the French, *oxigene*.

3. *Impure air*, called likewise *phlogisticated* and *mephitic*; and by the French, *azote*.

4. *Inflammable air*, called by the French *hydrogene*.

5. *Aërial acid*, called likewise *fixed air* and *acid air*, formed of charcoal and pure air.

6. *Hepatic air*, a solution of sulphur in inflammable air, in the state of gas.

7. *Acid vitriolic air*, commonly called *volatile vitriolic acid*, which by Monsieur Lavoisier's account is sulphur, with too

ſmall a proportion of pure air, to form it into vitriolic or ſulphureous acid.

8. *Nitrous air*, which forms the baſis of the nitrous acid, nearly, if not entirely, the ſame as *impure air*.

9. *Acid nitrous air*, which is the nitrous acid in form of a gas or vapour.

10. *Acid marine air*, which is the marine acid in a ſtate of vapour or gas.

11. *Acid marine air, with an exceſs of pure air*, which is the marine acid in a ſtate of vapour ſurcharged with pure air, by being diſtilled along with manganeſe, or other ſubſtances abounding with pure air.

12. *Acid vegetable air*, the vegetable raiſed into the ſtate of vapour by heat.

13. *Acid animal air*, animal acid in a ſtate of vapour.

14. *Phoſphoric air*, phoſphorus diſſolved in inflammable gas.

15. *Volatile alkaline air*, the volatile alkali in an aëriform ſtate.

Beſides theſe, a vaſt variety of other bodies reduced to the ſtate of vapour, have been called by the name of airs.

Mr.

Mr. Kirwan has given the following table of the ſpecific gravities of a number of theſe airs. He ſays that the ſpecific gravity of the air of the atmoſphere to water, which has commonly been reckoned as 1 to 850, is as 1 to 816.

And that 100 cubic inches of each weighs as follows:

100 cub. inches		Grains.	Propor. to com. air.
Of common air	weighs	31	1000
Of pure air		34	1103
Of impure air		30.535	985
Of nitrous air		37	1197
Of vitriolic		70.215	2265
Of fixed		46.5	1500
Of hepatic		34.286	1106
Of alkaline		18.16	600
Of inflammable		2.613	84.3

CLASS II.

THE next claſs of ſubſtances, which the French academicians conſider in their new Nomenclature, are what they call the *acidifiable baſes*, and alſo *radicals*, or radical principles of acids: under it they comprehend all ſuch bodies as, when joined with *pure air* (the true acidifying principle), form an acid.

Theſe are many in number, ſome of which are known, others hitherto unknown.

M. Lavoiſier, in his table of ſimple or elementary bodies, ſets down 6 of them, 3 of which are known, 3 unknown, under the deſcription of bodies which are not metallic oxidables and acidifiable. Theſe are,

Three known.	*Three unknown.*
1. Charcoal.	1. Baſe of muriatic acid.
2. Sulphur.	2. ——of fluor.
3. Phoſphorus.	3. ——of borax.

Beſides theſe, there are probably in nature a great many ſimple acidifiable baſes, of which hitherto we have no knowledge.

To theſe perhaps might be added all metallic ſubſtances which can be reduced to the ſtate of calces or oxides; but chymiſts as yet have only been able to bring three of them to the ſtate of acids, viz. *arſenic*, *molybdene*, and *tungſtene*; therefore they have put the metallic ſubſtances into a claſs by themſelves.

The

The acidifiable baſes of the vegetable and animal kingdoms are all compounds, and therefore are omitted here, but ſhall be conſidered in their proper place.

The authors of the new Nomenclature obſerve, that theſe radicals, or acidifiable baſes, as they call them, when managed differently, take up different quantities of the oxigene or pure air, by which means the acid produced has different qualities; and the neutral ſalts, formed with them and other ſubſtances, differ from each other likewiſe: thus they tell us that the acid produced from ſulphur, when fully ſaturated with pure air, is the common *acid of ſulphur*, called oil of vitriol, and vitriolic acid.

That the acid produced when the ſulphur is not fully ſaturated, is what is commonly called the *volatile vitriolic acid.*

That the neutral ſalts produced from theſe two acids, differently ſaturated with *pure air*, differ from each other.

And that the ſame holds good with reſpect to the acid of nitre and ſeveral other acids.

In order to diſtinguiſh theſe acids from each other in different ſtates of oxigenation, and the ſalts produced from each of them, the academicians propoſe, for the ſake of regularity and brevity, to add a different termination to the names which they have given to theſe acids and ſalts.

Thus they propoſe naming the acid which now goes by the name of vitriolic or ſulphureous acid, *acide ſulfurique*, or *ſulphuric acid.*

And the volatile vitriolic acid, or acid not completely ſaturated with pure air, *acide ſulfureux*, or *ſulphureous acid.*

And that every neutral ſalt made with the *acide ſulfurique*, ſhould be called a *ſulfate*.

And every one made with the *acide ſulfureux*, a *ſulfite.*

And every other combination of ſulphur with other bodies, and not carried to the ſtate of an acid, ſhould go by the name of a *ſulfure*, or a ſulphur.

Thus the table of ſulphur and its preparations may run thus:

SULPHUR,

Completely oxigenated, or ſaturated with pure air—*acide ſulſurique, ſulphuric acid.*

Salts prepared with this acid, called *ſulfates.*

Sulſate or *ſulphate* of vegetable alkali	—	Tartarus vitriolatus.
———————--of foſſil alkali	—	Glauber ſalt.
———————of volatile alkali	—	Vitriolic ammoniac.

Salts with the acide ſulfureux, or ſulphureous acid, called *ſulfites.*

Sulfite or *ſulphite* of vegetable alkali	known by no diſtinct names.
——————— of foſſil alkali	
——————— of volatile alkali	

The combinations of ſulphur with other ſubſtances, they expreſs thus:

Sulphur of antimony—to expreſs antimony combined with ſulphur or common antimony.

Alkaline ſulphur—liver of ſulphur, commonly called hepar ſulphuris.

Ammoniacal ſulphur—liver of ſulphur prepared with volatile alkali.

Sulphur of copper—to expreſs pyrites of Scopper

Sulphur of iron—pyrites of iron, *&c. &c.*

In this manner they have laid down tables of the different acidifiable bases or radicals; of the different degrees of their saturation with pure air; and of their combinations with other bodies, in their Dictionary for the new Nomenclature, inserted in their Methode de Nomenclature Chimique; and in the tables added to M. Fourcroy's third edition of his Leçons Chimiques.

CLASS III.

THE authors of the new Nomenclature make this class to contain all metallic substances. We know but little of their analysis or component parts; and therefore M. Lavoisier, and the other academicians, rank them amongst the simple bodies; excepting gold, and sometimes silver, they are seldom found in a metallic state in the bowels of the earth, but commonly more or less saturated with pure air, or combined with sulphur, arsenic, or some acid, from which they are separated by art.

The

The number of metallic ſubſtances known amounts to ſeventeen; though it is not at all improbable but that many more exiſt in nature, which hereafter may be diſcovered.

The metallic ſubſtances known are,

1. Gold.	7. Iron.	13. Molybdene.
2. Platina.	8. Antimony.	14. Nickel.
3. Silver.	9. Arſenic.	15. Quickſilver.
4. Copper.	10. Biſmuth.	16. Tungſtene.
5. Lead.	11. Cobalt.	17. Zinc.
6. Tin.	12. Mangaueſe.	

All theſe metallic ſubſtances may be made to unite with pure air, but they do not all produce acids. Three only can be reduced to this ſtate, *viz.* 1. Arſenic, 2. Molybdene, 3. And Tungſtene: all the reſt only abſorb a certain quantity of pure air (or oxigene), which deprives them of their metallic properties, and reduces them to the ſtate of calces, or of *oxides*, as the French academicians now call them; by which they mean to ſignify a body empregnated with a certain quantity of the oxigene, but not ſufficient to bring it to the ſtate of acid.

M. Lavoisier lays it down as a rule, that no metallic substance can be dissolved in an acid, till it be brought to the state of an oxide, by being united some how or other with *pure air* (the oxigene), whether that come from the decomposition of the acid, or of the water employed.

That all solutions of pure metals are accompanied with an effervescence, which is occasioned by a separation of gas, either from the decomposition of water, or of an acid. When the solution is brought about by the *nitric acid*, the gas is of the nitrous kind; when by the *sulphuric acid*, the gas is either volatile sulphureous acid (sulphureous acid), or inflammable gas, according as it may be separated from the acid or the water.

That if a metallic substance, which is intended to be dissolved, has been previously reduced to the state of an oxide, by having been calcined, or precipitated from a metallic solution, it dissolves without occasioning any effervescence.

That all metallic substances, soluble in oxigenated muriatic acid, dissolve in it without

without effervefcence ; the metal in that cafe taking up the fuperfluous pure air, by which means a metallic oxide and a common muriatic acid are formed at the fame time ; and the gas, which would have been feparated from the oxigenated muriatic acid, finds more water than is neceffary to keep it in a liquid form, and to prevent its appearing in th form of gas.

That metals which have little affinity with *pure air*, and do not act with fufficient force to decompofe either the acid or the water, are abfolutely infoluble in that ftate; and it is for this reafon that *filver*, *quickfilver*, and *lead* are not foluble in the muriatic acid, in their metallic form ; but if they be previoufly reduced to the ftate of an oxide, they are eafily foluble, and diffolve without effervefcence.

From thefe circumftances he concludes that *pure air* is the means of union between metals and acids, and that probably all fubftances, which have a great affinity with acids, contain pure air.

CLASS

CLASS IV.

THIS clafs comprehends the different forts of earth, which are reckoned to be five in number:

1. The vitrefcible, fuch as flint, &c.
2. Earth of alum.
3. Heavy earth or bafe of ponderous fpath.
4. Calcareous earth in a ftate of lime.
5. Magnefia.

None of thofe have hitherto been decompofed, and therefore they have been ranked amongft the fimple bodies. Four of them, viz. *aluminous earth*, *heavy earth*, *chalk*, and *magnefia*, are foluble in acids, and therefore are adopted into the clafs of acidifiable bafes. The vitrefcible earths are ufed for making glafs, and in other manufactures, but not as medicines.

CLASS V.

THE authors of the new Nomenclature have made a feparate clafs of the three alkalies; though M. Lavoifier, from knowing

ing that the volatile alkali had already been compoſed and decompoſed, and from ſuſpecting that the two firſt alkalies were likewiſe compounds, has omitted them in the liſt of bodies which he calls *ſimple.*

The academicians, in their new Nomenclature, have, and I think very improperly, changed the names of theſe ſalts; which for above theſe thirty years paſt have been known by the names

1. *Of vegetable alkali.*
2. *— foſſil alkali.*
3. *— volatile alkali.*

Which very clearly pointed out the nature of theſe ſubſtances, and the claſſes to which they belonged. The reaſon which they give is, that the names were too long, and that chymiſts had ſtill increaſed the length of the names, by adding the word *purum* to each of them, and the word *fixum* to the vegetable and the foſſil: but theſe epithets are certainly ſuperfluous; for where the properties of any ſalt are treated of, the ſalt uſed is always ſuppoſed to be pure; and the term *volatile* affixed to the volatile alkali, makes the diſtinction between it

and

and the two fixed ſo clear, that it was quite ſuperfluous to add the word *fixum* to the other two.

The names which they have choſen have no reference to the ſubſtances themſelves: they have called the vegetable alkali, *potaſſinum*; the foſſil, *natrum*; and the volatile, *ammoniacum*.

Potaſſinum is a barbarous Latin word, invented by themſelves, or rather an Engliſh or German word, to which they have affixed a Latin termination, and which ſignifies the aſhes of vegetables which have been burnt in an iron pot: theſe aſhes are commonly ſold in London under the name of pot-aſhes, and are often what their name implies, the aſhes of the plants, and not the pure ſalts ſeparated from them.

The *foſſil alkali* they term *natrum*, and at the ſame time let us know that they mean by it the ſalt got from the aſhes of the kali plant, which grows in Spain near to Alicant *(les cryſtaux de ſoude)*: but this is not the natrum or natron of the ancients; for that was the foſſil alkali, found either on the ſurface or in the bowels

of

of the earth, in Egypt, in Tripoli *, and other countries; which is unmixed with the vegetable alkali, as the aſhes of the kali plant always are, which renders them more deliqueſcent, and gives them other properties different from thoſe of the pure foſſil alkali; chymiſts hitherto not having been able to ſeparate theſe ſalts from each other.

The *volatile alkali* they have called *ammoniacum*, a term which is likely to create

* In vol. lxi. of the Philoſophical Tranſactions, art. 52, page 567, for the year 1771, I have given a ſhort ſketch of the hiſtory of the natron, or native foſſil alkali, and deſcribed a particular pure cryſtalliſed ſpecies of it, which is found in the country of Tripoli in Barbary, and goes there by the name of trona. It is the pureſt ſalt of this kind which I have ever ſeen, and has no mixture of the vegetable alkali in it. Moſt of the neutral ſalts which I made with it, and different vegetable acids, of which I have given an account in vol. lvii. of Philoſophical Tranſactions for the year 1767, ſtill remain entire, without running per deliquium, though kept in open cups in a drawer. It is certainly the pureſt and beſt foſſil alkali yet known, and the fitteſt for chymical experiments, where a pure ſalt of this kind is wanted.

confuſion;

confusion; the word ammoniacum having been originally applied to the crude *sal ammoniacum*, and to the *gummi ammoniacum*. And after all, what does this word ammoniacum signify, and from whence does it derive its origin? In the desarts of Lybia, west of the north part of Egypt, is a district, formerly called Ammonia, in which stood a temple dedicated to Jupiter, called, from its situation, the Temple of Jupiter Ammon, or Hammon: from this country both the sal ammoniac, and the gum ammoniac were brought to Europe; so that ammoniacum is the salt, either of the country of Ammonia, or of the temple of Jupiter Ammon, where some authors have alleged it was prepared by the priests: hence, if the word ammoniacum was to have been used at all, it ought to have been given to the crude sal ammoniac, and not to the volatile.

After considering the different names which modern chymists, for the sake of novelty, have given to the three alkaline salts, I cannot help thinking that none of them

them are ſo proper as thoſe which have been lately in common uſe ; as they expreſs clearly the nature of each of theſe ſalts, and diſtinguiſh them more ſcientifically from each other, than any other names which have hitherto been adopted*.

* If it be abſolutely neceſſary, as the academicians have hinted, to deſign each of theſe ſalts by one word, in order to avoid confuſion, the abbreviations propoſed by a young gentleman, Mr. Chriſtie, may be adopted, after having given their names at full length, and having obſerved that the terms uſed were abbreviations of theſe names.

The abbreviations which he propoſes are theſe:

For vegetable alkali	to write	Ve-kali.
For foſſil alkali		Fos-kali.
For volatile alkali		Vol-kali.

Which are ſhorter than either the words potaſſinum or ammoniacum, adopted by the academicians; and their propriety appears evident by the following table of neutral ſalts.

TABLE *of* NEUTRAL SALTS.

Ve-kali	Vitriolatum. Nitratum. Muriatum, &c.
Fos-kali	Vitriolatum. Nitratum. Muriatum, &c.
Vol-kali	Vitriolatum. Nitratum. Muriatum, &c.

OF

PART II.

Of the Analyſis of Vegetable and Animal Subſtances.

HAVING conſidered theſe things, I come next to take a view of the ſubſtances belonging to the vegetable and animal kingdoms; but as all of them are compound bodies, I think it right, before treating of each of them ſeparately, to make a few general remarks relative to their component parts, and the changes they undergo by being ſubjected to chymical operations; in doing which, I ſhall purſue the following plan:

1ſt, I ſhall mention the different groſs matters which theſe bodies yield in their natural ſtate, or when ſubjected to ſuch proceſſes as are not likely to form new combinations, or remarkable changes, in their conſtituent parts.

2dly, I ſhall next take notice of the different changes which theſe bodies undergo, and the different groſs matters which they yield, when ſubjected to the force of fire in cloſe veſſels, or when they are burnt in the open air.

3dly, I ſhall then mention the particular ſubtile principles which modern chymiſts ſuppoſe theſe ſubſtances to be compoſed of, and the different changes and combinations which they ſuppoſe to take place, in diſtilling and burning vegetable and animal ſubſtances.

4thly, I ſhall conſider the different changes which are produced on them by putrefaction.

5thly, And laſtly, I ſhall take notice of the vinous and acetous fermentations, and of the changes which ſuch of theſe bodies undergo, as are proper ſubjects of theſe operations.

SECT. I.

OF THE CONSTITUENT PARTS OF VEGETABLE SUBSTANCES.

1. WE know, from obſervation and experiment, that vegetable ſubſtances contain, 1. fine volatile particles and particular juices, which give the peculiar taſte and ſmell to each vegetable; 2. water; 3. mucilage; 4. fæcule; 5. ſaccharine juice; 6. ſalts; 7. oils, unctuous and eſſential; 8. balſams and reſins; 9. earth; 10. and iron.

1. *Spiritus Rector.*

NEITHER the nature of the fine volatile particles which affect the noſtrils, nor of thoſe which give the taſte peculiar to each vegetable, has as yet been aſcertained with certainty; they are of too ſubtile a nature to come under the obſervation of our ſenſes: Boerhaave and many other chymiſts have given them the name of ſpiritus rector; they are extremely volatile, and would fly off immediately, were they not retained by being mixed with the fine eſſential oils or other matters. They evaporate in a great part when vegetables are dried, or expoſed to the open air, though ſome retain them longer.

In delicate flowers, this ſpiritus rector is often very volatile, and evaporates ſoon; in odoriferous woods it ſhould ſeem to be in great quantity, and to be more fixed, for many of them retain their ſmell long after they have been dried. Macquer ſuſpected, with Boerhaave, that in general it was compoſed of an inflammable ſubſtance joined to ſome ſaline matter; that in ſome plants it participated more of a ſaline nature, in others of an oily; and that in ſome caſes he ſuſpected it to be a gas of a particular nature.

2. *Water.*

ALL vegetables contain more or leſs water, it being the vehicle of all their nouriſhment,

riſhment, and one of the principal conſtituent parts of all their juices. When vegetable ſubſtances are expoſed to the open air, a great part of the water evaporates; but ſtill a quantity remains united to the other component parts, which cannot be ſeparated without the aſſiſtance of ſuch a degree of heat as decompoſes the vegetable itſelf, and, according to the new doctrine, generates a freſh quantity of water, by combining the pure and inflammable airs which are ſet looſe.

3. *Mucilage and Gum.*

THE mucilaginous or gummous part of vegetables may be obtained in ſeveral ways; by evaporating the juices of ſome plants, by bruiſing or grinding others, and then mixing them with, or boiling them in water, ſtraining the liquor and evaporating it to a proper conſiſtence. The gums, ſuch as the gum arabic, the gum of the cherry-tree, &c. are the mucilaginous parts dried by the heat of the ſun, as is proved by evaporating with a gentle heat the infuſions or ſlight decoctions of mucilaginous plants.

4. *Fæcule.*

THE juices of moſt vegetables contain a farinaceous matter, which ſerves for the nouriſhment of their organic parts, and is lodged in their leaves, their branches, their trunks, their ſeeds, and their roots; and ſome of theſe particular parts ſeem to be moſtly formed of it; ſuch as the ſeeds of many of the farinaceous and leguminous tribe, and the tuberoſe roots of others.

This farinaceous part is called the fæcule, and is got from theſe ſubſtances in different manners: by maſhing ſucculent plants, expreſſing and ſtraining their juices, and then letting the liquor ſtand to allow the fæcule to precipitate; by bruiſing dry ſubſtances, or reducing them to a flower, ſteeping or infuſing them in a ſufficient quantity of water, ſtraining the liquor, then allowing the fæcule to drop

to

to the bottom, and afterwards ſeparating it by decanting off the clear water, and throwing the remainder into a filtre, to allow the reſt of the water to drain away. M. Beccarius, and ſince him M. Fourcroy, has obſerved, that a fæcule may be got from moſt vegetables, by treating them in ſome of theſe ways; but that ſome ſubſtances yield more, others leſs. The fæcules which are moſt commonly prepared are thoſe from *wheat*, *potatoes*, *ſago*, *ſalep*, *caſſavi*, and from ſome of the *tuberoſe roots*.

Some ſubſtances yield a mucilage, a fæcule, and a ſaccharine matter, by being treated ſomewhat in this manner, of which the wheat is a remarkable inſtance. In order to obtain theſe different ſubſtances from wheat, M. Fourcroy adviſes to take ſome fine flower of wheat, to make it up into a paſte with water; to put the paſte into a colander, placed upon a large earthen pan or veſſel, which will receive any liquor which ſhall paſs through the colander; then to ſet above the colander a caſk or barrel filled with pure water, and fitted with a cock, ſo that the water, paſſing through it, ſhall fall on the paſte; to turn the cock ſo that only a very ſmall ſtream of water may paſs through it, and to let the water continue to run, while it comes off milky from the paſte; but to ſtop it from running, by turning the cock, ſo ſoon as the water is obſerved to come off clear.

On examining the water in the pan placed below the colander, M. Fourcroy ſays that the wheat-flour will be found to have ſeparated into three different ſubſtances:

1. An elaſtic, tough, glutinous matter, which may be taken up by the hand, and extended to a great length; when boiled in water it becomes hard, and when dried it becomes tranſparent and brittle: it has many of the properties of animal ſubſtances; it becomes putrid when expoſed to moiſture in the open air, ſends out an empyreumatic ſmell when burnt, and yields a volatile alkali when diſtilled in cloſe veſſels. It has been called the *glutinous* or *vegeto-animal* part of wheat.

2. At

2. At the bottom of the water is found a whitiſh grey powder called *ſtarch*, which makes up the greater part of the wheat flour: if the ſtarch be allowed to remain in the watery liquor, the liquor ferments and becomes ſour, and whitens the ſtarch. M. Fourcroy ſays that the ſtarch, conſidered chymically, is a true mucilage of a particular nature, and, when diſtilled, yields the ſame principles as vegetable mucilages: when it is burnt, a fixt vegetable alkali is got from its aſhes.

3. A ſweetiſh mucilage, which, on being diſtilled, yields the ſame principles as ſugar, and remains diſſolved in the water from which the *gluten* and *ſtarch* have been ſeparated; and may be obtained by evaporating the water: it is but in ſmall quantity, though it ſeems to be the fermenting principle in this grain.

Such are the component parts into which the flour of wheat may be ſeparated; but if, before being ſubjected to the treatment here mentioned, it be mixed with a little ſalt, and then fermented by the addition of yeaſt, or of any other ferment, and this fermentation, when raiſed, be checked by the heat of an oven, its three component parts, the *gluten*, the *ſtarch*, and the *mucilage*, unite ſo intimately, that they cannot afterwards be ſeparated by any means we as yet know; and they form a wholeſome good bread, which is ſoluble by our juices, and very proper for our food.

5. *Sugar.*

MOST vegetables contain that ſweet matter called ſugar, which modern chymiſts look upon as a ſweet eſſential ſalt. It is in ſuch ſmall quantity in moſt plants as ſcarce to be perceived; though in ſome it abounds ſo much, as to be immediately diſtinguiſhed by the taſte. It is now generally looked upon as the principle of fermentation; and all plants, whoſe juices or decoctions ferment, are ſuppoſed to contain it. All that is uſed in this country is got from the ſugar cane; in Canada a ſmall quantity is prepared from the juice of the great paple tree, called by Linnæus the *acer platanoidea*. The juices which

which contain ſugar contain likewiſe mucilage and oleaginous parts, from which it is ſeparated by repeated boiling, whilſt the ſcum, which riſes to its ſurface, is taken off, and the liquor clarified by the addition of lime-water; after which it is boiled down to a proper conſiſtence, and is further purified by the means mentioned in treating of ſugar.

6. *Salts.*

THE ſalts got from vegetables are commonly divided into two ſorts: 1. Thoſe obtained either from the juices of plants, or from their infuſions in water, without any proceſs having been made uſe of which was likely to generate ſuch ſalts by forming new combinations. Theſe are ſuppoſed to have exiſted naturally in the plant, and have been called by the name of eſſential. 2. Thoſe which are found in the aſhes of plants which have been burnt in the open air, are commonly believed to have been generated by the force of fire uniting the principles fit for forming

ing them, which existed in the original plant.

Salts are obtained from the juices of plants, and from their infusions in water, by purifying the juices or infusions, by filtering them through paper, and by the other means recommended, in treating of vegetable acids ; and then by evaporating the liquors to a proper consistence, and allowing them afterwards to remain in a cool place till the salts crystallize.

It has not hitherto been determined what are the salts which vegetables contain in their natural state : formerly those only were called essential salts, in which an acid was prevalent, and which were got from acescent and acid vegetable substances, by purifying and evaporating their juices to the consistence of a thick syrup, and setting them in a cool place for some time, to allow the salts to crystallize. These salts generally contain a portion of earth, or of an alkali, and may be considered as neutral salts with a superabundance of acid. These are esteemed to be the essential salts proper to vegetables; the other

other ſalts (now called likewiſe eſſential) they have in common with ſubſtances belonging to the other kingdoms.

The following ſalts are alleged to have been got from different vegetables:

1. and 2. The *mild vegetable* and the *mild foſſil alkalies,* which were formerly, and ſtill are by many, believed to be the creatures of the fire. M. Metheric, in the ſecond edition of his *Eſſais ſur Differens Airs*, tom. ii. p. 308, tells us, that Monſ. Lorgna had got the foſſil alkali, by ſimply infuſing the kali plant, after it had been bruiſed, in boiling water; and M. Fourcroy, in his Leçons Elémentaires, tom. ii. p. 431, ſays, that both M. Marggraf and M. Rouelle, jun. had got both the vegetable and foſſil alkalies by infuſing plants in vinegar; however, notwithſtanding this evidence, ſome chymiſts of eminence ſtill doubt the truth of theſe facts. Future experience muſt determine this queſtion.

M. Fourcroy ſays that

3. *Tartarus vitriolatus* has been got from milfoil, old borage, &c.; 4. *Glauber ſalt* from tamariſk; 5. *Nitre* from borage,

borage, turnsole, tobacco, &c.; 6. *Digestive salt* from submarine plants; 7. *Sea salt* from wormwood, dwarf elder, and marine plants; 8. *Selenites* from rhubarb.

Boerhaave and Macquer have both asserted that some of the alkalescent plants contained a volatile alkali in their natural state; but Cartheuser, Vogel, and some late chymists have denied this fact.

When vegetables are burnt in the open air till reduced to a white ash, the ashes afford, on being lixiviated, salts of different kinds, principally the *fixt alkalies:* the generality of plants yield only the vegetable alkali, the marine plants both the fossil and vegetable; but they are often found mixed with neutral salts of different kinds, with *tartarus vitriolatus*, *Glauber salt*, *sal digestivus Sylvii*, *sea salt*, and *selenites*.

As so many salts have been procured from vegetables, and from their ashes, it has been doubted whether these salts were generated by the vegetative process, or whether they were absorbed from the ground by the vessels of the plants, along with the water which aſſiſts in the formation of their juices; and chymiſts are at preſent much divided in their opinions on this head. M. Fourcroy thinks that this queſtion might be determined by impregnating fields with different kinds of ſalts, planting each of them with different ſorts of vegetables; and afterwards analyſing the plants, when they had come to their maturity, to know what ſalts they contained.

7. *Oils, unctuous and eſſential.*

MOST plants contain more or leſs oil, either unctuous or eſſential, or both. The unctuous oils are commonly got by expreſſion from the ſeeds, nuts, roots, or other parts of vegetables which abound with them; the eſſential by diſtillation, as ſhall hereafter be mentioned, when theſe oils come to be conſidered.

8. *Balſams and Reſins.*

A NUMBER of plants, particularly in the warm climates, yield, by bleeding them, a thick

thick fluid matter, called a balsam, which is collected in vessels set below the wounded part, to receive it ; these balsams should seem only to be inspissated essential oils. The resins are inspissated balsams, which acquire consistence by being exposed to the open air, after they have been separated from the plants ; or they are the thicker parts of balsams which remain in the retorts when the fine oils have been drawn from them by distillation ; or the balsams inspissated by the heat of the sun in the substance, or on the surface, of the plants which afford them.

9. *Earth*, 10. *and Iron.*

WHEN all the salts have been separated from the ashes of plants burnt in the open air, by lixiviating them with water, there remains a quantity of a white insoluble matter, which has been alleged to be an earth of the argillaceous or calcareous kind ; though M. Fourcroy has suspected that it may hereafter be found to be a phosphorated calcareous earth, of the same kind

kind as is obtained from the aſhes of bones; but he ſays that hitherto he has made no experiments to ſupport the conjecture. This earthy matter, got from the aſhes of vegetables, has been found to be mixed with ſome particles of iron, which are attracted by the load-ſtone, and which ſome naturaliſts have ſuſpected to be the matter which gives colour to vegetables. M. Metherie, in his *Eſſais ſur differens Airs*, tom. i. p. 434, ſays that a very ſmall pittance, both of gold and of manganeſe, has likewiſe been diſcovered, mixed with theſe aſhes.

S E C T. II.

Of the constituent parts of Animal Substances.

ANIMAL ſubſtances are all of vegetable origin; for every animal, we know, either lives on vegetable food, from which it receives all its nouriſhment, or devours other animals which had fed upon herbs, roots, fruits, or other vegetable ſubſtances; hence

 all

all animal matter may be conſidered as vegetable, more or leſs elaborated by the animal proceſs, according to the animal which produced it.

The animal proceſs, when it is fully perfected in a full grown animal, brings all the fluids to a putreſcent ſtate; for they putrefy, when expoſed to a heat of about 60 degrees of Fahrenheit's thermometer, in a moiſt place in the open air, inſtead of fermenting or turning ſour; and therefore theſe juices muſt have undergone in the animal body ſuch changes, by the animal proceſs, as are analogous to thoſe effected by the two firſt proceſſes of fermentation, the vinous, and the acetous, and likewiſe the beginning of the third, the putreſcent: however theſe juices never become putrid in a healthy living animal, owing to the conſtant ſupply of freſh liquors, from the food the animal takes down, while in life.

Animals are compoſed of fluid and of ſolid parts. The *fluid* are the blood and the liquors ſeparated from it, *viz.* the ſaliva, the bile, the gaſtric and pancreatic juices; the mucus of the noſe, inteſtines, and joints; the fine liquors ſecreted into the cavities, and by the veſſels of the ſkin; the urine, the wax of the ear, the fat, the marrow, and other oils, &c. The ſolid parts are, the viſcera, the ſkin, the membranes, the muſcles, the bones, &c.

M. Fourcroy mentions three ſorts of viſcid juices found in animals:

1. The mucilaginous or gelatinous, which is ſofter, attracts humidity more readily, and is not ſo eaſily dried as the mucilages of vegetables: this, he ſays, is extracted from the white parts, *viz.* the ſkin, the ligaments, the perioſteum, and the cartilages.

2. The albuminous matter, which concretes and becomes opake by the application of heat, and the mixture with acids and with alcohol: of this kind is the whites of eggs, the caſeous part of milk, the ſerum of the blood.

3. And the concreſcible fibrous matter, which goes into a kind of membrane by cold; it is analogous to the gluten of vegetables, but of a much more tenacious

nature, and of it the muscles and organs of motion are composed.

The fixt oils of animal substances differ from those of vegetables, in being almost always found more or less in a concrete state; and in some instances, such as that of the spermaceti, are capable of becoming dry, and assuming somewhat of a crystalline form. Volatile oils are rarely to be met with in the animal kingdom, though a pittance of such oils is to be got from some particular substances, such as from musk, castor, &c.

The saline matters, which animal substances afford, are some of them of the same nature as what are got from vegetables, such as sea salt, &c. and as they contain more impure air than alkalescent vegetables, they yield by distillation a greater quantity of volatile alkali. The urine, evaporated, yields the sal mirabile perlatum, called likewise fusible salt, besides other salts of a particular nature; and the animal, as well as the vegetable, afford acids of a particular kind: of these M. Lavoisier reckons six:

1. The

1. The acid of milk.
2. ———— of ſugar of milk.
3. ———— of the ſilk worm.
4. ———— of ants.
5. ———— of fat.
6. The Pruſſian acid: to which may be added the acid of phoſphorus.

The bones, or hard ſolid parts of animals, on being analyſed, afford a gelatinous matter and other animal fluids; and their ſolid parts have been found to be compoſed of a particular kind of ſalt, formed of calcareous earth, and the phoſphoric acid.

The blood, from which all the other liquors are ſeparated, is made up of three different parts; a watery ſerum, a coagulable lymph, and red globules. When it comes from a vein of a living animal, it ſeparates into two parts, a watery, tranſparent, yellowiſh liquor, or ſerum; and a red coagulated part, which is called craſſamentum; part of the coagulable lymph remaining diſſolved in the ſerum, and the reſt of it ſerving to form the craſſamentum along with the red part of the blood.

Water mixes readily with the blood as it comes from a vein, and prevents, for some time, its separating into serum and crassamentum; and it dissolves all the secreted liquors of the animal body, except those of an oily nature, such as the fat, and the oil and marrow of the bones; and with the assistance of heat extracts most of the juices, the watery, the mucous, the glutinous, the saline, &c. from the solid parts of animal bodies.

Blood left exposed to a heat which raises Fahrenheit's thermometer to between 50 and 60 degrees, dissolves into a thin fetid liquor; first the serous, and then the grumous part; and if suffered to remain long enough, its fluid parts evaporate, leaving behind but a small quantity of residuum: when it is once dissolved by putrefaction, it cannot again be coagulated.

It is dissolved or rendered more fluid, by mixing with it alkaline salts or nitre. It is coagulated by alcohol, and by mineral acids. If thrown into boiling water, the lymph coagulates into a firm substance like the

the white of an egg, and becomes inſoluble in water.

If blood be put into an evaporating glaſs, and expoſed to a degree of heat which raiſes Fahrenheit's thermometer to about 140 degrees, its fluid parts evaporate, it becomes dry, and is reduced to about one ſeventh part of its original weight: if this ſolid part be put in an open fire, it burns, leaving but a ſmall quantity of ſolid matter behind; which, on examination, has been found to contain a ſmall quantity of earth, a ſalt compoſed of ſea ſalt and natron, and ſome particles of iron, which are attracted by the loadſtone, and alleged to give the blood its red colour.

SECT. III.

OF THE PRINCIPLES OF VEGETABLE AND OF ANIMAL SUBSTANCES.

HAVING mentioned the different matters which vegetable and animal ſubſtances produce in their natural ſtate, I ſhall next take notice of the principles of which modern chymiſts allege their component parts are formed.

M. Lavoisier ſays that all vegetable ſubſtances contain three principles, without which they cannot exiſt; viz. 1. *pure air*; 2. *inflammable air*; 3. *charcoal:* that ſome particular plants contain others beſides: the cruciform, or thoſe called alkaleſcent, containing likewiſe *impure (mephitic) air* and *phoſphorus*.

And that animal ſubſtances contain *pure*, *impure* and *inflammable airs*, *charcoal*, and *phoſphorus*, the ſame as the alkaleſcent vegetables; but they abound more with impure and inflammable airs, and hence afford more oil, and more volatile alkali when diſtilled.

M. Metherie alleges that common vegetables contain, beſides the principles mentioned by Lavoiſier, an *acid air*; and that the alkaleſcent plants, as well as animal ſubſtances, afford an *hepatic air* by putrefaction.

1. The fine volatile principle, called *ſpiritus rector*, which gives ſmell, &c. to aromatic vegetables, has not hitherto been examined,

examined, it being of too ſubtile a nature to be confined in veſſels.

2. *Oils.*—M. Lavoiſier alleges that oils are formed of charcoal and inflammable air, without its being reduced to the ſtate of a gas, by means of the matter of heat (calorique); and that the oils thus formed are more or leſs volatile, according to the proportions of charcoal, and of inflammable air they contain; the *fixt* or *unctuous* oils containing an exceſs of *charcoal*, which ſeparates when they are expoſed to a degree of heat above that of boiling water; the *eſſential* contain a greater proportion of inflammable air, and not being decompoſed by a degree of heat immediately above that of boiling water, riſe in form of gas, and coming over into the receiver, along with the aqueous vapour, there again unite in the form of oil. He ſays that the fixt or unctuous oils contain about ſeventy-nine parts of charcoal, and twenty-one of inflammable air; and that thoſe which appear in a ſolid form, ſuch as the bees-wax, probably contain a greater proportion of pure air than the fluid ones of the ſame

ſame claſs; and that all of them, when burnt in pure air, are converted into water and aërial acid.

3 and 4. The *balſams* and *reſins* were originally eſſential oils, and contain nearly the ſame principles: they acquire ſolidity by abſorbing a quantity of pure air, while part of their inflammable air evaporates.

5, 6, and 7. *Sugar*, *gums*, and *ſtarch*, M. Lavoiſier places in the claſs of oxides; and alleges that, in their formation, the inflammable air and charcoal unite to form a baſis, which, combined with more or leſs pure air, forms them into oxides; and that, by combining an additional quantity of pure air, they may be reduced to the ſtate of vegetable acids. He ſays they differ only from one another, in the proportion of the different principles which each of them contains.

8. *Salts*.—M. Lavoiſier and others have of late publiſhed an account of a number of experiments, to prove that pure air was the univerſal principle of acidity; and that this, combined with different ſubſtances, which

which they have called the baſes, conſtitutes the different ſorts of acids.—Thus

Pure air with *ſulphur* forms the *ſulphureous* or *vitriolic acid*; with impure (mephitic) air, *nitrous acid*; with an *unknown baſis*, *muriatic acid*; with *charcoal*, *aërial acid*; with *inflammable air* and *charcoal*, and ſometimes with the addition of *phoſphorus* and *impure air*, it forms the different vegetable acids; with a baſis compounded of *inflammable* and *impure airs*, *charcoal* and *phoſphorus*, it forms the different acids of the animal kingdom.

The true nature of the fixt alkaline ſalts is not hitherto known. M. Fourcroy and M. Lavoiſier both acknowledge their ignorance of their compoſition; though M. Metherie aſſerts that they are made up of *pure* and *impure airs*, *inflammable air*, water and matter of heat, which he calls *cauſticon*; and that the *volatile alkali* only differs from the *two fixt*, in containing more inflammable air.

The volatile alkali has been proved, by the experiments of Monſ. Bertholet and Dr.

Dr. Auſtin, to be a compound of impure and inflammable airs.

The neutral ſalts of courſe contain the principles of their component acids and alkalies, except ſuch as may be diſlodged by their union with one another.

9. and 10. Pure *earth* and *iron* are looked upon as primitive ſubſtances, having never hitherto been decompoſed.

Animal ſubſtances are only the vegetable more elaborated in the veſſels of animals by the proceſſes they there underwent. When they have been completely animaliſed, M. Lavoisier ſays they are made up of *pure*, *impure*, and *inflammable airs*, *charcoal* and *phoſphorus*; to theſe we may add earth, and a pittance of iron, which are got from the aſhes remaining after they have been burnt; and a very ſmall quantity of ſulphur, for they yield an hepatic air, on being putrefied.

SECT.

SECT. V.

OF THE CHYMICAL ANALYSIS OF VEGETABLE AND OF ANIMAL SUBSTANCES.

HAVING premiſed theſe few things relative to the component principles of vegetable and animal ſubſtances, I ſhall next take a view of the effects produced by ſubjecting them to a chymical analyſis, as it was formerly called, that is, by diſtilling them in cloſe veſſels; the method which chymiſts formerly employed for the diſcovery of their conſtituent parts; believing that the different matters, obtained in this way, were the ſame as thoſe which ſubſiſted in the ſubſtances which they diſtilled.

All the principles of which vegetable and animal ſubſtances are compoſed, remain in equilibrium with each other, while they continue in a ſound or healthy ſtate, in the degree of heat in which they naturally exiſt or live; but when theſe ſubſtances are ſubjected to a degree of heat conſiderably

considerably above that of the natural temperature of the atmosphere, or are set to ferment, or to putrefy, a decomposition of their component principles takes place; and these unite, two and two together, according to the degree of affinity they have to each other, and to the degree of heat applied.

1. *Analysis of Vegetable Substances.*

WHEN vegetable or animal substances are to be distilled, the retort in which they are put ought to have a tubulated receiver fitted to it, and another receiver or bottle fixed to its tube, to receive and keep the volatile vapours or airs which separate towards the end of the distillation; otherwise these volatile fluids fly off and escape, without our having it in our power to examine them.

Most vegetable substances, except those of the alkalescent kind, when distilled in retorts, yield the following products:

As soon as they begin to be heated, there arises a watery vapour, which has the flavour of the original substance. This vapour condenses

condenses into phlegm, which has something of an acid taste, acquires a yellowish colour, and becomes more acid, as the distillation advances. After some time, a yellow-coloured empyreumatic oil begins to come over, along with the watery phlegm, which gradually becomes of a deeper colour, and thicker consistence, while the quantity of water gradually diminishes: at the time when this empyreumatic oil comes over, there arises a quantity of elastic vapour, which formerly was believed to be air; but now, since chymists have been able to preserve it in receivers, or bottles fixed to the tubes of tubulated receivers, and to examine it, it has been found either to be aërial acid, or inflammable gas, or a mixture of both.

At last, after the fire has been raised till it has made the retort red hot, and has been kept up till nothing more comes over into the receiver, upon removing the fire, and suffering the vessels to cool, there is found remaining in the retort a black mass, commonly called the caput mortuum; which, on examination, is found

to

to be made up of charcoal, a little earth, a saline matter, and a pittance of iron; and if the retort has not been kept of a red heat, for some time, before the operation has been finished, the charcoal is sometimes found mixed with a little empyreumatic oil: M. Fourcroy seems to think that it generally contains some inflammable air. If this mass which remains in the retort be burnt in an open fire, the charcoal disappears, and there remains a white ash composed of an earth, a fixt alkaline salt, and some particles of iron, which may be extracted by means of a loadstone, and sometimes a little of some neutral salt.

The changes which happen, in performing this analysis, are accounted for, by the new theory, in the following manner:

Immediately on the application of heat, almost all the fine aromatic particles, which form what is called the spiritus rector, evaporate and fly off, being too subtile to be confined in vessels; at the same time, part of the pure and of the inflammable

air

air being reduced to the ſtate of gas, and ſet in motion by the heat, unite, and come over in form of water, along with part of the natural moiſture of the plant, and ſome of its fine aromatic particles which gave it flavour and ſmell. As the heat increaſes, it ſets more and more of theſe two principles in motion, and diſengages likewiſe part of the charcoal; the effect of which is, that part of the pure air, uniting with part of the charcoal, comes over in form of aërial acid; while another part of the pure air, uniting with inflammable air, continues to come over in form of water; and at the ſame time, another part of the inflammable air, uniting with part of the diſengaged charcoal, comes over in form of oil. As the heat increaſes, more and more of the charcoal is diſengaged, and a larger proportion of it is united to the inflammable air, ſo that the oil becomes thicker as the diſtillation advances. At laſt, when the heat is raiſed ſo much as to make the retort red hot, the remaining part of the pure and inflammable airs, which were moſt intimately united with the vegetable ſubſtance, and part of the charcoal being ſet in motion, inſtead of forming water and oil as before, are forced over into the receiver in form of inflammable gas, and of aërial acid.

The charcoal being the moſt fixed principle, a great part of it remains behind in the retort, mixed with a little earth, ſome fixed ſalt, and a pittance of metallic matter; but if it be burnt in the open air, it attracts a quantity of pure air from the atmoſphere, and evaporates in form of aërial acid, leaving behind the earth, and fixed ſaline and metallic parts.

2. *Alkaleſcent Vegetables.*

THE changes produced by diſtillation on thoſe vegetables called alkaleſcent, which, beſides *pure* and *inflammable airs* and *charcoal*, contain a ſmall portion of *impure air* and of *phoſphorus*, do not differ a great deal from thoſe obſerved on analyſing other plants; owing, as Monſ. Lavoiſier obſerves, to the ſmall quantity of theſe two laſt principles, which enter into their compoſition: however, they have their effect; for, in diſtilling theſe plants, it often happens that, ſoon after the application of heat, a pittance of the *inflammable* and *impure airs* riſing in form of gas, unite and form a volatile alkali, which mixes with the watery phlegm, and afterwards, towards the end of the diſtillation, when the heat is increaſed, is formed in quantity, comes over with the empyreumatic oil, and adheres to the ſides of the receiver. The phoſphorus, M. Lavoiſier ſays, continues united with the charcoal, which gives it fixity, ſo that it does not alter the appearances produced by the diſtillation.

When the black matter, compoſed of charcoal, &c. which remains in the retort, is burned in the open air, ſcarce any fixt alkaline ſalt is to be procured from the aſhes; the principles, which form it, having gone to the formation of the volatile alkali, during the diſtillation of the plant.

3. *Analysis of Animal Substances.*

ANIMAL substances contain, M. Lavoisier says, the same principles as the alkalescent plants, but have a much greater proportion of inflammable and impure airs* in their composition, than these plants;

* M. Bertholet, and since him M. Fourcroy, look upon the bases of impure air, which they call *azote*, as one of the most distinguishing principles of animal matter; and that it exists in greater or in less quantity in every species of it. M. Fourcroy seems to think that impure air is the great agent, which, by its fixation, changes vegetable into animal matter. He says that it is easily separated from it by means of the weakest nitrous acid, and a heat which will raise the quicksilver of Fahrenheit's thermometer to 64°; and that the proportion of the azote, in animal substances, determines the quantity of volatile alkali, which they furnish by the action of the fire: for when they are deprived of all their impure air, they yield no more volatile alkali; and when all the volatile alkali has been separated from them by the force of fire, they yield no more impure air or azote.

M. Fourcroy says that the principles fit for forming the volatile alkali and the Prussian blue, are found more abundantly in the animal than in the vegetable kingdom, and sometimes in such abundance, that these two compounds plants; they yield a much greater quantity of empyreumatic oil and volatile alkali on being diſtilled; and the coal left behind in the retort, on being burned in the open air, leaves no fixed alkali mixed with the aſhes which remain.

Of Charcoal, Earth, &c. left in the Retort.

I HAVE mentioned that, when vegetable and animal ſubſtances are diſtilled in cloſe veſſels, and the heat has been gradually raiſed till it made the veſſels red hot, and kept in that ſtate till all the parts, which are capable of being volatiliſed, have come over into the receiver, there remains in the retort a quantity of matter, which, when taken out of the retort, after it is cold, is of a black colour, and, on being examined, is found to be made up of *char-*

compounds have been found ready formed in animal ſubſtances ſome time after death; and in the *Annales de Chimie*, tom. i. p. 65, he mentions the caſe of a woman of thirty-five years of age, who was a patient in the Hotel Dieu, who was reduced to a very low ſtate, and whoſe blood tinged linen of a blue colour, and was in a diſſolved ſtate.

coal, an *earth*, a *ſaline matter*, and ſome few *metallic particles*. The quantity of this black matter is always more or leſs in proportion to the ſolidity of the ſubſtance which has been diſtilled, the moſt ſolid yielding the largeſt quantity; in ſome it amounts to near a third of the weight of the original ſubſtance, in others not to a ſixth.

M. Lavoiſier and ſome other modern chymiſts allege that *charcoal* is a primitive ſubſtance, at leaſt that it has not hitherto been decompoſed; that of itſelf it is of a fixed nature; but when united, by the force of fire, to pure air, it forms aërial acid; and with inflammable air, oil: that in animal and vegetable ſubſtances it aſſiſts in forming the ſolid parts; and that the vegetative and animal proceſſes produce effects ſomewhat ſimilar to thoſe of heat in the veſſels of theſe organic bodies; and unite part of it, in them, with *pure* and *inflammable airs*, for the formation of acids, and oils in vegetables; and of fat, oil, mucus, and other juices in animals.

On the contrary, M. Metherie, in the new

new edition of his *Eſſai Analytique*, publiſhed A. D. 1788, and other chymiſts, aſſert that charcoal is not a ſimple, but a compound ſubſtance, made up of *pure*, *impure*, *inflammable*, and *acid airs*; and affirm that they have extracted theſe matters from it; and that the charcoal of animal ſubſtances contains likewiſe a quantity of phoſphoric acid.

This account of charcoal, given by M. Metherie, is ſo very different from that given by M. Lavoiſier, that it is not eaſy to know what to think of it; it requires a number of accurate experiments to be made by able artiſts, to determine which of them is in the right.

The *earth* of bones and other animal ſubſtances which is left after the *caput mortuum* has been burned in the open air, is now known to be of the calcareous kind, but ſo intimately united with the phoſphoric acid, that it may be looked upon as a phoſphoric ſelenites; and M. Fourcroy ſuſpects that the earth of plants will be found to be of the ſame nature.

The fixed and the neutral ſalts, and likewiſe the metallic matters found in the aſhes of the *caput mortuum*, have been already conſidered; and therefore I ſhall ſay no more about them at preſent.

SECT. VI.

OF COMBUSTION, OR THE BURNING OF ANIMAL AND VEGETABLE SUBSTANCES IN THE OPEN AIR.

I HAVE already obſerved frequently that the fire and the effects it produces are every day preſented to our eyes; and although the ableſt philoſophers and chymiſts have in all ages employed their time in inveſtigating its nature, yet they had eſtabliſhed nothing certain; that all they had ſaid was only mere conjecture and hypotheſis; and that mankind remain as ignorant about its true nature, as they were a thouſand years ago: nor is it yet determined what fire is, or what are its real properties; for chymiſts are even at this day divided in their opinions whether light and heat be only properties of fire, or diſtinct

diſtinct bodies; and the different diviſions they have made of heat, matter of heat, and of light, phlogiſton, cauſticon, and calorique, &c. are only a play of words, to fill up blanks in the different theories and ſyſtems they have formed.

From the obſervation of the effects of fire which daily preſent themſelves to our view, it appears that all animal and vegetable, and likewiſe many mineral ſubſtances contain a quantity of matter which is readily acted upon, and ſet in motion by that active principle called fire, when ſubjected to its influence under certain circumſtances; and that even the ſmalleſt particle of fire, when once it is ſet at liberty, is capable of ſetting in motion all the matter, capable of feeding it, with which it comes in contact, and of ſpreading its influence all around with the greateſt rapidity; for the ſmalleſt ſpark which comes from a plate of iron ſtruck with a flint, if properly managed, is capable of ſetting on fire and deſtroying, in a very ſhort ſpace of time, the largeſt ſhips, houſes, and towns built of combuſtible matter.

It

It has long been obſerved that no body would burn without being in contact with air; and the experiments of late chymiſts have aſcertained that this air muſt contain *pure air;* and that the combuſtion is always more or leſs rapid in proportion to the purity of the air in which the body is placed, and to the quantity of pure air which is ſupplied during the time of the conflagration: for if a combuſtible body be placed under the receiver of an air pump, from which the air is extracted, it will not burn on the application of fire; but if the receiver be filled with pure air, it will burn in it, till all the pure air is exhauſted, or decompoſed, after which it will burn no longer: and if a combuſtible body be ſet in a place where it is expoſed to a briſk current of pure air, it will burn with the greateſt rapidity till all the combuſtible matter is either deſtroyed or evaporated, or ſo decompoſed as to be no longer capable of burning.

Hence we ſee the reaſon why bodies put into retorts, or other cloſe veſſels, to which the air has no acceſs, do not take

fire,

fire, or burſt out into flame, but are only decompoſed when expoſed even to a heat, which renders the veſſels in which they are contained red hot; and why the ſame bodies, on being expoſed to a current of pure air, burn briſkly, and are reduced to aſhes when fire is applied to them.

From all the experiments lately made it appears that pure air is one of the great agents for feeding or keeping up flame.

M. Lavoiſier, in his *Traité Elémentaire de Chimie*, p. 478, &c. obſerves, that combuſtion is no other thing than the decompoſition of oxigenous gas, effected by a combuſtible body, where the oxigene or pure air which formed the baſis of the gas is abſorbed; while the matter of heat (or calorique) and light are diſengaged, and ſet at liberty; and that, to bring this combuſtion about, it is neceſſary that the baſis of the oxigenous gas, that is the pure air, have more affinity with the combuſtible body than it has with the matter of heat, and be abſorbed by it; and that ſome heated body be brought near to break the equilibrium, and make the firſt impreſ-

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ſion, ſo as to ſet the whole in motion: for no combuſtion can take place while every thing remains in equilibrio, in the temperature in which we live; an additional quantity of heat muſt be at firſt applied, though the matter of heat, afterwards let looſe, by the decompoſition of the oxigenous gas, is ſufficient to keep up the combuſtion till the combuſtible body is fully ſaturated, and no longer capable of abſorbing pure air or oxigene.

He ſays that a great part of the appearances obſerved in diſtilling vegetable ſubſtances in cloſe veſſels, are to be met with in burning them in the open air; but that the preſence of atmoſpheric air introduces three new ingredients into the operation, which are *pure* and *impure airs*, and the matter of heat (the *calorique)*; two of which at leaſt occaſion conſiderable changes in the reſult of this proceſs. He alleges that the inflammable air of the vegetable, or that which comes from the decompoſition of water, on being driven off in form of gas by the force of fire, flames immediately on coming in contact with the air, and forms water again, by uniting with the pure air of the atmoſphere, and that the matter of heat (le calorique) of the two gaſes which become free, at leaſt in greater part, produces flame: that when all the inflammable air has been driven off, burned, and reduced to water, the charcoal which remains now burns, but without flame, and eſcapes under the form of aërial acid, carrying with it a portion of the matter of heat, which had reduced it to the ſtate of a gas. The ſurplus of the matter of heat (le calorique) being ſet at liberty, eſcapes, and produces the heat and light which one obſerves in the burning of charcoal.

Every vegetable, he ſays, is in this manner reduced to water and aërial acid; and there remains only a ſmall portion of a grey-coloured matter, known by the name of aſhes, which contains the only true fixed principles, which enter into the compoſition of vegetables.

SECT.

SECT. VII.

Of the Analysis of Vegetable and Animal Subtasnces by Putrefaction.

HAVING mentioned the changes brought about on animal and vegetable ſubſtances, by being expoſed to the influence of fire, both in cloſe veſſels and in the open air; I come next to take a view of thoſe produced by putrefaction.

Putrefaction, which is commonly looked upon as the third ſtage of fermentation, makes a complete analyſis of all vegetable and animal matter; it diſengages and diſſipates the totality of their conſtituent principles, leaving nothing behind but their fixed earthy and metallic parts, and a little charcoal.

While plants or animals live and remain in health, the vegetative and animal proceſſes prevent any fermentation or putrefaction from taking place; but when they are dead, and expoſed to a certain degree of heat

heat and of moiſture, in a place to which air has acceſs, they begin to ferment, or to putrefy, according to what nature they are of. Vegetable ſubſtances generally undergo a kind of fermentation before they putrefy: animal moſt commonly putrefy immediately; their juices having already undergone ſuch changes in the veſſels to which they belonged, as were analogous to the two firſt ſtages of fermentation, and to the beginning of the third or the putrid.

When vegetable or animal ſubſtances are ſo placed as to be expoſed to a certain degree of heat and moiſture, the matter of heat unites with the different ſorts of air which form part of their component principles, and reduces them to the ſtate of gaſes, which, being volatile, ſeparate from the body left to putrefy; but theſe gaſes, on coming in contact with each other, and with the charcoal and other component principles of the body, which are now ſet at liberty, either immediately evaporate, or unite two and two together, according to the degree of affinity which they have

to

to each other, and form new combinations.

1. *Of the Putrefaction of Vegetable Subſtances.*

M. LAVOISIER ſays that vegetable ſubſtances, formed of the three neceſſary ſubſtances only, *viz.* the *pure* and *inflammable airs* and *charcoal,* ferment with difficulty; and their putrefaction is a long time of being completed; and, when it does take place, that the inflammable air, on ſeparating, eſcapes in form of inflammable gas; and that the pure air and charcoal, uniting with the matter of heat, evaporate in form of aërial acid, leaving nothing behind but the vegetable earth, mixed with a little charcoal and iron.

Alkaleſcent vegetables, ſuch as thoſe of the cruciform and cepaceous tribes, which contain impure (mephitic) air, beſides the three neceſſary principles, putrefy ſoon; for this air has been found to haſten and to promote putrefaction greatly, and it unites with part of the inflammable gas, and eſcapes

eſcapes with it in form of a volatile alkali, which gives a peculiar penetrating ſmell to ſuch putrid matter.

Some plants contain alſo phoſphorus, and others ſulphur; and when vegetables containing them putrefy, part of the inflammable air unites with the phoſphorus, and forms phoſphorated inflammable gas, which ſtrikes the noſe with a ſmell of rotten fiſh; and part unites with the ſulphur, and forms inflammable hepatic gas, which has the ſmell of rotten eggs; hence vegetables, and more particularly animal ſubſtances that contain *impure air*, *phoſphorus*, and *ſulphur*, when they putrefy, emit a moſt diſagreeable fetid ſmell, which ariſes from a mixture of the volatile alkali, and of phoſphorated and ſulphurated inflammable gaſes, which ſeparate from theſe ſubſtances during the time of putrefaction.

2. *Of the Putrefaction of Animal Subſtances.*

ANIMAL ſubſtances contain nearly the ſame principles as the alkaleſcent vegetables, viz. *pure*, *impure*, and *inflammable airs*, *charcoal*, *phosphorus*, and a *pittance of sulphur* and *of iron*; but the proportions of impure and inflammable airs, and of phosphorus and of sulphur, is greater in them than in vegetables: hence a greater quantity of volatile alkali, and of phosphorated and sulphurated inflammable gases is formed, and separated from them, and occasions a stronger, more disagreeable, fetid smell, than what arises from vegetables. Hitherto neither vegetable nor animal substances have been so accurately analysed, as to ascertain either the proportions of their component principles, or the quantity of the different products which they yield.

With regard to putrefaction, M. Metherie observes, if vegetables be putrefied, either under water or in heaps, that the inflammable air, or the inflammable hepatic air, if there be any, acts upon the iron, reduces it to the state of a black æthiops, which is attracted by the leadstone, and gives a black colour to the whole mass; hence that all plants or woods which putrefy under water, or in a heap, acquire a black colour: whereas, if the putrefaction is made in the open air, the iron paſſes to the ſtate of an ochre, and the putrefied vegetables become of a reddiſh or ochry colour. That all ſalts, even tartarus vitriolatus, nitre, ſea ſalt, and fixed alkalies, are decompoſed by putrefaction; and, after vegetable or animal ſubſtances have been completely putrefied, that not a reſidue of them is to be found in the matter which remains. He tells us that M. Parmantier diſſolved two pounds (thirty-two ounces) of ſea ſalt in a quantity of water, and put into the water ſome ſkait and brett fiſh, which he allowed to ſtand till they putrefied; and, afterwards, till the putrefaction was entirely over, and they emitted no more putrid ſmell: for a long time the fetid ſmell was almoſt unſupportable, and he was obliged to add water from time to time. At laſt, when the putrefaction was quite completed, he examined the water which remained, and got from it only one ounce of ſea ſalt, without any looſe alkali; ſo that thirty-one ounces of the ſea-ſalt had been decompoſed. And he adds, that the ſame thing takes place in putrefying vegetable subſtances with ſalts, as happened here with the fiſh.

The excrements, particularly of carnivorous animals, contain a quantity of oily matter, formed by the union of charcoal with part of the inflammable air; and likewiſe a quantity of hepatic and phoſphorated inflammable gaſes, which give them their fetid ſmell. M. Metherie tells us, that it has been found by experiment that the green matter, which ſwims at the top of water that covers human excrement in ditches, which are uſed as neceſſaries, is compounded of ſulphur and calcareous earth.

M. Lavoiſier obſerves, that the proceſs of putrefaction ſometimes produces particular effects under certain circumſtances: he tells us that M. Fourcroy and M. Thouret, in examining the progreſs of putrefaction in bodies which had been buried under ground, where the acceſs of air was prevented, found *the muſcular parts often converted into a true animal fat*, which he thinks muſt have happened from the *impure* (mephitic) air of the animal

mal ſubſtance having ſome how or other made its eſcape; and from the inflammable air and charcoal, which remained, uniting and forming fat after it was gone. This explanation of the manner in which this change was brought about, ſeems to be mere conjecture, founded on no certain facts or experiments.

SECT. VIII.

Of the Vinous Fermentation.

FERMENTATION, or that proceſs by which certain ſubſtances combined with water produce a fermented liquor, containing ſpirit, or alcohol, has been called the vinous fermentation; and the continuance of it to produce an acid or vinegar, has been called the acetous fermentation. The proper ſubjects of theſe fermentations are vegetable juices, which contain a ſaccharine principle, and a certain quantity of an extractive matter. Sugar refined to its utmoſt purity will not ferment; it requires the aſſiſtance of yeſt, or of ſome other extractive matter, called a ferment, to excite an inteſtine motion in the liquor; though brown ſugar, or melaſſes, which contain likewiſe an extractive matter, ferment readily. When a liquor impregnated with a due proportion of ſuch materials is to be fermented, it muſt be put into a caſk, which is to be filled about nine tenths of its height; then to be ſlightly covered, and ſet in a degree of heat capable of raiſing the quickſilver of Fahrenheit's thermometer to between 60 and 70 degrees; after which the fermentation will ſoon begin, and muſt be allowed to go on till the vinous proceſs is finiſhed.

Hitherto chymiſts are neither agreed as to the nature or number of the principles which compoſe the bodies which are the ſubjects of fermentation, nor as to the changes which are produced during the operation, nor as to the principles of which the ſpirit or matter produced are formed.

If the facts mentioned by M. Lavoiſier, in the account he gives of experiments made by himſelf, relative to the ſubject, ſhall be found to agree with thoſe of future operators, and no mistake has been committed, it will set this matter in a clear light. His experiments were made with substances whose component principles he had ascertained; to wit, *sugar*, *water*, and *yest*, in preference to the juice of the grape, or of other vegetables, whose analysis was more complicated, and not so easy to be made with accuracy.

He dissolved 100 pounds of sugar in 400 pounds of water; and added to this solution 10 pounds of yest from beer, which contained 7 pounds, 3 ounces, 6 drachms, and 44 grains of water, and 2 pounds, 12 ounces, 1 drachm, 28 grains of dried yest.

The 100 pounds of sugar contained

8	pounds of inflammable air
28	——— of charcoal
64	——— of pure air

The 407 pounds, 3 ounces, 6 drachms, 44 grains of water, including the water of the yest, contained

	lb.	oun.	dr.	gr.	
	61	1	2	71.40	of inflammable air
and	350	2	3	44.60	of pure air

 The

The 2 pounds, 12 ounces, 1 drachm, 28 grains of dried yeſt, contained

lb.	oun.	dr.	gr.	
—	12	4	59	of charcoal
—	4	5	9.30	of inflammable air
—	0	5	2.94	of impure air
1	10	2	28.76	of pure air

Hence we ſee that the whole materials uſed in this proceſs contained

	lb.	oun.	dr.	gr.
Of inflammable air	69	6	0	8.70
Of pure air - -	411	12	6	1.36
Of impure air - -	0	0	5	2.94
Of charcoal - - -	28	12	4	59
	510			

Having aſcertained the quantity and quality of each of the component principles of the liquor to be fermented, he put the whole into a veſſel fitted with an apparatus for receiving, and afterwards examining the different gaſes, which might be ſeparated (a deſcription of which he has given in the third part of his Traité Elémentaire), and ſet this veſſel in a place where

where the heat raiſed the quickſilver from $65\frac{3}{4}$ to $72\frac{1}{2}$ degrees of Fahrenheit's thermometer.

In an hour or two after, he could perceive the marks of a beginning fermentation; ſome air bubbles roſe to the ſurface of the liquor, and broke. After ſome time the air bubbles became very frequent, roſe to the ſurface, and diſcharged a quantity of aërial acid, accompanied with a froth or ſcum, which, on examination, proved to be part of the yeſt; and the whole liquor ſeemed to be in a ferment, or to boil.

At the end of ſome days, according to the degree of heat, the fermentation diminiſhed, but did not ceaſe entirely till after ſome time.

The weight of aërial acid which had ſeparated in this operation, and which was preſerved in a proper receiver, was 35 pounds, 5 ounces, 4 drachms, and 19 grains; and it had carried along with it 13 pounds, 14 ounces, and 5 drachms of water, which had condenſed in the receiver.

And M. Lavoiſier ſays that there remained

mained behind in the veſſel, where the fermentation had been carried on, a vinous liquor, gently acid, which was at firſt muddy or turbid, and then clear, after depoſiting a little yeſt, which weighed 397 pounds, 9 ounces, and 29 grains.

There ſhould ſeem either to have been loſt during the time of the operation, or to have remained in the veſſel, a lee or dreg weighing 63 pounds, 3 ounces, 6 drachms, and 24 grains, which M. Lavoiſier takes no notice of; though he lumps them into the following table which he gives of the products got by fermentation, and of the principles which he obtained from each of theſe products by analyſing them ſeparately.

The products obtained were,

	lib.	oun.	dr.	gr.
1. Of aërial acid - - -	35	5	4	19
2. Of water - - - -	408	15	5	14
3. Of alkohol - - - -	57	11	1	58
4. Of acetous acid - - -	2	8	0	0
5. Of ſugar which remained undecompoſ.	4	1	4	3
6. Of yeſt undecompoſed - -	1	6	0	50
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The

The principles of which theſe products were compoſed were as follow;

			lb.	oun.	dr.	gr.
Aerial acid. 35lb. 5 oun. 4 dr. 19 gr.	contained	Of pure air - - -	25	7	1	34
		Of charcoal - - -	9	14	2	57
Water. 408lb. 15 oun. 5 dr. 14 gr.	contained	Of pure air - -	347	10	0	59
		Of inflammable air -	61	5	4	27
Alkohol. 57 lb. 11 oun. 1 dr. 58 gr.	contained	Of pure air combined with inflammable	31	6	1	64
		Of inflammable air combined with pure air	5	8	5	3
		Of inflammable air combined with charcoal	4	0	5	0
		Of charcoal - - -	16	11	5	63
Acetous acid. 2 lb. 8 ounces	contained	Of inflammable air -	0	2	4	0
		Of pure air - - -	1	11	4	0
		Of charcoal - - -	0	10	0	0
Sugar remaining undecompoſed. 4lb. 1 oun. 4 dr. 3 gr.	contained	Of inflammable air -	0	5	1	67
		Of pure air - - -	2	9	7	27
		Of charcoal - - -	1	2	2	53
Yeſt remaining undecompoſed. 1 lb. 6 oun. 50 gr.	contained	Of inflammable air -	0	2	2	41
		Of pure air - - -	0	13	1	14
		Of charcoal - - -	0	6	2	30
		Of impure air - - -	0	0	2	37

In looking over this table, which ſhews the groſs matters which were obtained from

from the five hundred and ten pounds of materials that were employed, and the principles of which each of these products was composed, one observes that 4 pounds, 1 ounce, 4 drachms, and 3 grains of the sugar remained undecomposed; so that only 95 pounds, 14 ounces, 3 drachms, and 69 grains of it were divided into its original principles, which were,

	lb.	oun.	dr.	gr.
Of pure air - -	61	6	0	45
Of inflammable air	7	10	6	6
Of charcoal - -	26	13	5	19
	95	14	3	70

From whence it appears, that most of the *alkohol*, and of the *aërial and acetous acids*, which were the products of the fermentation, were formed from the principles of the decomposed sugar; for in examining the quantities of the different principles which these products are said to have yielded, we find them to be as follow:

	lb.	oun.	dr.	gr.
Of pure air - -	58	8	7	26
Of inflammable air	9	11	1	3
Of charcoal - -	27	4	0	48
	95	8	1	5

Which comes near to what the ſugar produced: the greateſt difference is in the quantities of the inflammable air; that in the products being above two pounds more than in the original ſugar. This additional quantity was probably ſupplied from the water and yeſt, which were all in ſome meaſure acted upon by the fermenting proceſs.

M. Lavoiſier alleges, that the effects of fermentation are to ſeparate into two portions the ſugar, which is an oxide; to oxigenate one at the expence of the other, to form of it aërial acid; and to diſoxigenate the other in favour of the firſt, to form a combuſtible ſubſtance, which is alkohol; inſomuch that if it was poſſible to recombine the *aërial acid* and the *alkohol*, one would form again *ſugar*. It ought however to be remarked, that the

inflammable

inflammable air and the *charcoal* are not in a ſtate of oil in the alkohol, but are united with a portion of *pure air*, which renders them miſcible with water; that theſe three principles exiſt in a ſtate of equilibrium in the alkohol; and that, by making them paſs through a glaſs or china tube made red hot, you may recombine them two and two, and form again *water*, *inflammable air*, *aërial acid*, and *charcoal*.

Such is the ſubſtance of the account given by M. Lavoiſier, of the changes and new combinations which are brought about by the fermenting proceſs; it is the firſt of the kind which has been publiſhed; and ſuch inaccuracies as may have crept into it, may probably be corrected by the author himſelf, who is ſtill buſied in making experiments of the ſame kind, or by other chymiſts who are following the ſame purſuits.

SECT.

SECT. IX.

Of the Acetous Fermentation.

AFTER the vinous fermentation is over, if the liquor be left in the ſame temperate degree of heat as before, where the air has free acceſs to it, a freſh fermentation, called the acetous, takes place; which converts the wine into vinegar.

The addition of the lees of wine, or of vinegar, or of tartar reduced to a powder, or of a ſmall quantity of good vinegar, or of the ſkins and ſtalks of grapes, cherries, currants, &c. or of yeſt or other ferments, promotes the acetous fermentation greatly; and the putting the liquor into wooden caſks in which vinegar has been kept, produces the ſame effects.

M. Fourcroy ſays that the three conditions neceſſary for promoting this fermentation are, 1. A degree of heat which raiſes Fahrenheit's thermometer to between 76 and 84 degrees: 2. A viſcous and at the ſame time an acid body, ſuch as mucilage and tartar: 3. The contact of air. And he approves much of the method recommended by Dr. Boerhaave, of employing two casks, with a hurdle made of ozier, and covered with twigs and stalks of vine put near the bottom; and filling the one full, and the other only half full; and daily filling the one that is only half full, from the other that is full; and continuing to do so till the vinegar is completely formed, which generally happens in about twelve or fifteen days.

M. Lavoisier alleges, that the acetous fermentation is no other than the acidifying of wine by the absorption of *pure air* from the atmosphere; in proof of which he says, 1. That wine cannot be converted into vinegar without the contact of air: 2. That the acetous fermentation is accompanied with a diminution of the volume of air in which it is performed; and that this diminution is occasioned by an absorption of pure air by the fermenting liquor: 3. That wine may be transformed into vinegar, by impregnating it with pure air in any manner whatever.

Vinegar

Vinegar, he ſays, is a compound, whoſe acidifiable baſis is made up of *inflammable air* and *charcoal*; but that the proportions of theſe two ingredients are not yet known; and that this baſis is reduced to the ſtate of an acid, by the mixture of pure air: and he thinks this proved by an experiment made by M. Chaptal, profeſſor of chymiſtry at Montpelier. He took a quantity of aërial acid, diſengaged from beer in a ſtate of fermentation, and impregnated it with water to the point of ſaturation, which was till it had abſorbed about a quantity equal to its own bulk: this he put into a cellar, in veſſels which allowed acceſs to air; and at the end of ſome time the whole was converted into vinegar. The aërial acid ariſing from beer in fermentation in the vat, is not pure; it carries with it a ſmall quantity of alcohol, which it keeps diſſolved: there are therefore in water, impregnated with aërial acid, diſengaged from vinous liquors in a ſtate of fermentation, all the materials fit for forming an acetous acid. The alcohol furniſhes the inflammable air and a portion of charcoal, and the aërial acid ſupplies the reſt

 of

of the charcoal and pure air; and the air of the atmoſphere contributes what is deficient of pure air, to carry the mixture to the ſtate of acetous acid.

From hence, he ſays, it appears that it is only neceſſary to add inflammable air to aërial acid, to convert it into vinegar, or, to ſpeak more generally, to transform it into a vegetable acid, for theſe differ from each other only in the degree of their oxigenation; and that, on the contrary, it is only neceſſary to take away the inflammable air from a vegetable acid, to convert it into aërial acid.

When the acetous fermentation has been completed, and the liquor has dropped its feculent part, and become clear and tranſparent, the clear part of the vinegar is to be drawn off into another caſk, which is to be ſtopped and put in a cool place: if it be allowed to remain on the lees or dreg, the putrid fermentation is apt to take place, and the vinegar to be ſpoilt.

It has been common to employ the worſt wines for making vinegar; but experience has ſhewn that the ſtronger and more ſpirituous the vinous liquor is, the better and ſtronger vinegar it yields.

Vinegar does not depoſit tartar, as wine does; that ſalt, M. Fourcroy ſays, ſeems to combine with the ſpirit and water, and to contribute to the taſte and other properties of this acid.

SECT. X.

OBJECTIONS MADE TO THE NEW THEORY OF CHYMISTRY.

SUCH are the outlines of the new chymical ſyſtem laid down by Meſſrs. Lavoiſier, Morveau, Fourcroy, and Bertholet, which was firſt made known to the world in a work entitled The New Chymical Nomenclature, which was publiſhed in the year 1787, and ſince then by works of the above-named and other ingenious philoſophers, who have adopted their theory, and made experiments relative to theſe ſubjects. However, ſince the publication of the Nomenclature, other able chymiſts have raiſed a number of objections to it, of which the following ſeem to be amongſt the principal:

1ſt, It has been doubted whether light and heat are real diſtinct ſubſtances, or are only the qualities and properties of other bodies.

2dly, That what is called the *calorique*, or matter of heat, is either the phlogiſton of Stahl, or a matter nearly approaching to it, or what has been called *latent heat*; and that it was only a love of novelty which could induce them to give it a new name. M. Gadolin thinks that, according to the plan of the Nomenclature, the academicians ought to have called it *gaſogene*, becauſe in melting bodies it reduces them to a ſtate of gas, or elaſtic fluid; in the ſame manner as they have expreſſed themſelves by the word *oxigene*, for the matter they ſuppoſe generates acid; and *hydrogene*, for the matter which contributes to the formation of water.

3dly, That the compoſition and decompoſition of water, diſcovered by the Hon. Henry Cavendiſh, and ſupported by a number of ingenious experiments made by M. Lavoiſier and other French academicians, on which a great deal of the new theory is built, has been denied of late by Dr. Prieſtley

Prieſtley and M.Metherie. Future trials, however, can only determine whether Mr. Cavendiſh and the French academicians, or Dr. Prieſtley and M. Metherie, have committed miſtakes in performing their experiments.

4thly, That the authors of the New Nomenclature have aſſerted, that the baſis of pure air (called by them *oxigene)* is the univerſal acidifying principle ; but they have mentioned no leſs than twenty-ſix different kinds of acids, and have demonſtrated from experiment (or believed they have done ſo) that only a few of theſe acids are thus formed : but they have not hitherto been able to make, or to decompoſe, any of the others which they mention ; nor have they been able to ſhew the exiſtence of pure air in them, or to aſcertain the nature of their acidifiable baſes : and therefore, till they can analyſe them, or at leaſt part of them, it cannot be admitted as a certain truth, that all acids are formed in this manner. Profeſſor Gadolin, of Abo, ſays, further, that as we are ignorant of the nature of the baſis of pure air, and of the manner in which it combines itſelf with bodies, we cannot affirm that it is the principle of acidity; for we do not know whether it gives acidity, or whether, by its combination, it only sets at liberty bodies which already had the properties of acids.

5thly, That Dr. Priestley, M. Metherie, and a number of other late authors, tell us they have performed experiments, which prove that the aërial and other acids have been formed in a different manner from what is mentioned by M. Lavoisier; and that, in repeating many of the experiments mentioned by him, and the other French academicians, in support of their new system, they had turned out differently from what is reported by them. Dr. Priestley, in the Philosoph. Trans. vol. lxxix. p. 7, tells us that he never failed, when the experiments were conducted with due attention, to procure some acid, whenever he decomposed dephlogisticated (pure) and inflammable air in close vessels; and concluded from thence that an acid was the necessary result of the union of these two sorts of air. And in vol. lxxviii. p. 319, he says, " I have supposed, with M. Lavoisier and others,

that

that the principle of acidity is in the dephlogiſticated (pure) air only; but as the acid is always formed by the union of this air and the inflammable, it may perhaps with equal probability be ſuppoſed to be in either of them, or to be a compound of them both."

6thly, That M. Gadolin does not think the denomination of *oxide* agrees to all metals combined with the oxigene; becauſe, if ſome appear to have acquired ſome properties of an acid, others ſeem to have acquired thoſe of earths or of alkalies.

7thly, That they have denied that inflammable air is ſeparated from many metals, during the time of calcination, and when ſubjected to other particular proceſſes; which ſeems to be proved by the experiments of the Honourable H. Cavendiſh, of Dr. Prieſtley, and others.

8thly, In conſidering the account given of water being compoſed of 85 parts of pure air, and 15 parts of inflammable air, as above mentioned, it ſhould ſeem that, if this was the caſe, water ſhould be one of the moſt inflammable ſub-

ſubſtances known ; for, on the application of fire to inflammable air, placed in a large receiver filled with pure or dephlogiſticated air, it burns with great violence: may not one ſuſpect that, if water is a compound, ſome ſubtile and hitherto unknown matter enters into its compoſition, which renders it an extinguiſher inſtead of a promoter of flame? This however is only mere conjecture, thrown out with a view of engaging thoſe very able and accurate philoſophers, who are employed at preſent in chymical reſearches, to remove all objections to this doctrine, if it be well founded.

From all which it appears that, although the new theory ſeems to be juſt in ſome points, yet that a great deal remains ſtill to be done, before it can be received in its full extent ; and that, although it may be well founded, yet that it will require a length of time, and the labours of many, to eſtabliſh it on a firm baſis, and to correct the many errors and miſtakes which may have been committed, in operating on ſuch ſubtile objects.

PART

PART III.

Of the Application of the New Theory to the former Parts of this Work.

IN this third part the Author has endeavoured to point out ſome of the principal alterations which it may be neceſſary to make in the theoretical part of the foregoing work, ſhould the new chymical doctrine prove well founded; and has likewiſe marked ſome few things, which he thought neceſſary, that had either been omitted, or have occurred ſince his work was printed.

SECT. I.

Of ACIDS.

(See vol. i. chap. ii. p. 41.)

IN the chapter on Acids, the following are the principal things which occurred to the Author, in looking over the very late works of our modern chymiſts, that had not been taken notice of before.

1. *Of the Sulphureous or Vitriolic Acid.*

(See vol. i. p. 42, &c.)

THE ſulphureous or vitriolic acid is now almoſt always prepared from ſulphur, which was believed by Dr. Stahl to be made up of a large quantity of this acid, and a ſmall quantity of phlogiſton; and that ſulphur, when it was burnt *, was decompoſed,

* Of late it has been found, both in England and in France, that ſulphur may be burned more eaſily and at a cheaper rate in chambers, than in any ſort of glaſs or earthen veſſels; and therefore chambers, lined every where with lead, have been fitted up for that purpoſe; and

decomposed, and that the acid rose in form of a fine vapour, which, when received into a proper vessel, condensed in form of a liquor; whilst the phlogiston, which was too subtile to be confined in any sort of vessels, made its escape; and that the condensed liquor, when purified, by distilling off the water which was mixed with it, formed the fixed vitriolic or sulphureous acid; but that when this fixed acid was united to a certain quantity of inflammable matter, as mentioned in vol. i. p. 48, it became volatile, and was called the volatile vitriolic acid. But M. Lavoisier, and his associate academicians, now tell us that sulphur is a simple substance, which, when burned in *atmospheric* or in *pure* air, attracts, during the time of its combustion, such a quantity of the basis of pure air (the oxigene) as converts it into a sulphureous acid; which, they say, may be demonstrated by burning a quantity of sulphur in a close vessel, filled

and the sulphur has been so placed in them, as to be exposed to a current of air; and a sufficient quantity of water has been put in the bottom of the chambers, to facilitate the condensation of the acid vapour.

with pure air: for, after the burning is over, it will be found that the ſulphur converted into this acid, has gained as much additional weight as the pure air, in which it has been burned, has loſt. M. Bertholet, in repeating theſe experiments, obſerved, in one experiment, that 69 parts of ſulphur attracted 31 parts of the baſis of pure air, and with them formed 100 parts of vitriolic acid; and, in another, that 72 parts of ſulphur only attracted 28 parts of the pure air, to form the ſame quantity of acid.

The ſame academicians allege that ſulphur is capable of two degrees of impregnation with the baſis of pure air (the oxigene); the firſt, when it is fully ſaturated with it, and conſtitutes the fixed ſulphureous or vitriolic acid, which they call *acide ſulphurique*: the ſecond, when it is impregnated only with a certain quantity of the oxigene (leſs than in the former caſe), and becomes of a volatile nature; in which ſtate it has been called by the Engliſh *volatile vitriolic acid*, and by the French academicians *acide ſulphureux*.

They tell us, likewiſe, that this acid, in

theſe

theſe two different ſtates, has different properties, for that neutral ſalts made with them and alkaline ſalts differ from one another; but hitherto theſe ſalts have not been particularly examined.

Notwithſtanding what the French academicians have ſaid, Dr. Prieſtley ſtill continues to ſupport the doctrine of phlogiſton, and to aſſert that ſulphur is a compound body made up of vitriolic acid and it; and, amongſt other proofs of its being ſo, he ſays that he has converted oil of vitriol into ſulphur, by evaporating it to dryneſs, under a receiver filled with inflammable air.

Mr. Kirwan, in the new edition of his Eſſay on Phlogiſton and the Conſtitution of Acids, publiſhed in the year 1789, after conſidering what the French academicians have ſaid on this ſubject, admits that ſulphur enters wholly into the compoſition of the acid of ſulphur, and that air of ſome ſort or other is abſorbed, during the converſion of ſulphur into an acid; and has given it as his opinion, that this acid conſiſts of a baſis or radical principle, which

which, when ſaturated with phlogiſton, conſtitutes ſulphur; when ſaturated with fixed air, becomes common *fixed vitriolic acid*; and, when combined partly with the one and partly with the other, becomes *volatile vitriolic acid*; ſo that volatile vitriolic acid is nothing elſe but common vitriolic acid, holding ſulphur in ſolution.

The French academicians have made a long reply both to Dr. Prieſtley and Mr. Kirwan; but the matter in diſpute ſtill ſeems to remain undecided.

2. *Nitrous Acid.*

(See vol. i. p. 55, &c.)

THE nitrous acid has for ſome years been known to be made up of two ſorts of air, or rather of their baſes, to wit, the *impure* (or azote), and the *pure* (or oxigene), in the proportion of one part of the *impure* to three parts of the *pure*. It has been divided into theſe two ſorts of air, and been again formed by uniting them.

Dr. Prieſtley mentions the nitrous air in vol. lxii. of the Philoſophical Tranſactions for the year 1772; and the Hon. H. Cavendiſh, in vol. lxxv. for the year 1785, gives an account of his having produced nitrous acid, by uniting theſe two airs by means of the electric ſpark; and, in the year 1788, he repeated the ſame experiment* with the ſame ſucceſs; and the experiments of M. Lavoiſier and the other academicians confirm the truth of M. Cavendiſh's opinion, of the nitrous acid being formed by the intimate union of theſe two ſorts of air. From theſe accounts it appears that the acid of nitre is made up of the ſame materials as the common atmoſpheric air, but in different proportions: this accounts for the artificial formation of nitre, when certain earths, containing alkaline ſalts and materials capable of fermenting and of putrefying, are expoſed

* Mr. Cavendiſh's experiment was this: he put into a glaſs tube ſome ſoap ley, and with it ſeven parts of pure air and three parts of impure air; and, having ſhut the tube, he made the electric ſpark paſs through it; after which, by filtering and evaporating the ſoap ley, he obtained a ſmall quantity of nitre, the acid of which muſt have been formed by the intimate union of the two airs, brought about by the electric ſpark.

to the common air for a length of time; for the materials, when thus expoſed, attract from the atmoſphere a quantity of *pure* and *impure* airs, which are united by the fermenting and putreſcent proceſſes, which are perpetually going forward in theſe heaps of materials, and form nitrous acid; which is immediately attracted by the alkaline ſalts, with which theſe materials abound.

M. Lavoiſier, and the other academicians, tell us that the nitrous, like the vitriolic acid, is capable of appearing in various forms, which depend upon the different proportions of *pure* and of *impure air* of which it is compoſed. 1. When there are two parts (in weight) of pure air to one of impure, the product is *nitrous gas*, which is not miſcible with water, but has ſuch an affinity with pure air, that it attracts it from the atmoſphere when it comes in contact with it. 2. When there are three parts of *pure* to one of *impure air*, the product is a red fuming liquor, called *nitrous acid:* M. Lavoiſier ſays that theſe two ſubſtances, the nitrous gas, and

nitrous

nitrous acid, may be converted into each other; for, by adding pure air to the gas, it becomes nitrous acid; and, by ſeparating ſome of the pure air from the nitrous acid, by means of heat, it is reduced to the ſtate of gas. 3. When the proportion of *pure air* is to that of the *impure* as four to one, the product is a white acid, without colour, which the French call *acide nitrique*; this Dr. Metherie ſays is the pure nitrous acid, and is much more active than the fuming ſpirit of nitre.

3. *Muriatic Acid.*

(See vol. i. page 65, &c.)

THE authors of the new chymical theory have ſuppoſed, from analogy, that this, like the ſulphureous and nitrous acids, is a compound formed by the union of an acidifiable baſis with pure air (the oxigene); but hitherto they have not been able to demonſtrate its acidifiable baſis, or to prove that it contains pure air. This acid however ſhould ſeem to be capable both of being compoſed and decompoſed, though hitherto we are ignorant of the manner in which this is brought about; for a quantity of ſea ſalt is always got from the mud walls prepared for the generation of nitre: and M. Palmantier, as I before obſerved, found that 31 ounces of ſea ſalt (out of 32 which he diſſolved in water, in which ſkate and bret fiſh were allowed to putrefy, and let ſtand till the putrefaction was entirely over) had been decompoſed, and had evaporated during the time that the putrid proceſs had been going forward; without leaving a remnant of either the acid or the alkaline parts behind.

One part of muriatic acid mixed with three of the nitrous, has been called *aqua regia*, from its having the property of diſſolving gold, which uſed to be called the king of metals. For a long time it was ſuppoſed that the addition of the pure nitrous acid gave it this property; but it has been diſcovered lately that it was not the nitrous acid itſelf, but a quantity of pure air (oxigene), which it imparted to the muriatic acid, which gave it this quality; for if the muriatic acid be impregnated with a quantity of the oxigene, by diſtilling it along with the calces of manganeſe, or of mercury, or with any other ſubſtance abounding with pure air, it acquires the ſame property of diſſolving gold, as when it is mixed with nitrous acid.

This acid, when ſaturated with pure air, becomes more volatile, and is always in a ſtate of gas; when thus impregnated, it is not abſorbed by water in ſuch quantity as before; it diſſolves ſilver, quickſilver, lead, &c. without efferveſcence: and M. Bertholet mentions that it is capable of uniting with a number of acidifiable baſes; and that the ſalts formed from this union are capable of detonating with charcoal, and with a number of metallic ſubſtances; and that, when the baſis of the pure air (the oxigene) is in large quantity, the exploſions are frequently ſo violent as to become dangerous. M. Lavoiſier ſays, if this acid be oxigenated beyond a certain degree, that it precipitates to the bottom of the veſſel in which it is kept, in a concrete form.

 M. Bour-

M. Bourdelin, in the Memoirs of the French Royal Academy of Sciences for the year 1742, has endeavoured to prove that the acid of ſuccinum (amber) was the muriatic; but from the experiments I made with this ſalt in the year 1767, an account of which is given in vol. lvii. of the Philoſophical Tranſactions, p. 509, &c. it is evident that the ſal ſuccini is an acid of a particular kind; and the neutral ſalts made with it and alkaline ſalts, are very different in figure, taſte, and other properties, from thoſe made with the muriatic acid.

4. *Aërial Acid, called Fixed Air.*

(See vol. i. page 93, &c.)

CHYMISTS are not as yet agreed about the compoſition of this acid. M. Lavoiſier calls it *acide carbonique*, and aſſerts that it is made up of 72 parts of the baſis of pure air (the oxigene) and 28 parts of charcoal; and ſays that it may be prepared by burning charcoal in pure air in form of gas, or by combining powder of charcoal

with

with a metallic calx (or oxide), in a juſt proportion. Dr. Metherie ſeems to doubt of theſe facts: and Dr. Prieſtley, in a paper publiſhed in vol. lxxviii. art. 2, for the year 1788, tells us that he has procured *fixed air* by uniting *pure* and *inflammable airs* together.

5. *Phoſphoric Acid.*

(See vol. i. page 100.)

THE phoſphoric acid, according to the new chymical doctrine, is phoſphorus, ſaturated with the baſis of pure air (or oxigene).

Phoſphorus was diſcovered about the year 1667, by an alchymiſt of the name of Brandt. Till within theſe few years it was believed to exiſt only in the urine; but of late it has been diſcovered to be contained in almoſt all animal ſubſtances, and in many vegetable, particularly in thoſe called alkaleſcent. At preſent its acid is moſtly procured from bones, which contain it in large quantity, ſo firmly united to a calcareous earth, that it is not diſlodged by calcination. The method now generally employed for ſeparating it from bones, is this:

Take a quantity of bones, calcine them to whiteneſs, reduce them to a very fine powder; pour on this powder as much diluted ſulphureous acid as will diſſolve a great part, but not the whole, of the powder; digeſt them together for 12 hours, and during that time ſtir them about frequently with a wooden ſpatula, by which means the ſulphureous acid will diſlodge the phoſphoric, and form a ſelenites with the calcareous earth of the bones, which will precipitate to the bottom of the liquor, while the phoſphoric acid will remain united to the water; then decant off and ſtrain through a cloth the watery acid liquor; waſh the ſelenites with diſtilled water, and add the water to the diluted phoſphoric acid; after this, boil the liquor, which will drop a quantity of ſelenites as it evaporates; and, when it drops no more, ſeparate all that has formed, either by ſtraining the liquor through a fine cloth, or by filtering it through paper; and then evaporate the liquor till there remains in the evaporating glafs a matter of the confiftence of honey, or foft extract, and of a brown colour; put this into a crucible, and let it remain over the fire till it emits no more fulphureous and aromatic fmell, and till it ceafes to boil. In this ftate it has a half vitreous confiftence, an acid tafte, and attracts the humidity of the air: if this glafs be reduced to a fine powder, and be mixed with a third part of its weight of powdered charcoal, and then thrown into a heated crucible, it forms a good phofphorus.

The acid of phofphorus, procured in the manner above mentioned, is not fo pure as that obtained by combuftion, or by the nitrous acid, and therefore is not fo proper to be ufed for experiments. M. Lavoifier fays that the beft method of obtaining it pure, and free of all mixture, is to burn phofphorus under a glafs bell, whofe infide has been moiftened with water; and that during the combuftion it abforbs twice and a half its own weight of the bafis of pure air, the oxigene. Phofphorus may likewiſe be converted into an acid, by burning it ſlowly in the following manner:—Place ſmall bits of it, ſupported by pieces of wood, in the inſide of a wide glaſs funnel, whoſe noſle has been ſet into the mouth of a cryſtal bottle; and leave it expoſed to the air, when it will abſorb by ſlow degrees ſuch a quantity of the baſis of pure air (the oxigene) as will convert it into an acid; and this acid, as it forms, will attract moiſture from the open air, and will run per deliquium, and fall down into the bottle in which the noſle of the glaſs funnel had been placed: but the phoſphoric acid thus formed will contain leſs of the oxigene, that is, it will be leſs acid, than when the phoſphorus has been burnt quickly.

Phoſphorus may likewiſe be converted into phoſphoric acid, by diſtilling it when mixed, either with the nitrous acid, or with oxigenated muriatic acid, in the following manner:

Take a retort with a tube riſing from the upper ſide of the wide part of its neck, and let the tube have a glaſs ſtopper fitted to it. Place this retort, after it has been half

filled

ſilled with nitrous acid (or with oxigenated muriatic) in a ſand heat, and fit a receiver to it: take out the ſtopper of the glaſs tube, and introduce by it, ſucceſſively, ſome ſmall pieces of phoſphorus, which the nitrous acid will immediately diſſolve with an efferveſcence, and part of the nitrous acid will riſe in form of red fumes; continue to add by degrees, after the efferveſcence raiſed by each piece of phoſphorus is over, till the acid will diſſolve no more; then put the ſtopper into the tube, and apply ſuch a heat to the retort as will force over all the nitrous acid into the receiver, which ought to be a tubulated one; then remove the fire, and allow the retort to cool; when the phoſphoric acid will be found in it, partly in a ſolid, partly in a liquid form. In this proceſs, the nitrous acid, or the oxigenated muriatic, if that has been employed, imparts to the phoſphorus ſuch a quantity of the baſis of pure air (the oxigene), as to convert it into an acid; and the remainder of the nitrous acid evaporates, or is forced over into the receiver, when the heat is applied to the

retort.

retort. With this acid, and the pure foſſil alkali, a neutral ſalt, called NATRON PHOSPHORATUM, has lately been prepared, and been uſed as a purgative medicine, in doſes from ſix to ten drams, diſſolved in from half a pint to a pint of mutton or veal broth. Dr. Pearſon recommends it to be prepared by diſſolving two ounces, ſeven drams, and two grains of pure cryſtallized natron, or foſſil alkali, in four ounces and three drams of diſtilled water, which has been heated till it raiſes the quickſilver of Fahrenheit's thermometer to between 140 and 150 degrees; and then to add, by degrees, an ounce and a ſcruple of pure phoſphoric acid; and, after the efferveſcence is over, to boil the liquor for a few minutes, and then to pour it into a ſhallow veſſel, placed in a temperature of air which will raiſe Fahrenheit's thermometer to between 80 and 90 degrees, and allow the ſalts to ſhoot into cryſtals of a rhomboidal figure. By repeated evaporations and cryſtallizations, one gets from this quantity of materials, from three ounces ten grains, to three ouncesand a dram, of cryſtallized ſalt; and

if

if the water which remains be evaporated to dryneſs, it will leave about 150 grains of a ſaline matter.

6. *Of Vegetable Acids.*

(See vol. i. page 71, &c.)

HITHERTO our modern chymiſts have not examined vegetable acids with that care and attention which they deſerve. Even M. Lavoiſier and M. Fourcroy, in their lateſt works, tell us that only thirteen different kinds of them had been diſcovered; though, ſo long ago as the year 1767, I had publiſhed, in vol. lvii. of the Philoſophical Tranſactions, an account of twenty-two different kinds of vegetable acids; and had proved, by ſaturating them with the native foſſil alkali of the country of Tripoli in Barbary, and then by cryſtallizing the neutral ſalts thereby produced, that each of them differed from the other, and that probably the acid of every vegetable differs in its natural ſtate, in ſome reſpects, from that of another.

Monſ.

Monſ. Lavoiſier has ſaid that all vegetable acids are formed by the union of the oxigene and a baſis made up of inflammable air and charcoal, and ſometimes with the addition of phoſphorus and of azote (or impure air); and that the different proportions of theſe materials, in their compoſition, conſtituted the difference between them.

The beſt method of obtaining vegetable acids for making experiments with, is to purify the acid juice by filtering and by other means, and then to concentrate them by evaporating with a gentle heat, or by expoſing them in the open air in the time of a hard froſt, which will freeze the watery part, and leave the acid pure behind. M. Georgius of Stockholm, by expoſing lemon-juice to a froſty air, in which the quickſilver of Fahrenheit's thermometer ſtood at about 24 or 25 degrees, reduced it to one eighth part of its bulk.

The common method of obtaining vegetable acids in a concentrated ſtate, employed by modern chymiſts, has been to form neutral ſalts with them and the vegetable

getable alkali, or with calcareous earth, or with ſome metallic ſubſtance; and then to put theſe neutral ſalts into a retort, and to pour over them ſome of the ſtrong mineral acids, which ſets looſe the vegetable acid; ſo that, on diſtilling, it comes over into the receiver: however, it ought to be obſerved that this method is apt to lead into error, if we are not on our guard; for generally ſome of the lighter parts of the mineral acids riſe and come over into the receiver, and mix with the vegetable acids; and if the nitrous or oxigenated muriatic acids be employed, they are apt to impart to the vegetable acids ſuch a quantity of the baſis of pure air (the oxigene) as alters their properties; beſides, theſe ſtrong mineral acids may decompoſe the vegetable; and it may perhaps be owing to ſome of thoſe cauſes, that M. Lavoiſier and his aſſociates were able to convert the acid of tartar into that of ſorrel, or into that of apple, or into the acetous acid. For theſe reaſons, if we make uſe of the ſtrong mineral acids to ſeparate the vegetable from neutral ſalts, ſome method ought to be fallen upon to difcover, and to correct, any miftake which may have been committed, before we draw any conclufion with regard to the nature of thefe acids in the natural ftate.

7. *Pruffian Blue.*

(See vol. i. page 98.)

IN note to p. 170, 171, of this Appendix, I have mentioned that M. Fourcroy had obferved the Pruffian blue ready formed in animal fubftances: fince that fheet was printed, a gentleman, who formerly ftudied phyfic, came to town to afk my advice, for a pain and uneafinefs at his ftomach; attended fometimes with ficknefs and vomiting, which he had laboured under for fome months. In giving the hiftory of his cafe, he mentioned that what he had thrown up, when attacked with ficknefs and vomiting, was generally mixed with a green or yellow bile; but that, in two of thefe attacks, what he vomited was of a bright blue colour, exactly refembling a folution of copper in diluted volatile alkali; a circumftance which he faid neither he, nor the apothecary who attended him

him in the country, could account for. Might this blue colour have proceeded from Pruſſian blue generated in the biliary veſſels, which coloured the bile that was mixed with the contents of the ſtomach? Or might the blue colour have been generated in the ſtomach, the gentleman having taken about that time ſome bark mixed with a ſmall quantity of ſal martis?

S E C T. II.

Alkaline Salts.

(See vol. i. page 120.)

HITHERTO chymiſts have not been able to decompoſe the fixed alkaline ſalts, and therefore many of them have ranked theſe amongſt the ſimple ſubſtances; but, notwithſtanding, others ſtill ſupport the old opinion of their being compounds. M. Metherie is of this opinion, and ſays that they only differ from the volatile alkali, which is now known to be a compound, in containing more inflammable air; but he has not hitherto brought any certain proof of its being ſo. He ſeems likewiſe to ſupport the opinion of alkaline ſalts being originally formed in plants, and not generated by the force of fire; and ſays that the neutral ſalts got from the juices of many plants, and the nitre and ſea ſalt generated in the earthen banks prepared for the formation of nitre, evidently prove that the vegetable and foſſil alkalies are not always the product of combuſtion; and he quotes M. Lorgna for a fact, which, if true, ſhould ſeem to put this matter beyond all manner of doubt. In p. 308 of tom. ii. ſecond edition, of his Eſſay *Sur Differens Airs,* he ſays that M. Lorgna, having got a large parcel of the kali plant, burned one half of it, and infuſed its aſhes in boiling water for ſome hours; and then from the water, which he ſtrained off and evaporated to dryneſs, he got 436 grains of foſſil alkali: that after this he bruiſed the other half of the kali plant; and, by infuſing it in like manner in boiling water, and then evaporating the water after it had been ſtrained through a cloth, he got 473 grains of the ſame ſort of foſſil alkaline ſalt as he had obtained from the other parcel.

1. *Vegetable Alkali.*

(See vol. i. page 125, &c.)

M. FOURCROY tells us, that, by saturating the caustic vegetable alkali with aërial acid, and exposing it to the vapour of fermenting liquors, it will shoot into most beautiful crystals, which taste mild, and undergo no alteration from being exposed to the open air; that they dissolve in four times their own weight of water; and generate cold, in the time of their solution in the water. This should seem to be another instance of what I have mentioned in page 69 of this Appendix, of some salts generating cold in the time of their solution, when in a crystallized state, which generate heat when dried, and deprived of the water of their crystallization.

2. *Fossil Alkali.*

(See vol. i. page 131.)

THE native fossil alkali, the natron of the ancients, can by care be freed of all impurities, and obtained in a state of purity; but the salt got by burning the kali, or other marine plants, is always mixed with the vegetable alkali, from which it cannot be ſeparated by any means we hitherto know: it is brought to us from Spain, mixed with aſhes and other impurities, in form of large hard black lumps, and goes by the name of *ſoda* or *barilla:* by breaking theſe lumps, and reducing them to a fine powder, and then boiling this powder repeatedly in ſix times its own weight of water, till the water becomes inſipid, and then ſeparating all the inſoluble matters, one obtains, by evaporating to dryneſs all the water in which the barilla has been boiled, about 55 pounds of alkaline ſalt from 100 of the beſt groſs black barilla, according to the account given by Dr. Dejean of Leyden, in his Inaugural Diſſertation de Soda Hiſpanica. The ſalt, thus obtained, ought afterwards to be purified, in the manner recommended in the New Pharmacopœia of the College of Phyſicians in London.

In vol. xxxv. of Obſervations ſur la Phyſique, &c. p. 295, for the year 1789, there is an account given by M. Weſtrumb of his having precipitated the foſſil alkali from ſea ſalt, by means of the vegetable; by which it

appears

appears that from 26 pounds of ſea ſalt diſſolved in 60 pounds of water, by the addition of 25 pounds of pure pot-aſhes, he obtained by repeated evaporations, cryſtallizations, &c. 20 pounds of foſſil alkali in large cryſtals, and one pound and a half which was not ſo pure; beſides a large quantity of ſal digeſtivus and ſome tartarus vitriolatus.

3. *Volatile Alkali.*

(See vol. i. page 158, &c.)

M. BERTHOLET, in the year 1784, proved, by a number of experiments, that the volatile alkali is formed by the union of impure and inflammable airs; which has ſince been confirmed by other experiments, mentioned in art. 23 of vol. lxxviii. of the Philoſophical Tranſactions, by Dr. Auſtin; who ſays, many other ſimilar experiments might be mentioned, but theſe are ſufficient to prove that, if light phlogiſticated (*i. e.* impure) and light inflammable airs be preſented to each other, at the inſtant of their ſeparation from ſolid or liquid ſubſtances, and before their particles have receded from each other, they readily combine, and generate volatile alkali.

SECT. III.

OF NEUTRAL SALTS.

(See vol. i. page 172.)

IN looking over this chapter on Neutral Salts, I ſee little to be added or ſubtracted, as I have mentioned all thoſe which are at preſent uſed in practice, beſides ſeveral which are not; and have given a particular account of the beſt methods of preparing them, and of their virtues and uſes. The ſalts made with alkaline ſubſtances and the mineral acids in their different ſtates; that is, when, according to the new ſyſtem, they have been more or leſs impregnated with the baſis of pure air (the oxigene), I have not mentioned; as hitherto none of them have been uſed as medicines, or been particularly examined.

The accounts we have of the quantity of water it takes to diſſolve the different ſalts, and of the degrees of cold or of heat which they occaſion during the time of their ſolution in water, differ very much from

from one another, even thoſe related by authors of credit; owing to the different ſtates the ſalts were in, at the time the experiments were made with them, and to the purity and temperature of the water employed for their ſolution: circumſtances which were formerly little attended to, as being ſuppoſed to be of no moment; but have of late been diſcovered to occaſion a great difference in the reſult of ſuch experiments. Thus Glauber ſalts, fully impregnated with water, diſſolve readily in this fluid, and generate cold during the time of their ſolution in it; but if the ſame ſalt be perfectly dried, and freed of all the water of its cryſtallization, it becomes much more difficult of ſolution, and generates heat at that time.

In order to obtain a complete table of the quantity of diſtilled water it requires to diſſolve neutral ſalts, a quantity of each of them ought to be prepared in the moſt exact manner, and in a ſtate of perfect cryſtallization, and experiments be tried with each of them in that ſtate; after which the ſame experiments ought to be repeated with parcels of the ſame ſorts of ſalts, after they have been well dried, and freed of all the water of their cryſtallization; and likewiſe be repeated with parcels of the ſame ſorts of ſalts, freed of a half, and of two thirds, of their water, to ſee what difference the different quantities of water will occaſion. And all ſuch experiments ought to be made repeatedly, and with diſtilled water of different degrees of heat, and in a room where the air is kept of the ſame temperature, during the time the operations are performed.

1. *Magneſia Vitriolata.*

(See vol. i. page 198.)

Epſom Salt.—M. Fourcroy, in a memoir publiſhed in the year 1784, ſays that the pure magneſia vitriolata, made with magneſia and the vitriolic acid, is an efflorescent ſalt; and not one that runs perdiliquium, as the common Engliſh Epſom ſalt does, which he alleges is owing to that ſalt containing about a fifth part of the magneſia muriata.

2. *Borax.*

2. *Borax.*

(See vol. i. page 231, &c.)

IN my preface to vol. i. I have mentioned that this ſalt has been found native in the country of Thibet in the Eaſt Indies; and of late we have had an account, publiſhed by Mr. H. Fr. Hoëfer, apothecary to the Duke of Tuſcany, in Italy, of its acid, called *ſal ſedativus*, having been found diſſolved in the water of the lakes of Caſtel Nuovo, and Monte Rotundo, in that duchy, ſo pure as to form a true borax, by ſaturating it with foſſil alkali.

SECT. IV.

OF METALS.

(See vol. i. page 23 , &c.)

METALS have for a number of years been looked upon as compound ſubſtances, made up of a certain earthy matter united to phlogiſton (or matter of heat), which gave them their metallic properties; and the changes which they underwent, in being calcined, were alleged by Stahl and his difciples to be brought about by the force of fire diffipating their phlogifton; and that, when this phlogifton was reftored to them, they again acquired the properties of metals, and became fufible, ductile, &c. But the authors of the new doctrine have ranked metals amongft the fimple fubftances; and allege that they do not contain phlogifton; and that, when they are calcined, they abforb from the atmofphere a quantity of the bafis of pure air, the oxigene, during the time of their combuftion; which gives them the form, and other properties, of thofe fubftances which ufed to be called *calces*, but which the fupporters of the new doctrine name *oxides*; believing them to be impregnated with a certain quantity of the oxigene, the fuppofed principle of acidity, though not fufficient to convert them into acids; and that, if thefe metallic calces or oxides be again deprived of their oxigene, or bafis of pure air, by being expofed to a very ftrong heat in crucibles, along with charcoal or other fluxes,

fluxes, which attract or take up the oxigene (the basis of pure air) which they had absorbed, they return to the state of metals.

When metals are dissolved in acids, and precipitated from them by means of alkaline salts, they are likewise reduced to the state of calces or oxides: and M. LAVOISIER lays it down as a rule, that no metallic substance can be dissolved in an acid, till it be brought to the state of a calx or oxide, by being united some how or other with *pure air*; whether it get this air from the decomposition of water, or of the acid itself: and he says that the following things are to be observed in the solution of metals by acids.

1. That in all solutions of pure metals an effervescence arises, occasioned by a separation of gas (aërial fluid) on the decomposition of either the acid, or of the water employed—That, when the solution is brought about by means of the nitrous acid, the gas is the nitrous; when the vitriolic or sulphureous, the gas is either the volatile sulphureous acid, or inflammable air,

air, according as it may be ſeparated from the ſulphureous acid, or from the water, whoſe pure air (oxigene) oxidated the metal.

2. That all metals diſſolve without effervescence in the aërated (i. e. oxigenated) muriatic acid; the metal in that caſe taking up the ſuperfluous pure air: by which means a metallic oxide or calx, and common muriatic acid, are formed at the ſame time; and the gas, which would otherwiſe have been ſeparated, finds more water than is neceſſary to keep it in a liquid form, and to prevent its appearing in form of gas or vapour.

3. That, if the metallic ſubſtances have been previouſly reduced to the ſtate of calces (oxides), they diſſolve without any effervescence; for, the metal having been already aërated, no decompoſition of water or of acid takes place during the time of the ſolution.

4. That metals which have ſuch a ſmall degree of affinity with the baſis of pure air, the oxigene, as not to be capable of attracting it from the acid or from the water,

water, ſo as to decompoſe theſe bodies, are abſolutely inſoluble: and it is for theſe reaſons that ſilver, mercury, and lead are not ſoluble in the common muriatic acid, in their pure metallic ſtate; though the ſame acid diſſolves them eaſily when they have been reduced to the ſtate of calces.

Hence M. Lavoiſier ſays it ſhould appear that the baſis of pure air, the oxigene, is the means of union between metals and acids; which makes one inclined to believe that all ſubſtances which have a ſtrong affinity with acids, contain pure air.

Mr. Kirwan, who acknowledges the decompoſition of water, has in the new edition of his Eſſay on Phlogiſton, and the Conſtitution of Acids, publiſhed in 1789, p. 167, given it as his opinion, that metals, when calcined, loſe their phlogiſton, which is nothing elſe than inflammable air in a concrete ſtate; and that they at the ſame time unite moſt commonly to fixed air, formed during the operation; but ſometimes ſome of them unite to water, and other ſubſtances, by whoſe means they are calcined: and that the calces of the

perfect

perfect metals may be reduced or brought back to their metallic ſtate, by the decompoſition of fixed air ; and thoſe of the imperfect and ſemi-metals, partly by the decompoſition of their fixed air, and partly by its expulſion, and that of the other bodies they had abſorbed, and their ſimultaneous re-union to the inflammable principle. In anſwer to this, M. Fourcroy has ſaid, that it is only the oxigene, the baſis of pure air, which is capable of changing metals to the ſtate of calces or oxides ; and that the phenomena are the ſame in the calcination of all metals : and therefore there is no reaſon to ſuſpect that the means of bringing about calcination are different in different ſubſtances.

1. *Gold.*

(See vol. i. page 244.)

GOLD is of a very fixed nature, and requires the heat of the focus of a burning-glaſs to reduce it to the ſtate of a calx.

Formerly

Formerly the only menſtruum capable of diſſolving it (when in a metallic ſtate), that was known, was a mixture of the nitrous and muriatic acids, which went by the name of *aqua regia*. But it has been lately diſcovered, as I before obſerved, in treating of the muriatic acid, that the nitrous acid did not contribute further to the ſolution of this metal, than in furniſhing the muriatic with a quantity of the baſis of pure air (or oxigene); for that, if the muriatic acid was impregnated with the ſame quantity of oxigene by other means, it produced the ſame effects. But although this metal is not ſoluble by other acids, in its metallic ſtate; yet, after it has been precipitated in form of a calx, or oxide, from aqua regia, by means of fixed alkaline ſalts, it becomes ſoluble in the ſulphureous and nitrous acids.

2. *Silver.*

(See vol. i. page 247.)

SILVER is one of the moſt unchangeable metals we know: for although heat makes

makes it boil, and even volatilizes it, it does not change its nature; for M. Fourcroy ſays that its vapours, condenſed in chimneys or in retorts, are found to be pure ſilver unchanged. Junker however reduced it to the ſtate of a calx, by keeping it long in a reverberatory furnace; and M. Macquer, by expoſing it to the focus of a burning-glaſs.

3. *Copper.*

(See vol. i. page 249.)

COPPER, expoſed to the air, contracts a ruſt on its ſurface, which does not penetrate into its ſubſtance, but ſeems to ſerve as a cover to preſerve it, and to prevent its being deſtroyed or corroded by other bodies. It ſhould ſeem to be owing to this ruſt, that many antique medals and ſtatues have been ſo long preſerved entire. The Italian antiquarians call it *patina.*

4. *Iron.*

(See vol. i. page 259.)

THE firſt claſs of the preparations of iron which I have mentioned, comprehends, 1. the filings; 2. the æthiops; 3. the ſafron or crocus; 4. and the ruſt of iron.

If the new chymical doctrine be true, the three laſt are calces or oxides of iron.

Æthiops Martialis.

(See vol. i. page 262.)

THIS preparation is commonly called Dr. Lemery's Æthiops Martialis, and is prepared thus:

Put filings of iron into an unglazed earthen veſſel; pour pure water over them, till it riſes four inches above the filings; ſtir them well about every day, and ſupply them with more water, as that in the veſſel evaporates, ſo that the filings remain always covered with ſome inches of water; continue this operation for ſome weeks, till the filings fall down into an impalpable black powder, which ſeparate and dry. In this proceſs it ſhould ſeem as if the iron had attracted the pure air of the water, and was thereby converted into a calx or oxide. A black powder of the ſame kind may be procured by burning ſome very fine thin laminæ of iron in pure air, under the receiver of an air pump, in the manner recommended by M. Lavoiſier in his Traité Elementaire, page 45, &c.; and then reducing them to a fine powder, which is eaſily done, as they are extremely brittle and friable. When the operation has ſucceeded well, 100 grains of iron yield 135 or 136 of æthiops.

Rubigo Ferri.

(See vol. i. page 262.)

The filings of iron expoſed to the air, and moiſtened frequently with water, imbibe a quantity of the baſis of pure air (the oxigene); and are converted to the ſtate of a calx or oxide, in form of a brown powder, called *ruſt*. M. Lavoiſier ſays that 100 grs. of the filings of iron, when reduced to the ſtate of ruſt, weigh from 140 to 150 grains:

 hence

hence the difference, between the *ruſt* (rubigo) and the *æthiops*, ſeems to be in the one taking up a greater quantity of the oxigene than the other; and, as a further confirmation of this, M. Lavoiſier ſays, if 100 grains of the *æthiops martialis* be expoſed to the open air, it will be converted into a ruſt, which, on being weighed, will be found to have increaſed from 5 to 14 or 15 grains in weight.

Crocus Martis.

(See vol. i. page 262.)

THE crocus martis is a preparation of the ſame nature, being iron reduced to the ſtate of a calx by the force of fire, while it is expoſed to the open air.

Sal Martis, or Green Vitriol.

(See vol. i. page 263.)

THIS ſalt, called in the London Pharmacopœia *ferrum vitriolatum*, is ſeldom prepared by diſſolving iron in the vitriolic acid: M. Fourcroy ſays that it is commonly extracted from the pyrites ſtone; for, by expoſing it to the air, it becomes covered with a white efferveſcence: that is the ſal martis; which, on being ſeparated, diſſolved in boiling water, and evaporated, forms itſelf into beautiful green cryſtals.

Ferrum Ammoniacale.

(See vol. i. page 266.)

THIS preparation, which uſed formerly to go by the name of *flores martiales*, is commonly made by ſublimation; but it may be prepared by ſolution in the following manner:

Diſſolve a pound of crude ſal ammoniac in as ſmall a quantity of boiling water as poſſible, and filter it through paper whilſt quite hot; then immediately add to it a clear ſolution of half an ounce of filings of iron in the muriatic acid, and ſet it in a cool place to cryſtallize. This preparation has the advantage of that prepared by ſublimation, in ſo far as it lets us know the exact proportion of iron that is contained in any

any given quantity of it, which cannot be known when the medicine is prepared by ſubliming the materials.

It may be given in doſes from five grains to a ſcruple.

Of Iron being abſorbed by the Lacteal and Lymphatic Veſſels.

(See vol. i. page 260.)

IT has long been doubted by phyſicians, whether iron, given as a medicine, is taken up into the blood by the abſorbent veſſels, or whether it only acts as a tonic on the nerves of the ſtomach and bowels.

Of late it is generally believed that it is abſorbed, and acts on the general ſyſtem; and that the blood owes its red colour to the effects of this metal. In analyſing animal ſubſtances, particles of iron are found amongſt the products: and the account given by M. Menghini, in the Commentaria Academiæ Bononienſis, of the blood of perſons uſing chalybeate medicines becoming of a deeper colour, and containing more iron than the natural quantity;

tity; joined to the obſervations mentioned by Dr. Lory in M. Fourcroy's *Leçons de Chimie*, of the urine of people who were taking preparations of iron ſtriking a red colour with galls—put it beyond all doubt that this metal enters the blood, and acts upon the general habit.

5. *Lead.*

(See vol. i. page 273, &c.)

I HAVE mentioned that the ſaccharum ſaturni, called ceruſſa acetata, was formerly given freely in many diſeaſes; but that now its uſe was confined to ſome particular caſes of violent or obſtinate hæmorrhages, where other remedies had failed. In complaints which ariſe from manufacturing lead in any form, or from ſwallowing any of its preparations, M. Navier recommends a ſolution of hepar ſulphuris in water, or repeated doſes of five or ſix grains of it made up into pills with mild ſubſtances, as a good remedy for removing them; as likewiſe for removing thoſe occaſioned by arſenic, or corroſive ſublimate.

6. *Quickſilver.*

(See vol. i. page 292.)

IT is commonly believed that all thoſe people who work in the quickſilver mines are unhealthy: but M. Juſſieu, when he was at the quickſilver mines at Almaden in Spain, had obſerved that none of the miners, except the ſlaves who worked in the inner chambers, where there were fires, were ſo; and ſays that he believes that their bad health was owing to the fires volatilizing a portion of mercury, ſo that they lived perpetually in a mercurial vapour.

I have already obſerved that quickſilver is commonly found combined to ſulphur, in form of cinnabar, in the bowels of the earth. M. Fourcroy mentions its being found in form of priſmatic cryſtals, in a mine of earthy iron, at Muſhel Landſberg, in the duchy of Deux-ponts, in Germany; and that M. Leſage looked upon theſe cryſtals as a ſweet mercury *(murcurius dulcis)* formed of quickſilver and the muriatic acid.

Æthiops Mineral,

(See vol. i. page 314, &c.)

NOW called *hydrargyrus cum ſulphure*, has ſometimes raiſed a ſalivation: might not this have happened from its having been prepared with unwaſhed flowers of ſulphur, which had a quantity of looſe vitriolic acid adhering to them, which united during the trituration to ſome of the particles of the quickſilver, and in that way formed an active medicine?

Mercurius Calcinatus,

(See vol. i. page 317, &c.)

NOW called *hydrargyrus calcinatus*, is a calx or oxide, formed by quickſilver abſorbing a quantity of the baſis of pure air (the oxigene), by being kept long expoſed to a heat capable of raiſing Fahrenheit's thermometer to 600 degrees.

Quickſilver,

Quickſilver, with the Muriatic Acid.

(See vol. i. page 328.)

QUICKSILVER, in its metallic ſtate, does not diſſolve in the common muriatic acid; though it unites readily with it, when reduced to the ſtate of a calx, either by the force of fire, or by being precipitated from other acids: and this acid acts remarkably upon it, when it comes in contact with it in a divided ſtate; as may be ſeen by dropping it into a ſolution of quickſilver in the nitrous acid; when each drop of it lays hold of ſome of the diſſolved quickſilver, and precipitates with it in form of a white powder.

Mercurius, or Hydrargyrus acetatus.

(See vol. i. page 345.)

M. FOURCROY obſerves that a ſalt of this kind may be preſently formed by mixing a ſolution of quickſilver in the nitrous acid, with a ſolution of the diuretic ſalt (the alkali vegetabile acetatum), in water; for, immediately on mixture, the nitrous acid lays hold of the vegetable alkali, and remains diſſolved in the liquor; and the acetous acid unites with the quick-ſilver, and precipitates in form of brilliant ſpangles, which may be ſeparated by throwing the whole into a coffin of ſpongy paper, and filtrating off the liquor.

7. *Antimony.*

(See vol. i. page 347.)

CRUDE antimony, as I formerly obſerved, is a half purified ore, which on examination has been found commonly to conſiſt of about ten parts of regulus (that is, pure metal) and ſix parts of ſulphur; though the proportion of metal to ſulphur frequently varies in different parcels of this ſubſtance.

Of the Grey Calx, the Glaſs (Vitrum), the Saffron (Crocus), the Regulus, and the Argentine Flowers of Antimony.

(See vol. i. page 358, &c.)

BY reducing crude antimony to a powder, and calcining it with a ſlow fire, while it is perpetually ſtirred about till no more ſulphureous vapours ariſe, it will be found to be converted to the ſtate of a *grey calx*; and to have abſorbed, during the time of the evaporation of the ſulphur, a quantity of the oxigene, or baſis of pure air.

If this grey calx or oxide be expoſed to a great heat, it abſorbs more of the baſis of pure air, and melts into a reddiſh vitreous matter, called *glaſs of antimony*, which is more or leſs fuſible, and more or leſs tranſparent, according as it has been more or leſs calcined, or contains more or leſs ſulphur. If it contains little ſulphur, the glaſs is tranſparent, is not eaſily fuſed, and is what is called the *true glaſs of antimony*; but if it contains more ſulphur, and

and approaches more to the ſtate of a metal, and is more fuſible and opaque, it is then called the *ſaffron* or *crocus* of antimony, on account of its colour *.

If

* The crocus or ſaffron of antimony, prepared by deflagrating crude antimony in powder, mixed with an equal quantity of powdered nitre, is a preparation entirely of the ſame nature as the crocus here mentioned. From what has been ſaid above, it appears that the principal difference between the crocus and the glaſs of antimony conſiſts in the crocus containing a much larger proportion of ſulphur than the glaſs does. For a number of years paſt, great complaints have been made, that the emetic tartar was not always of the ſame ſtrength; for that at one time it was a very ſtrong active medicine, and a grain or two operated powerfully; while at another it required two or three times that quantity to produce the ſame effect. This ſhould ſeem in part to have been owing to the crocus having been uſed for making this preparation, inſtead of the preparations more free of the ſulphur; for, as we have no criterion to judge of the proportion there is of ſulphur to the regulus in the crocus, the quantity of regulus is much greater in the crocus uſed at one time than at another: beſides, in preparing the emetic tartar with crocus, if the operator is not very careful, a quantity of undiſſolved regulus precipitates along with the ſulphur, and is ſeparated along with it; by which means the emetic tartar is rendered too weak: for theſe reaſons, the glaſs

If the grey calx, or the glaſs, or the ſaffron, be mixed with an equal weight of the black flux, and a little black ſoap or oil, and be then expoſed to a ſtrong heat in a crucible, theſe ſubſtances abſorb the baſis of pure air (the oxigene) which they had imbibed during the time of their calcination; and they return back to their metallic ſtate, that is, to regulus of antimony.

If the pure regulus of antimony be melted with a ſtrong fire in an iron or an earthen veſſel, into which there is free acceſs of air, it calcines readily, that is, it abſorbs a quantity of the oxigene (or, according to Dr. Prieſtley, of water); and it riſes in form of a thick white ſmoke, which either falls back on the ſurface of the melted metal, or attaches itſelf to the cover of the crucible, where it forms a number

glaſs of antimony is preferable to the crocus; and the calx precipitated from the antimonium muriatum, by throwing it into a watery ſolution of the vegetable alkali, is preferable to either, and more likely to form an emetic tartar which will at all times be of the ſame ſtrength.

of

of ſmall white ſpiculæ, called by the name of *the ſnow, or argentine flowers, of the regulus of antimony*; which, on examination, are found to be a pure calx, or oxide, as the academicians call it.

Of the Preparations of Antimony, by deflagrating it with Nitre.

(See vol. i. from page 270 to page 272.)

NITRE abounds with the baſis of pure air (the oxigene); and, when deflagrated with crude antimony, it carries off a quantity of ſulphur, at the ſame time that it imparts to the regulus, or metallic part of the antimony, a quantity of the oxigene; and, in proportion to the quantity of nitre employed, the antimony is more or leſs freed of its ſulphur, and reduced to the ſtate of a calx.

8. *Arſenic.*

(See vol. i. page 408, &c.)

SINCE the printing of the firſt volume of this work, I have peruſed a treatiſe on the Effects of Arſenic, written by Dr. Thomas Fowler of Stafford; accompanied with two letters, one from Dr. Arnold of Leiceſter, and

and another from Dr. Withering of Birmingham, on the ſame ſubject; in which it is mentioned, that a medicine ſold under the title of *Taſteleſs Ague and Fever Drops* (or the Patent Ague Drops) has been largely circulated through the kingdom as a ſpecific for agues; which, on trial, has been found to be a preparation of white arſenic, and probably is the ſame I have mentioned in vol. i. page 410 of this work, to have been ſold by an itinerant quack in Lincolnſhire, about thirty years ago. Dr. Fowler ſays that he adminiſtered the following preparation of arſenic with ſucceſs in aguiſh complaints: he diſſolved ſixty-four grains of white arſenic, and as much fixed vegetable alkali, by boiling them in half a pint of diſtilled water, in a Florence flaſk; and then, after filtering the liquor, and adding half an ounce of compound ſpirit of lavender, he mixed with it as much more diſtilled water as made the whole to weigh exactly ſixteen ounces; by which means each ounce contained four grains of arſenic: and this medicine he adminiſtered in the following manner:

To

To patients		Drops.	
From 2 to 4	years of age, he gave from	3 to 5	twice or thrice a day, at the diſtance of 8 or 12 hours.
—— 5 to 7		5 to 7	
—— 8 to 12		7 to 10	
—— 13 to 18		10 to 12	
—— 18 & upwards		12	

Dr. Arnold and Dr. Withering both made a ſolution of eight grains of white arſenic in eight ounces of diſtilled water, without the addition of any alkaline ſalt; though Dr. Withering added nitre, to prevent the arſenic from precipitating, which Dr. Fowler alleges neutralized the arſenic, by its having a greater affinity with the alkaline baſis of the nitre than the nitrous acid; and theſe practitioners adminiſtered their medicines in doſes from 15 to 30 or 40 drops.

Theſe three phyſicians all aſſert that they have cured a great many agues by the preparations of arſenic mentioned; they acknowledge that, in ſome inſtances, the medicines produced a nauſea and vomiting, and ſometimes a purging, and ſometimes both; and that, in other caſes, they occaſioned ſwellings, particularly of the face, and of the eye-lids ; and which ſometimes were pretty general, affecting the limbs and other parts. They ſay that theſe ſymptoms were not attended with danger, but generally went off by ſuſpending the uſe of the medicine ; and by giving a puke, or a doſe of rhubarb, or a few drops of laudanum.

Notwithſtanding what theſe phyſicians have ſaid, I cannot help having doubts whether this mineral, which is of ſuch a deleterious nature, may not have produced bad effects on the conſtitutions of many of thoſe who have taken it : and I ſhould not now have mentioned it, had I not known that it is at this time adminiſtered freely in many parts of this kingdom ; and that I wiſhed that enquiries ſhould be made by practitioners, gentlemen, and magiſtrates, in the counties where it is uſed, concerning the healths of thoſe people who have taken it, and to have it aſcertained whether or not any people have fallen ſacrifices to its uſe.

SECT. V.

Of EARTHS.

(See vol. i. page 417.)

EARTHS, according to the new chymical ſyſtem, are ranked amongſt the ſimple ſubſtances. Macquer had alleged that there were only three ſorts of primitive earths, *viz.* 1. the calcareous; 2. the argillaceous; 3. and the vitreſcible. Since then Sir Torbern Bergman has mentioned five different kinds, which he ſays are diſtinct, and have not been tranſmuted into each other by any menſtruum or proceſs which has hitherto been tried; and theſe are, 1. lime or calcareous earth; 2. magneſia; 3. clay (argilla); 4. heavy earth (terra ponderoſa); 5. and vitreſcible earth, ſuch as flint, &c.

Alum.

(See vol. i. page 442.)

SINCE the firſt volume of this work was publiſhed, a ſurgeon of character informed

formed me that he had removed ſmall ſteatomatous tumors from the face, by applying to them the coagulum aluminoſum mixed with conſerve of roſes, and renewing the application daily for ſome time.

SECT. VI.

Of WATER.

(See vol. ii. page 1, &c.)

I HAVE already mentioned that the Hon. H. Cavendiſh had, from a number of experiments made in the years 1781, 1782, and 1783, concluded that water was a compound body, made up of *pure* and *inflammable airs*; and that this ſeemed to be confirmed by other experiments ſince made by M. Lavoiſier and other French academicians; but that of late Dr. Prieſtley had aſſerted that water was not a compound, but an elementary body, as it had always been believed to be; and that what water theſe gentlemen had obtained was ſeparated from the pure and inflammable airs, of which it made a confiderable part. Since then MM. Faets, Van Trooftfwyk, and Deiman, have publifhed a letter in vol. xxxv. of the *Obfervations fur la Phyfique, fur l'Hiftoire Naturelle, & les Arts*, for the laft fix months of the year 1789, in which they give an account of experiments they made by paffing the electric fpark through water; by which they think they have proved, both by analyfis and fynthefis, that water is a compound body, as the Hon. Mr. Cavendifh had afferted it to be.

They tell us that they were oppofers of the new chymical theory, till on making experiments lately, along with Mr. Cuthbertfon, on different bodies, with the electric fpark, they agreed to try what effects it would have on water; and for that purpofe took a glafs tube, the diameter of which was the eighth part of an inch, and its length twelve inches: they fealed up one end of it hermetically, after having fixed in it a gold thread (or wire), which went down about an inch and a half into the tube; and then filled it with water, and introduced by the open end a long gold thread

(or

(or wire), till its end came to within five eighths of an inch of the lower end of the ſhort thread fixed in the ſealed end of the tube; and, after putting the open end of the tube and the end of the long thread in a veſſel filled with water, they placed the tube, with its apparatus, in a proper electric machine; by working of which they conveyed the electric fire to the gold wires (or threads), and ſoon obſerved, as they worked the machine, that the electric fire came out in a ſtream from the ends of the gold wires which were near each other; and at the ſame time ſaw a number of air bubbles, ſeparated from the water, aſcend to the top of the glaſs tube, which was hermetically ſealed; and there form an apparent vacuity, by forcing down the water till it ſunk below the lower end of the ſhort gold wire, from which there iſſued a ſtream of electric fire; and ſo ſoon as this fire touched the airs which formed the ſeeming vacuum, an exploſion took place, in the ſame manner as happens when fire is applied to inflammable air, mixed with a quantity of pure air: imme-

 diately

diately after the explofion, the water in the tube rofe, and filled up moft of the vacuity which had been made by the airs that had feparated from the water.

By repeating thefe experiments for a number of times, thefe gentlemen concluded that the pure and inflammable airs (or rather their bafes, the oxigene and hydrogene) were feparated from the water, of which they made a part; and that, when the electric fpark from the lower end of the fhort tube pervaded the column which thefe airs formed, they exploded, and returned to the ftate of water.

They likewife mention a number of experiments which they made, which they think prove that the airs feparated came from the water itfelf, and not from any atmofpheric air which had been mixed with it; and that the electric fpark did not contribute in any manner to their formation. They alfo mention that, from the experiments they made, they think that the acid obtained by Dr. Prieftley and others, on mixing pure and inflammable airs together, was accidental, and was

formed

formed by ſome *impure air*, which had ſome how or other been mixed with the pure or inflammable airs employed, and united with ſome of the pure air, and formed nitrous acid; though they do not ſeem to have proved this laſt fact. The particular account of theſe experiments, which is inſerted in the above-mentioned work, deſerves to be peruſed by all thoſe who are employed in making experiments of this kind; and the force of the arguments uſed to prove that water is a compound body, ought to be well conſidered.

SECT. VII.

Of Mineral Waters.

(See vol ii. page 14, &c.)

1. *Of Hepatic Air.*

THE principal diſcovery made with regard to mineral waters ſince the printing of vol. ii. of this work, is that of the nature of hepatic air, with which moſt natural ſulphureous waters are impregnated.

Sir Tobern Bergman, as I have mentioned in vol. ii. page 60, had alleged that ſulphur had been reſolved into the form of vapour, by means of phlogiſton and the matter of heat in the ſulphureous mineral waters; and that the ſulphur might be precipitated from theſe waters by the addition of the ſtrong nitrous acid, which attracted the phlogiſton that was united to the matter of heat: but M. LAVOISIER has ſince then, in the Memoirs of the Academy of Sciences, proved that hepatic air, which gives the ſmell, taſte, and other ſulphureous qualities, to mineral waters, is nothing but ſulphur, diſſolved and ſuſpended in inflammable air. This hepatic air may be got by adding ſulphureous acid to hepar ſulphuris, or to ſulphur united to iron; and it is produced in moſt proceſſes where ſubſtances containing inflammable air and ſulphur are employed. This hepatic air may be decompoſed by the addition of pure air, or of any other body which has a greater affinity with inflammable air, than inflammable air has with ſulphur; and hence moſt mineral ſulphureous waters let drop their ſulphur on being expoſed to the open air, or when nitrous acid, or aërated muriatic acid, is added to them, as they are taken up from their ſprings.

1. *Tilbury Water.*

(See vol. ii. page 70.)

IN the account of the analyſis of this water publiſhed by Dr. Higgins in the year 1780, the Doctor, amongſt other products, ſays that he got 49 grains of true nitre from a Wincheſter gallon of this water. If no miſtake has been committed in performing the analyſis, this is the only water ſituated at a diſtance from large cities, in this country, in which a true nitre has been found. It is to be wiſhed that this water was repeatedly evaporated, to aſcertain the true nature of its ſalts.

2. *Cheltenham Water.*

(See vol. ii. page 134.)

IN a late account of this water, publiſhed by Dr. Fothergill, of Bath, 2d edition, a wine gallon of theſe waters contain the following principles:

Of Solid Contents.

1. *Purging ſalt*, partly Glauber, partly Epſom, an ounce, or 480 grains. 2. *Of marine ſalt*, 5 grains. 3. *Of iron*, combined with fixed air, nearly 5 grains. 4. *Magneſia*, combined partly with marine acid, partly with fixed air, 25 grains. 5. *Calcareous earth*, combined with vitriolic acid in form of ſelenites, 40 grains.

Of Aërial Fluids.

1. Fixed air combined with water, 24 ounce meaſures. 2. Phlogiſticated air, with a portion of hepatic air, alſo looſely combined with the water, 8 ounce meaſures.

3. *German*

3. *German Spa Waters.*

(See vol. ii. p. 128.)

In the year 1788, Dr. John Aſh publiſhed an account of five of theſe waters, and gives the following table of their contents:

Fountain.	Quantity of water.	Solid contents.	Aerated lime.	Magneſia aerated.	Aerated min. alkali.	Aerated iron.	Selenite.	Aerated veg. alkali.	Gas, ounce meaſure.
Pohoun	33 ounces	$16\frac{1}{4}$ grains	$2\frac{3}{4}$ grains	$9\frac{1}{2}$ grains	$2\frac{1}{4}$ grains	$1\frac{3}{4}$ grains			$35\frac{3}{4}$
Geronſtere	$32\frac{3}{4}$	$5\frac{1}{2}$	$2\frac{1}{2}$		$1\frac{3}{4}$	$\frac{3}{4}$	$\frac{1}{2}$ grain		$24\frac{3}{4}$
Sauviniere	$32\frac{1}{2}$	$3\frac{3}{4}$	$1\frac{1}{2}$		$2\frac{3}{4}$	$\frac{1}{2}$		1 grain	$33\frac{1}{2}$
Groiſbech	$32\frac{1}{4}$	$5\frac{1}{4}$	$1\frac{1}{2}$		1	$\frac{3}{4}$		2 grains	$35\frac{1}{2}$
Tonnelet	32	2	$\frac{1}{4}$		$\frac{3}{4}$	$\frac{3}{4}$			$40\frac{3}{4}$

SECT. VIII.

Of Vinous Liquors, Fermentation, &c.

(See vol. ii. page 202, &c.)

NOTHING at preſent ſeems neceſſary to be added to what has been ſaid on Fermentation and Vinous Liquors, in vol. ii. and in part ii. of this Appendix.

1. *Of the Mixture of Spirit with Vitriolic Acid.*

(See vol. ii. page 220.)

HAVING mentioned the moſt approved methods of obtaining the *dulcified ſpirit, the oil of wine*, and the *vitriolic æther*, from the mixture of ſpirit with this acid, I ſhall only now obſerve that chymiſts have differed very much with regard to the proportion of ſpirit to the acid which they have uſed: ſome have ordered ſix parts of ſpirit to one of the acid, while others have ordered an equal weight of each; and of late that has been the proportion adopted in moſt of the new Pharmacopœias; and the

the oil of wine has been ordered to be drawn off, as I have mentioned, from the materials which remain in the retort, after the diſtillation of the dulcified ſpirit, which contains the æther. Some have lately directed the oleum vini to be prepared by a diſtinct proceſs, in which double the weight of vitriolic acid to that of the ſpirit is employed; but on enquiring at Apothecary's Hall, and of Mr. Godfrey and other chymiſts who had performed this proceſs, I was informed that the product of oil of wine obtained by this proceſs is ſo ſmall as to render it a much dearer medicine, than that got by diſtilling from the materials which remain after the diſtillation of the dulcified ſpirit, and that it is not better in quality.

2. *Æther Vitriolicus.*

(See vol. ii. page 233.)

M. LAVOISIER, in his Traité Elémentaire, p. 14, obſerves that, as a heat equal to that of the blood is capable of raiſing æther into aërial vapour, it muſt be converted

verted into that ſtate in the firſt paſſages when ſwallowed as a medicine ; and that probably many of its virtues depend on this mechanical effect, if one may term it ſo.

S E C T. IX.

Sulphur.

(See vol. ii. page 248.)

I HAVE already mentioned that the authors of the new theory of chymiſtry have alleged that ſulphur is a ſimple ſubſtance, which, by the addition of the baſis of pure air, is converted into the ſulphureous or vitriolic acid ; and that the ſupporters of the doctrine of phlogiſton ſtill imagine it to be a compound formed of the ſame acid and phlogiſton.

Of late it has been diſcovered to be ſoluble in inflammable air; and, when diſſolved in this menſtruum, forms what is called hepatic air, which is the matter which commonly gives the ſulphureous properties to the ſulphureous mineral waters.

Hepar

Hepar Sulphuris, or Sulphur Alkaliſatum.

(See vol. ii. page 261, &c.)

DR. NAVIER, a phyſician at Chalons in France, who has made it his ſtudy to diſcover the medicines which counteract the effects of mineral poiſons, has recommended the hepar ſulphuris as one of the beſt remedies for preventing the bad effects of *arſenic* and of *corroſive ſublimated mercury*, when taken down into the ſtomach, and to remove complaints ariſing from the effects of lead. He orders, in ſuch caſes, to diſſolve a dram of hepar ſulphuris in a French pint (near an Engliſh quart) of water, and to give frequent repeated glaſsfulls of this ſolution to people who have ſwallowed any of the above-mentioned corroſive ſubſtances; or to make them take five, ſix, or more grains of the hepar ſulphuris made up into pills with ſome mild body, in frequent repeated doſes, and to drink a glaſs-full of warm water after each doſe. In caſes of arſenic he ſays that the addition of iron improves the virtues of this

this remedy ; for the hepar unites with the arſenic to form orpiment, at the ſame time that it combines with the iron.

SECT. X.

Foſſil Oils.

(See vol. ii. page 261, &c.)

M. MACQUER had alleged that theſe oils are of vegetable origin : M. Fourcroy and Parmantier think that ſome of them have been ſo ; but that others were originally animal oily matter, particularly of ſhell and other ſea fiſh ; as they are often found in the earth at places where there are layers of ſhells, and other traces which ſhew that they had been formerly covered with the ſea.

SECT. XI.

Animal Oils.

(See vol ii. page)

M. FOURCROY, in his Leçons de Chimie, obſerves that the fat of man and of quadrupeds

quadrupeds has consistence, and is white or yellow; that of carnivorous animals is more or less fluid; that of animals which live on fruits or herbs is firm and solid; that of birds is more fine, soft, and unctuous; that of fishes is almost fluid; and that the fat of all animals is softer and more fluid in the living than in the dead subject.

I have already observed that all oils contain an acid, and that the firmer consistence they have, the more acid in general they yield; and in page 99 of vol. i. I mentioned that probably the acid of our food and drink was united with the oily particles of our fluids by the animal process, and formed the fat; and, since the publication of this work, I was happy to see that so ingenious a physician as Dr. Cullen, in the second volume of his Materia Medica, page 338, published in the year 1789, had adopted this doctrine. The effects of fixed alkaline salts (which are of an opposite nature to acids) on the human body, seem in some measure to confirm this conjecture; for I have observed that most people, who have put themselves on

a course

a courſe of the ſoap ley, with an intention of diſſolving the ſtone in the bladder, and continued this courſe for ſome time, have been emaciated thereby.

S E C T. XII.

Oil of Camphor.

(See vol. ii. page 326, &c.)

A YELLOW, clear, tranſparent liquor, ſmelling ſtrong of camphor, which goes by the name of its oil, is often brought home from the Eaſt-Indies, where it is much eſteemed as a powerful remedy for removing rheumatic and other pains, by being rubbed on the parts affected. Whether it is got by diſtillation from the camphor tree (the *laurus camphora*), or from any other ſubſtance; or whether it be a ſolution of camphor in any particular liquor, or a preparation made by diſtilling camphor along with other things, I know not, having never been able to procure any authentic account of it. I have had ſeveral ſpecimens of it given me by gentlemen who

brought

brought it home from the Eaſt-Indies, but none of them could give me any information of its origin.

S E C T. XIII.

Mucous Gums, Starch, and Sugar.

(See vol. ii. pages 434 and 443, &c.)

M. LAVOISIER, in his Traité Elémentaire, chap. xi. ranks *mucous gums*, *ſtarch*, and *ſugar*, amongſt the vegetable oxides: he ſays they contain inflammable air united to charcoal, ſo as to form in a manner one baſis, which is brought into the ſtate of an oxide by a portion of the baſis of pure air (the oxigene); that they do not differ from one another, but in the proportion of the principles which compoſe them; and that they may be made to paſs to the ſtate of acids, by combining with them an additional quantity of the baſis of pure air, the oxigene. The acid which Sir Tobern Bergman got from ſugar, by pouring nitrous acid over it, and diſtilling, ſhould ſeem to have been formed in this manner; that is, the nitrous acid which abounds with the oxigene, ſhould ſeem to have imparted to the ſugar ſuch a quantity of it, as to convert its acidifiable parts into an acid.

S E C T. XIV.

Cantharides (Spaniſh Flies).

(See vol. iii. page 39, &c.)

M. FOURCROY, in his Leçons Elémentaires, tells us that M. Thouvenel analyſed the cantharides, and found that one half of the dried inſect conſiſted of the viſcera (un Parenchyma) which he did not examine; that an ounce of the other part yielded three drams of an extractive yellow reddiſh matter, which afforded an acid by diſtillation, twelve grains of a yellow waxy matter, that gives colour to the flies, and ſixty grains of a green oily matter, analogous to wax, which ſmells of the cantharides, and has a ſharp taſte; and, if diſtilled, yields a ſharp acid, and a concrete oil like wax.

Water

Water diſſolves the yellow extractive matter, the yellow oil, and even part of the green; but æther only diſſolves this laſt, and may be employed to ſeparate, from the other matters, this green waxy oil, in which the virtues of the cantharides reſide. In order to obtain a tincture which ſhall contain the extractive matter, as well as the green and yellow waxy part, one muſt employ a liquor compoſed of equal parts of alkohol and water, which if diſtilled affords a ſpirit that ſmells ſtrong of the cantharides. M. Thouvenel tells us that he tried the effects of the green waxy matter, in which the virtue of the cantharides reſides, on himſelf; and found that nine grains of it applied to the ſkin raiſed a bliſter full of ſerum; and that the tincture above-mentioned, when applied externally, in the quantity from two drams to two ounces and a half, produced good effects in rheumatic pains, the ſciatica, and wandering gout; that it warms the parts, accelerates the circulation, and excites an evacuation by ſweat, by urine, or by ſtool, according to the parts to which it is applied.

Cinchonæ Species, quæ Insulâ Sanctæ Luciæ innascitur.

IN the year 1783, Mr. Davidſon, one of the ſurgeons to the troops then at the iſland of St. Lucia in the Weſt-Indies, ſent to Mr. George Wilſon, apothecary in Henrietta-Street, Covent-Garden, a quantity of bark got from a ſpecies of the cinchona, or Peruvian bark tree, which had been diſcovered growing in that iſland by a Mr. Alex. Anderſon; accompanied with an account of its effects in curing intermittent diſorders in that iſland.

In the year 1784, an account of this bark was publiſhed in vol. lxxiv. art. 34, page 452, of the Philoſophical Tranſactions. This bark breaks more woody, is more nauſeous than the true Peruvian bark, and has an emetic and purgative quality. Its decoction is of a dull Burgundy colour, and its extract reſembles more the bitter of gentian, than of the true cinchona. Sir Joſeph

ſeph Banks, who examined the ſpecimens of the tree ſent home, ſays that the tree is undoubtedly a cinchona, but not the cinchona officinalis of Linnæus.

The bark, which was firſt uſed at the iſland of St. Lucia, not having been ſufficiently dried, had a ſtrong emetic and purgative quality, which ſoon brought it into diſrepute; but afterwards Mr. Davidſon having procured ſome which had been kept long, and was perfectly dry, he again adminiſtered it; and it fully anſwered his wiſh, and cured a number of ſoldiers who laboured under intermitting complaints.— He generally uſed the cold infuſion of it, either prepared in lime-water or in ſimple water, in the proportion of one ounce to three pints of the water. He ſays, "I have likewiſe given it in ſubſtance from 20 to 30 grains, but never exceeded the laſt quantity: in general the ſtomach would not retain more than 20 grains." This bark, mixed with canella alba, yields an agreeable and elegant tincture with ſpirit. A tincture made with the ſeeds has an infinitely ſtronger taſte than the bark itſelf.

This bark has been tried in the London hoſpitals; but it was found ſtill to retain its emetic and purgative qualities.

In remitting and intermitting complaints, particularly of the warm climates, where the firſt paſſages are loaded with bile, it may probably be found to be a very uſeful remedy to clear off the bile, before the true bark is adminiſtered; and if its emetic and purgative qualities can be corrected by the addition of cordials and opium, it may prove a good ſubſtitute for the true bark, where that cannot be had.

Duke of Portland's Gout Powder.

BETWEEN forty and fifty years ago a powder compoſed of equal parts of the roots of *birthwort* and *gentian*, and of the leaves and tops of the *germander*, *ground pine*, and *leſſer centaury*, was recommended as a cure for the gout. It was ordered to be taken in doſes of a drachm every morning faſting, in a tea-cupful of wine and water, broth, or tea, for three months; and then three fourths of this quantity for three months longer; and

afterwards

afterwards half, for ſix months; and, when the year was out, to take half a drachm every other day for a year longer. It was called lately the Duke of Portland's Powder, from the late Duke having been believed to have received benefit from its uſe.

Medicines of this kind were uſed many hundred years ago by the Greek phyſicians, as we ſee by the account given of them by the late Dr. Clephane, in art. 14 of vol. i. of London Medical Obſervations and Enquiries. He ſays many of the ancient phyſicians beſtow great encomiums on the uſe of medicines of this kind, in that ſort of gout which they call pituitous; though in the other ſpecies of gout, which they term ſanguineous and bilious, they deemed them prejudicial; and Ætius ſays they are extremely hurtful in the hot and bilious habits, and are only proper in cold and phlegmatic conſtitutions.

The ancients recommend the uſe of theſe remedies principally in recent caſes; and ſeem to think that their uſe is unſafe, if the gouty perſon has already laboured

 under

under the diſorder for five years, or at fartheſt for ſeven years.

Several people in England have been thought to have hurt their health by the uſe of this powder; and the death of others has been ſuppoſed to have been haſtened by the ſame means: and Dr. Cullen, in his Materia Medica, publiſhed laſt year, mentions that ſome people of rank in Scotland, who took theſe powders for above a year, in the manner recommended, ſeemed at firſt to receive benefit, but afterwards died of complaints which were ſuppoſed to have been occaſioned by the effects of this powder; which has brought it into diſrepute in that country.

Fumaria. *H.*

Fumaria Officinalis—Fumitory, the herb.— This plant has long been eſteemed to be a moſt uſeful bitter; and formerly was much uſed to ſtrengthen the tone of the viſcera. It looſens the belly, and promotes the urinary and other ſecretions; and it has been greatly recommended for its efficacy in removing many cutaneous diſorders. Simon Pauli aſſerts that he has removed the moſt inveterate ſcabies by an infuſion of this herb in whey of cow's milk, and by decoctions of it in beer: Hoffman and many other authors extol its virtues greatly; and Dr. Cullen, in his Materia Medica, vol. ii. page 77, ſays that he has experienced its good effects in many inſtances of cutaneous diſorders, which he would have called the lepra.

Its expreſſed juice is given the length of two ounces, two or three times in the day; and an extract is ordered to be made from it, in many of the foreign diſpenſatories, which is adminiſtered for the ſame purpoſes as the herb itſelf.

The dried plant retains the flavour and taſte of the freſh, and is uſed in infuſion and decoction when the freſh plant cannot be procured.

Maredant's Drops.

THIS medicine, which ſometimes of late goes by the name of Norton's Drops, has been

been ſold in large quantity for the cure of eruptive diſorders. By the receipt of it given in to the Patent Office, and by its frequently having brought on a ſalivation, it ſhould appear to be only a ſolution of the corroſive ſublimate mercury.

The original proprietor ſhould ſeem to have been guilty of an evaſion, when he gave in the receipt to the Patent Office; for he only mentions the ingredients, which he tells us are *corroſive ſublimate, gentian and ginger roots, and cochineal*; but takes no notice of the proportions uſed of any of them, or of the menſtruum in which the tincture is prepared. It is given in doſes which are meaſured by the number of drops.

Nux Moſchata.

THE nutmeg is ſaid by Bontius, in his treatiſe *De Medicina Indorum*, to have a ſoporific quality. Dr. Cullen, in vol. ii. page 204 of his Materia Medica, mentions his having ſeen an inſtance of this:—A perſon

perſon ſwallowed in the forenoon above two drachms of nutmeg in powder: he felt no uneaſineſs for an hour; but at the end of that period he was ſeized with a drowſineſs, ſucceeded with a complete ſtupor. Being put to bed, he continued in a deep ſleep for ſome hours, waking from time to time in a ſtate of delirium; and ſoon after dropt again aſleep. He continued in this manner for above ſix hours, when he awoke perfectly returned to his ſenſes; though he ſtill complained of a head-ach and drowſineſs all the remainder of that day. But going to bed late in the evenii g, he fell into a profound ſleep, and awoke next morning in good health.

Of the Tables of Affinities or Elective Attractions.

OF late M. Lavoiſier * and his aſſociate academicians have raiſed a number of

* See M. Lavoiſier's notes on Mr. Kirwan's criticiſms on his Table of Affinity of the Oxigene, in page 46, &c. of the French tranſlation of Mr. Kirwan's Eſſay on Phlogiſton and Acids.

objections

objections to all the tables of affinities, or of elective attractions, which have hitherto been offered to the public; the principal of which are,

1ſt. That they only repreſent the reſults of ſimple affinities; whereas there only exiſt in nature, ſo far as has been obſerved, caſes of double affinity, often triple, and others perhaps ſtill more complicated.

2dly. That they take no account of the effects of the attractions of water, and perhaps its decompoſition in its combinations in the humid way: it is conſidered as an agent ſimply paſſive, though it acts with a real and diſturbing force, which ought to be brought into conſideration in the reſults.

3dly. That there are certain ſubſtances which, when combined with others, have two or three evident degrees, or periods, of ſaturation: and there are others in which a greater number obtain; as is the caſe with the baſis of pure air, called oxigene, and acidifiable baſes.

4thly. That different degrees of heat, applied to the ſame ſubſtances, produce different

ferent effects on them: thus mercury, or quickſilver, expoſed for a long time to a certain degree of heat, in a place to which there is acceſs to air, attracts the oxigene, and is converted into an oxide or calx: but if this calx be expoſed to a ſtill greater heat, which is capable of ſoftening glaſs, the oxigene, which had been abſorbed, is diſengaged, and the mercury is revived, or returns to the ſtate of quickſilver.

For theſe reaſons neither M. Lavoiſier, in his Elementary Treatiſe, nor M. Fourcroy, in his third edition of his Elements of Natural Hiſtory and Chymiſtry, has given us any general tables of affinities.

But although the objections raiſed are certainly juſt, and the tables we have are for theſe reaſons defective in many points; yet we know that they have been the inſtruments which have led to many of the moſt important diſcoveries of modern times; and therefore they ought not to be laid aſide, till others, in which their defects have been ſupplied, are conſtructed.

Lunar Caustic, or Nitrated Silver.

IN vol. iii. page 307 of the Annales de Chimie, publiſhed by MM. Morveau, Lavoiſier, &c. we are informed that M. Hahnemann has proved that lunar cauſtic (the argentum nitratum Pharm. Lond.), which is ſilver diſſolved in the nitrous acid and evaporated to dryneſs, is one of the moſt powerful antiſeptic ſubſtances known; for if one part of it be diſſolved in 500 parts of pure water, the water thus impregnated will preſerve a piece of meat (animal fleſh) for ever from putrefaction.

And if a ſtronger ſolution be uſed, and the meat be kept in it for 15 days, and be then expoſed to heat, it dries without putrefying, and hardens ſo that no worms will affect it.

If one part of the lunar cauſtic be diſſolved in 1000 parts of pure water, it will preſerve it ſweet in every degree of heat, provided it be not expoſed to the ſun. If people are afraid to drink the water in this ſtate, which certainly cannot be attended with any ſort of danger, they may, before

uſing

uſing it, diſſolve in it a little common ſea ſalt, which will precipitate ſome of the ſilver in form of a black powder, when expoſed to the heat of a fire, or to the ſun.

M. Hahnemann has employed with ſucceſs a ſolution of one part of lunar cauſtic in 1000 parts of pure water, for the cure of old ſores, particularly of thoſe of the mouth, occaſioned by the uſe of mercury; and he has found aſtoniſhing good effects from the uſe of this water, as a drying and ſtrengthening remedy.

Repeated trials ought certainly to be made of the effects of this ſolution of ſilver in the nitrous acid, to aſcertain whether it may be uſed in quantity with ſafety; as it may be of the greateſt ſervice in preſerving meat as well as water in long ſea voyages, ſhould it be found not to injure the health of thoſe who uſe it.—And trials ought likewiſe to be made with the pure nitrous acid, to aſcertain whether the effects produced depend on the ſolution of ſilver, or upon the acid independent of the ſilver.

Acer Major, & Periclymenum rectum foliis laurinis.

BFFORE concluding this treatise, I think it is right to observe, that there are two substances mentioned in it, both growing in cold climates, which particularly deserve the attention of the public; which are—1st, the acer major, or great maple tree, which grows in Canada, whose juice yields a sugar that is used by the inhabitants of the country.—2d. The other the periclymenum rectum, foliis laurinis, or tree which affords the warm aromatic bark, called after Capt. Winter, Winter's bark. Both these trees would probably grow in this climate; and the sugar and warm bark which they afford, would be of the greatest service to the poorer sort of people, particularly to the inhabitants of the mountainous parts of this island. *

* The seeds or young plants or shoots of the great maple tree, may be easily imported by the ships which come yearly from Canada; and those of the winter bark tree, which grows on the shore of the Streights of Magellan, in South America, by the vessels employed in the southern whale fishery.

FINIS.

A

GENERAL INDEX

TO THE

THREE VOLUMES AND THE APPENDIX,

The LONDON PHARMACOPOEIA excepted, which has a copious Index annexed to itſelf.

N. B. The names in this Index are all in Engliſh, as the Latin Names are moſtly uſed in the Tables of Contents of each Volume; and in the Table to Vol. III. the Latin Names of entire Animal and Vegetable Subſtances are ranged alphabetically with the Engliſh Names after each; ſo that a Latin Index was not neceſſary.

A.

U Æther

B.

Balsam

Gold,

H.

I.

K.

LABDANUM,

2

Scammony,

T.

V.

U.

W.

F I N I S.

ERRATA CORRIGENDA.

Vol. i. p. 269, l. 20, *for* vitriolatum, *read* muriatum.

Vol. iii. p. 325, l. 4, *for* grapes, *read* dried grapes, or raiſins.

Ap. p. 86, l. 10, ~~*for* 88 and 89, *read* 87 and 88~~.

—— p. 103, ~~*for* vol. lxxix. *read* vol. lxxviii.~~

—— p. 112, l. 17, *for* poung, *read* pouring.

—— p. 114, l. penult. &c. *for* By itſelf it burns ſlowly, *read* By itſelf in an open veſſel it burns ſlowly when fire is applied, and that only on the ſurface where it is expoſed to the external air.

—— p. 144, lin. penult. *for* paple tree, *read* maple tree.

—— p. 163, l. 19, *for* equilibrium, *read* equilibrio.

—— p. 206, l. 3, *dele* filled.

—— p. 231, l. 11, *for* p. 69, *read* p. 59.