FIRST LINES

OF THE

THEORY AND PRACTICE

OF

PHILOSOPHICAL CHEMISTRY.

BY

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TO THE

RIGHT HONOURABLE

WILLIAM EDEN,

AMBASSADOR EXTRAORDINARY

FROM

HIS BRITANNIC MAJESTY

TO THE

CATHOLIC KING,

L.L.D. and F.R.S. &c. &c. &c.

THIS VOLUME

IS

INSCRIBED,

BY HIS

MOST FAITHFUL

HUMBLE SERVANT,

THE AUTHOR.

PREFACE.

PERSONS, who know nothing more of Chemiſtry than the name, naturally ſuppoſe it to be a trade exerciſed by the ſhopkeepers, called *Druggiſts and Chemiſts*, who are thought to be chiefly employed in preparing medicines for the uſe of apothecaries; Chemiſtry, therefore, they imagine, belongs excluſively to phyſic: but if, excited by curioſity, they become better acquainted with this bewitching ſcience, they will ſoon diſcover its intimate connection with every other branch of human knowledge; and that the arts and manufactures ſo peculiarly conducive to the proſperity of nations, conſtantly look up to Chemiſtry in their progreſs towards perfection. In this point of view, it claims the ſupport of miniſterial power in all countries.

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The hiſtory of Chemiſtry, like the hiſtories of nations, originates in fable and obſcurity; nor, indeed, if it were poſſible to diſpel the cloud by which it is enveloped, would the diſcovery anſwer any rational purpoſe. Whether angels, falling in love with the fair daughters of men, and having no gold wherewith to purchaſe their favours, taught them how to make it?—Whether Tubal-Cain underſtood metallurgy?—Whether Tubal-Cain and Vulcan were the ſame perſon?—Whether Hermes was Noah's grandſon?—Whether, becauſe Moſes burnt and pulverized the golden calf, and made the children of Iſrael to drink it, we are to conclude that he underſtood Chemiſtry?—Whether Hermes the elder, or Hermes Triſmegiſtus, were the firſt Chemiſts in Egypt?—Theſe enquiries, I ſay, important as they may be to antiquarians, are of no conſequence in the hiſtory of Chemiſtry.

Suidas (who lived in the tenth century) tells us, that Diocletian (who lived ſeven centuries before him) ordered all the books in in Egypt, that taught the art of preparing gold or ſilver, to be burnt. Probably they were numerous; and, ſince the invention of printing, no leſs than 5000 volumes on alchemy have been publiſhed. If theſe had alſo been burnt, we ſhould have ſuſtained no great loſs. The authors of theſe books did not intend to inſtruct, but to deceive the world into a belief that they converſed with devils, who had revealed to them the moſt profound ſecrets of nature, particularly that by which ſhe makes gold; and they took ſuch ſpecial care to envelope their ignorance in myſtery, that their books are perfectly unintelligible.

It has been often ſaid, by way of apology for theſe alchemiſts, that in their attempts to make gold, or to produce an univerſal medicine, they ſtumbled accidentally upon valuable diſcoveries. I do not recollect what theſe valuable diſcoveries were; but I know that the preſent ſyſtem of philoſophical Chemiſtry is founded principally on diſcoveries made within our own times.

The Greeks and Romans doubtlefs were fo far acquainted with metallurgy, as to fmelt metals from their ores, and manufacture them into coins, utenfils, and ornaments; but they have bequeathed us no chemical books.

The Arabian phyficians who lived in the eighth, ninth, and tenth centuries, wrote feveral alchemical books in Arabic, fome of which were tranflated into Latin. The fourteenth and fifteenth centuries produced feveral Chemifts of the fame ftamp. Thefe were fucceeded, in Germany particularly, by men of abilities, who made confiderable progrefs in metallurgy. But, how carefully foever we may trace the progrefs of Chemiftry from Tubal-Cain down to the beginning of the prefent century, it is not till we arrive at this late period that we meet with any difcovery of importance to the conftitution of a rational theory. Stahl, a German phyfician, had the fingular felicity of difcovering, or rather of comprehending that principle of inflammability, and of all

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metallic ſubſtances, which Beccher had called *phlogiſton*, the real exiſtence of which hath been ſince irrefragably demonſtrated by other Chemiſts, and particularly by our countryman Mr. Kirwan, in a late very excellent treatiſe on this particular ſubject. A modern ſect of French philoſophers, called *Antiphlogiſtians*, have endeavoured to blow up this firſt pillar of chemical theory; but in vain: it ſtands upon the firm baſis of demonſtration, and it will ſtand forever.

The ſecond pillar of rational Chemiſtry, is our preſent knowledge of the exiſtence and properties of that elaſtic fluid called *fixed air*, or *calcareous gas*, or *aerial acid.* For this knowledge we are entirely indebted to Dr. Black, profeſſor of Chemiſtry at Edinburgh. Without this knowledge, innumerable chemical phenomena were inexplicable. He publiſhed his experiments in 1755. But the nature and properties of this elaſtic fluid were never fully inveſtigated till the year 1774, when Bergman read an admirable dissertation on the subject, to the Royal Academy of Upsal.

The third pillar of the science of Chemistry, is the doctrine of chemical attractions: its foundation was laid by Geoffroy, and it was finished by the immortal Bergman; from whose dissertations, together with those of his countryman Scheele, there is more of Chemistry to be learnt, than from the thousands of volumes by which they were preceded. Alas! these two excellent men are no more!

The fourth grand column on which our present system rests, is the positive knowledge, that there are in nature five distinct primitive earths, two of which were unknown to Macquer, even so late as the publication of the last edition of his dictionary. Margraaf had divided earths into four species, and Baumé had reduced them to two.

The fifth pillar of Chemistry, is our present knowledge of the existence and properties of various permanently elastic aerial fluids.

fluids. It is a column of the composite order. Dr. Hales built the base about fifty years ago. Dr. Priestley erected the entire shaft, and Mr. Cavendish finished the capital by his discovery that pure and inflammable air constitute water.—" *Non dubito fore plerosque qui hoc genus scripturæ leve, et non satis dignum, judicent.*" I am of the same opinion; but I have not leisure to alter it.—This reminds me, that there are some few passages (I hope not many) in this volume, on reading which, philosophers will, with reason, accuse me of too much levity. Doubtless, to laugh is beneath the dignity of philosophy; but I should think, she might sometimes be permitted to smile.

Other proofs of the rapid progress of Chemistry in the present age, are the discovery of several new semi-metals, which, in all, are now nine in number; the multiplication of acids, distinctly characterized, from six or seven, to upwards of twenty; and the discovery of ten different species of aerial fluids.

Mineralogy, which is now properly confidered as a branch of Chemiftry, hath, in confequence of this confideration, been, in Sweden and in Germany, wonderfully improved, and finally reduced to a regular fyftem, by Mr. Kirwan, in his admirable *Elements of Mineralogy*.

From the prefent fcientific manner of inveftigation, an infinite number of important fecrets of nature have been difcovered; but thefe difcoveries are but a part of the obligation which Chemiftry owes to the philofophy of the prefent age: it is to the knowledge of that fcientific manner of inveftigation that fhe is principally indebted; that *modus operandi*, from which future difcoveries are to be expected.

From the preceding part of this preface, it muft appear that Chemiftry is an entire new fcience; that all the old books are ufelefs, and that many of thofe of no very ancient date, muft be defective and erroneous. This truth is the beft apology I can make for obtruding the preſent volume on the public.

I have mentioned a new ſect of philoſophers called *Antiphlogiſtians.* The reader may perhaps be curious to know ſomething of their origin and their creed. Who was the real founder of this ſect, I am not quite certain. I think that honour is due to M. Lavoiſier, a Chemiſt high in fame, and very deſervedly ſo: but, I believe, their whole ſyſtem was firſt promulgated in Fourecroy's *Elements de Chimie.* Their doctrine is briefly this:

1. Phlogiſton has no exiſtence.

2. Inflammable bodies contain no principle of inflammability; but are inflamed in conſequence of their attraction to the acid principle of pure air, which pure air conſiſts of this acid principle and the matter of heat or light. Now this pure air being thus decompoſed, the matter of heat and light is ſet at liberty, and inflammation and combuſtion are the conſequence.

3. This *oxygenous* principle, as they are pleaſed to call it, of pure air, combined with a baſis peculiar to each, conſtitutes all acids.

4. Fixed air is a combination of charcoal and pure air: conſequently charcoal exiſts in all bodies that contain fixed air.

5. When metals are diſſolved in acids, the water contained in the acid is decompoſed: its pure air unites with the metal and forms a calx, and its inflammable air is ſet free.

Such are the fundamental principles of this new philoſophical Chemiſtry. It was born in France, and there let it die. It has been conſidered in other nations only to be ridiculed.

Probably it may be expected that I ſhould apologize for having, in different parts of this volume, taken the liberty to contradict the illuſtrious French Chemiſts Baumé and Macquer. I confeſs, *they are both honourable men*; I eſteem them for their zeal, their aſſiduity, and their abilities; their books are uni-

universally read, and, for that very reason, their errors are dangerously important. The first of these Chemists is so unfortunate as to be mistaken, in point of theory, in almost every page of his voluminous publications; and, what is still worse, *il fait plier souvent l'experience a la theorie.*—M. Macquer's Dictionary *was* a very useful book. Before it be re printed it should be re-written, and the diffusive alphabetical dissertations of which it consists, condensed into half the number of pages.

I have taken some liberty with our great national *Cyclopædia*. It is so very useful a book in its present state, that the editor deserves every acknowledgement from the public. But the Chemistry of Mr. Boyle, and of the early volumes of the Philosophical Transactions, both French and English, should have been retained *historically* only, and always contrasted, and, when necessary, refuted by later discoveries.

If, in the Table of Philosophical Opinions, I have been guilty of misrepresentation,

I hope

I hope thoſe whom I have thereby offended, will do me the favour to ſet me right.

That there are *blots* in this volume, I make no doubt; and, with great ſincerity, I declare, that I wiſh they may be *hit*.— The diſcovery of truth is, or ought to be, the ſole object of philoſophical enquiry; and he that is offended at the means by which the diſcovery is made, deſerves not the name of a philoſopher.

When I began the ſecond part of this volume, I meant to proceed ſyſtematically; but finding it impoſſible to reduce the remainder of the practical part to a ſcientific arrangement, without frequent repetitions and omiſſions, I determined to throw it into the form of a dictionary; which form, I believe, the reader will find moſt convenient.

A CRONOLOGICAL CHART of EMINENT CHEMISTS.

A.D.				
	A R A B I A.			
700.	Geber.	Meſue.	Rhazes.	Avicenna.
	GERMANY, &c.	BRITAIN.	FRANCE AND ITALY.	SWEDEN.
1200	Albertus Mag.	Rog. Bacon		
1300	Js. Hollandus Bas. Valentine	Geo. Repley	Arnoldus R. Lully	
1500	Paracelſus Agricola Earckern Eraſtus.			
1600	Libavius V. Helmont Glauber Kunckel Beccher Homberg	Boyle	Lemery	
1700	Stahl Hoffman Boerhaave Juncker Henkel Pott Cramer Newman Margraaf Achard Quiſt Weigleb Rinman Hermſtædt Weſtrumb Heyer Gmelin Meyer Crell Klaproth Richter Rothenberg Troſtwick Schiller Stouth Piepenbring.	Shaw Hales Cullen Black Lewis Prieſtley Bewly Cavendiſh Kirwan Watt Woulfe Watſon Higgins Perceval Beddoes Keir Withering Wedgewood Falconer Nooth Henry	Geoffroy Macquer Baumé Fontana Landriani Rozier Morveau Saluces Sauſſure Metherie Lavoiſier Fourecroy Berthollett Haſſenfratz Sage Senebier De la Place Monnet Laſſone D. de Chaulnes Lauragais M. d'Arconville Montigny Trudaine Brugnatelli Gadolin Bonvoiſon Lorgna.	Cronſtedt Brandt Swab Gahn Scheele Bergman Rinman Hielm.

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FIRST LINES

OF

CHEMISTRY.

CHAP. I.

CHEMISTRY, as a Science, involves the whole creation. Many of the operations of Nature in the atmoſphere, in the animal œconomy, and in the vegetable and foſſil kingdoms, are chemical proceſſes. The great inſtrument of theſe operations is that immenſe fountain of light and heat, which is the viſible cauſe of fluidity, and conſequently of all animal and vegetable exiſtence.

As an Art, the ſole object of CHEMISTRY is inanimate MATTER, the phyſical Elements of which are ſuppoſed to be Fire, Air, Water, and Earth.

They are called Elements, or Principles, becauſe Chemiſts tell us, that all bodies in nature, after the moſt elaborate analization, are reduced to one or more of these, which hitherto are found to be unalterable and indestructible.

Philosophers ascribe to *matter*, four general properties, viz. extreme divisibility — impenetrable hardness — positive inertness — gravitation.

Divisibility is exemplified in the ductility of gold, a single grain of which will gild a silver wire upwards of 1600 yards long; also in the immense diffusion of light, and of many volatile substances; and particularly in chemical solutions.

Impenetrable hardness, is supposed to be demonstrated by the clink of water falling on a hard body inclosed in a glass vessel, whence the air is exhausted by means of an air-pump. But water is in some degree compressible; therefore, if its particles touch each other, they are elastic, and consequently not absolutely hard. Besides, water is discovered to be not a simple element, but a compound of air and fire, as we shall soon learn. Thus the physical elements are reduced to three.

Positive inertness: for, say the philosophers, *matter* cannot move without being either impelled or attracted. I doubt much whether this be true of *fire*, and whether, when uncombined, motion be not one of its essential properties.

Gravitation. This property of matter seems also no property of fire, which moves with equal facility in all directions, and may be accumulated in in hard bodies to any degree without increaſing their weight. Fire, being the cauſe of volatility, ſeems rather to be in conſtant counter-action to gravity.

CHAP. II.

PHYSICAL ELEMENTS.

FIRE is pure and volatile, or combined and fixed.

Pure fire is diſtinguiſhed by the following properties.

1. It is eſſentially fluid, inviſible and without weight.

2. It is the immediate cauſe of all fluidity.

3. It penetrates and pervades all bodies on the ſurface of the earth, and as far beneath the ſurface as hath been hitherto explored. Water hath never been found in a congealed ſtate, in the deepeſt mines.

4. It has a conſtant propenſity to diffuſe itſelf equally through all bodies howſoever different in point of denſity. A marble ſlab, a plate of iron, a decanter of water, and a lady's muff, at the ſame diſtance from the fire, and other external circumſtances being equal, poſſeſs an equal degree of heat, which is preciſely that of the atmoſphere in which they ſtand.

5. It is perpetually in motion from one body to another, and from different parts of the ſame body, becauſe external circumſtances are inceſſantly varying.

6. In fluctuating from one body to another, it produces a conſtant vibration of their conſtituent parts; for all bodies expand and contract in proportion to the quantity of pure fire they contain.

7. Accumulated beyond a certain quantity, it effects the diſſolution of bodies, by forcing their conſtituent parts beyond the ſphere of mutual attraction, called the attraction of coheſion, which is the cauſe of ſolidity. Hence the ſovereign agency of fire in chemical operations.

8. It excites the ſenſation of heat when the body touched contains a greater quantity of uncombined fire than the finger.

Heat, or the *matter of heat*, is, by Scheele and Bergman, ſubſtituted for fire, which they believe to be the action of heat when increaſed to a certain degree. The firſt of theſe celebrated chemiſts believed this *matter of heat* to be a compound of phlogiſton and pure air. He was certainly miſtaken. It ſeems more philoſophical to conſider heat as an *effect* of which fire is the ſole cauſe.

But, notwithſtanding the teſt of the thermometer, by which all bodies, in the ſame ſituation, appear to poſſeſs an equal degree of heat, it is found, by their different powers of melting ice, that

that their ſpecific heat is not equal. See the annexed Tables: the firſt three of which are from Bergman; the fourth by Lavoiſier and de la Place.

Heat I conſider not as a diſtinct ſubſtance, but as an effect of fire, fixed or volatile; in both which ſtates fire ſeems to exiſt in all bodies, ſolid and fluid. Fixed fire I believe to be a conſtituent part of all bodies, and their ſpecific heat to depend on the quantity of fixed fire in each. This fixed, this latent fire, cannot be ſeparated from the other conſtituent parts of bodies, but by their decompoſition: it then becomes volatile and incoercible. If this hypotheſis be true, fire exiſts, in all natural bodies that contain phlogiſton, in three different ſtates: firſt, in that volatile ſtate in which it perpetually fluctuates between one body and another; 2°, combined with an acid, probably in the form of fixed inflammable air, or phlogiſton; 3°, uncombined and fixed as a conſtituent principle, determining the ſpecific heat of bodies according to its quantity. That the ſpecific heat depends on ſome fixed principle, is evident from its not varying with external circumſtances; and, that it is independent of phlogiſton, appears from the tables annexed, where we obſerve that oils poſſeſs far leſs ſpecific heat than the incombuſtible liquids.

SPECIFIC HEAT.

TABLE I.

SOLIDS.

	Specific gravity.	Speci. heat.
Volatile alkali, mild,	——	1,851
Swedish glass,	2,386	0,187
Flint glass,	——	0,174
Agate,	2,648	0,195
Ice,	——	0,900
Sulphur,	——	0,183
Gold,	19,040	0,050
Silver,	10,000	0,082
Mercury,	13,300	0,033
Lead,	11,456	0,042
Copper,	8,784	0,114
Iron,	7,876	0,126
Tin,	7,380	0,060
Bismuth,	9,861	0,043
Antimony,	6,107	0,063
Brass,	8,356	0,116
Calcined lead,	——	0,068
Calcined iron,	——	0,320
Calcined tin,	——	0,096
Calcined lead and tin mixed,	——	0,102
Diaphoretic antimony washed,	——	0,220

TABLE

TABLE II.

LIQUIDS.

	Specific gravity.		Speci. heat.
Pure water, - -	1,000	—	1,000
Clear vitriolic acid, -	1,885	—	0,758
Dark-coloured vitriolic acid,	1,872	—	0,429
Pale nitrous acid, -	——	—	0,844
Red and ſmoking do. -	1,355	—	0,576
Smoking marine acid, -	1,122	—	0,680
Red wine vinegar, -	——	—	0,386
Diſtilled ditto concent. -	——	—	0,103
Olium tartari, -	1,346	—	0,759
Cauſt. vol. alkali, -	0,997	—	0,708
Vitriolated foſſile alkali 1 part, in water p. 2. 9. -	——	—	0,728
Nitrated veg. alkali, p. 8. -	——	—	0,646
Muriated foſſile alkali, p. 8. -	——	—	0,832
Muriated vol. alkali, p. 1. 5.	——	—	0,798
Depurated tartar, p. 237. 3.	——	—	0,765
Vitriolated magneſia, p. 2.	——	—	0,844
Vitriolated clay, p. 4. 45.	——	—	0,649
Vitriolated iron, p. 2. 5. -	——	—	0,734
Brown ſugar diſſolved, -	——	—	1,086
Oil of olives, - -	——	—	0,710
Do. of linſeed, - -	——	—	0,528
Do. of whale (ſpermaceti) -	——	—	0,399
Do. of turpentine, -	——	—	0,472
Spirit of wine, rectified, -	0,783	—	1,086
Vol. liver of ſulphur, -	0,818	—	0,994

TABLE III.

FLUIDS.

	Specific gravity.		Speci. heat.
Vital air, - -	000,132	—	87,000
Atmofpheric air, -	000,125	—	18,000
Ærial acid, -	000,181	—	0,270

TABLE IV.

	Specific heat.
Common water, - -	1,
Sheet iron, - - -	0,109985
Glafs without lead or cryftal, -	0,1929
Mercury, - - -	0,029
Quick lime, - -	0,21689
Ditto and water 9 to 16 - -	0,334597
Oil of vitriol, fpec. grav. 1,87058 -	0,60362
Ditto with water 4 to 5 - -	0,663102
Nit. acid, not fmoking, fpec. grav. 1,20895	0,661391
Ditto with lime, $9\frac{1}{3}$ to 1 - -	0,61895
Nitre 1 part to 8 of water, - -	0,8167

SECT.

SECT. II.

AIR.

ATMOSPHERICAL Air is an heterogeneous fluid composed of various volatile and soluble matter, in combination with foul or phlogisticated air, calcareous gas, and pure, or, as it called by some, dephlogisticated or vital, air.

The properties of atmospheric air, are these,

1. It is permanently elastic, and capable of extreme compression and expansion.

2. Its weight is, to water, as 1 to 850.

3. It is an indispensible agent in all chemical operations; particularly evaporation and combustion, which are considerably accelerated by a forcible application of air, by means of bellows or other contrivance.

4. It is necessary to the support of animal life, to vegetation, to the combustion of inflammable bodies, and to the calcination of metals.

5. It unites with water in a state of perfect solution.

6. It is diminished by the combustion of inflammable bodies, by the calcination of metals, and by animal respiration.

7. It is contained, in its elastic state, in various fluids and in vegetable substances, from which it may be extracted by the air-pump.

SECT.

SECT. III.

WATER

IS a ſolid body when the ſtate of the atmoſphere is ſuch as to ſink the mercury in Farenheit's thermometer below 32 degrees; is fluid when the mercury is above that point, and riſes in vapour copiouſly at 212. It then boils, and is incapable of a greater degree of heat in open veſſels. Confined in Papin's digeſter it may be made red hot.

Water is naturally volatile and ſoluble in atmoſpheric air. It is compreſſible in a ſmall degree, and by heat may be rendered moſt powerfully elaſtic and expanſible.

Water is produced by the exploſion of inflammable with pure air, of which two fluids, or of their principles, it is believed to conſiſt. It is alſo produced by reviving mercury from red precipitate in alkaline air. In this experiment the precipitate ſupplies the pure, vital, or *dephlogiſticated* air, as it is called by Dr. Prieſtley, and the alkaline air gives the phlogiſton, or rather the inflammable air, of which, with phlogiſticated air, alkaline air is ſuppoſed to conſiſt. But no water is produced by reviving mercury from red precipitate in inflammable air. Why?

Water

Water is believed to be neceſſary to the formation of nitrous as well as of inflammable air, becauſe neither a ſolution of copper in nitrous acid will produce nitrous gas, nor of iron, in the vitriolic, inflammable gas, unleſs both theſe acids be conſiderably diluted with water.

Water is 850 times heavier than air.

SECT. IV.

EARTH

IS that conſtituent part of natural bodies which is neither volatile, nor ſoluble in leſs than 600 times its weight of water; nor fuſible by fire without the addition of extraneous matter. The ſpecies of earths hitherto diſcovered are *ſiliceous*, *calcareous*, *argellaceous*, *magneſia*, and *ponderous earth*, by Mr. Kirwan called *barytes*.

The preſent ſpirit of chemical inveſtigation hath produced phenominæ which have almoſt convinced ſome modern philoſophers, that, not only metallic earth, but every ſpecies of earth, is an acid. Now, if acids are compound ſubſtances, and if water be alſo a compoſition, our phyſical elements are reduced to two. But if, according to ſome chemiſts, pure air be a combination of fire with an acid; and if, according to others,

fire,

fire, or, as they chuſe to call it, *matter of heat*, be compoſed of pure air and phlogiſton, there are no elements at all. One ſtep more and the Berkleian hypotheſis is eſtabliſhed.

CHAP. III.

CHEMICAL ELEMENTS

ARE natural bodies diſtinguiſhed by peculiar properties, and which have not hitherto been poſitively reſolved into primary conſtituent parts. Theſe are,

PHLOGISTON.

GAS, Vital,
Calcareous,
Inflammable,
Phlogiſticated,
Nitrous,
Vitriolic acid,
Marine acid,
Nitrous acid,
Fluor acid,
Alkaline.
Hepatic.

Acid, Mineral.		Vitriolic,
		Marine,
		Fluor,
		Arſenic,
		Of borax,
		Of amber,
		Of molybdæna,
		Of tongſten.
	Vegetable.	Of ſugar,
		Of tartar,
		Of ſorrel,
		Of benzoin,
		Of lemons,
		Of vinegar.
	Animal.	Nitrous,
		Of ſugar of milk,
		Of milk,
		Of ants,
		Of fat,
		Of phoſphorus,
		Of Pruſſian blue.
Alkali, Fixed.		Vegetable,
		Foſſile.
	Volatile.	

Earths. Ponderous,
Lime,
Clay,
Flint,
Magneſia.

Calx

CALX of metals	perfect.	Gold,
		Platina,
		Silver,
		Mercury.
	Imperfect.	Lead,
		Copper,
		Iron,
		Tin.
	Semi ——	Biſmuth,
		Neckel,
		Arſenic,
		Cobalt,
		Zinc,
		Antimony,
		Manganeſe,
		Molybdæna.
OIL.	Eſſential,	
	Expreſſed,	
	Animal,	
	Foſſil.	
ALCOHOL.		
WATER.		

CHAP. IV.

PHLOGISTON.

PHLOGISTON is that modification or combination of fire with ſome other principle, which is a conſtituent part of all inflammable bodies, and of many other ſubſtances in nature. It eſſentially conſtitutes inflammability, and being decompoſed by inflammation, the pure fire regains its liberty and mixes in the atmoſphere: thus inflammable bodies are reduced to aſhes.

Inflammation may be produced by converging the ſolar rays by means of a lenſe or concave mirror; by percuſſion of flint and ſteel, and by friction of hard inflammable bodies againſt each other; alſo by the contact of a body already inflamed, and by the ſudden mixture of concentrated acids with certain oils; by fermentation, as when a hay-rick takes fire; by a mixture of iron filings with ſulphur and water, and by electricity.

Inflammable bodies are, charcoal, vinous ſpirit, oils, wax, bitumens, ſulphur, reſins, phoſphorus, ether, inflammable air, wood, and every other ſpecies of vegetable matter.

Phlogiſton hath been generally ſuppoſed to be a combination of fire with ſome unknown principle.

ciple. It hath lately been imagined, in consequence of certain experiments, to be inflammable air. Probably it is a combination of fire with an acid.

'Be it, however, what it may, this phlogiston, this fixed fire, is not only a constituent part of the inflammable bodies above enumerated, but it is likewise a constituent part of all metallic substances, which, when deprived of this principle, become mere calces: to this fixed, this latent fire, therefore, all their metallic properties are to be ascribed.

Metals are decomposed, or deprived of their phlogiston, by calcination in a strong fire, and may be again reduced, that is, restored to their metallic state, by the addition of charcoal, oil, other metals, or any substance containing phlogiston. But phlogiston cannot be obtained and preserved separate and uncombined with other bodies; because, in the moment of separation, it becomes pure elementary fire, which is an invisible, volatile fluid, pervading every species of matter, and consequently cannot be seen or confined in vessels of glass, of metal, or of any other substance.

This phlogiston may also be separated from the calces of metals by solution in acids, to which having a superior attraction, they readily unite, leaving the fire at liberty to resume its volatility. If to these solutions be added any alkaline or cal-

careous

careous earth, to which acids have a ſuperior attraction, they unite with theſe, and ſuffer the metallic calces to fall to the bottom of the veſſel. Theſe calces may be again reſtored to their metallic ſplendor, by fuſing them with charcoal, or with any other phlogiſtic matter.

But though phlogiſton cannot be detained or rendered viſible in a ſeparate ſtate, it may eaſily be transferred from one body to another, as in the reduction of metals, and in many other chemical experiments.

The chief properties of phlogiſton, according to the various opinions of philoſophers, are theſe.

1. With metallic earths it forms metals.

2. With vitriolic acid, when ſaturated, it forms ſulphur; when united with the ſame acid in ſmaller proportion, it forms vitriolic acid air.

3. With nitrous acid it forms inflammable air.

4. With pure air it forms water.—According to Scheele, *matter of heat*.

5. With pure air it forms calcareous gas.

6. With pure air, or calcareous gas, it forms phlogiſticated air.

7. With water and with *heat* it forms inflammable air.

8. With dephlogiſticated nitrous vapour it forms nitrous air.

9. With the acid of phoſphorus it forms phoſphorus.

10. It is probably the general cauſe of volatility, of colour, and of ſmell.

11. Combined with water, earth, and an acid, it forms oils.

12. With water alone it conſtitutes ardent ſpirit, and is the ſole principle of what is called ſtrength in ſpirituous liquors. But, if ardent ſpirit conſiſt of fire and water, and water conſiſt of fire and pure air, then the conſtituent principles of ardent ſpirit are the ſame as thoſe of water, viz. fire and air; they differ, therefore, only in the proportion of the two ingredients. Water is a compound of air with a ſmall proportion of fire: ardent ſpirit is fire with a ſmall quantity of air. If this be true, it follows evidently, that the buſineſs of fermentation, which converts water into wine, is to add to the former a greater proportion of fire: in other words, to collect and unite with vital air a larger proportion of phlogiſton, or fire.

But, from later experiments, it ſeems probable that ſpirit of wine contains fire and water, and an acid, ſuppoſed to be the acid of tartar, or of ſugar, or of vinegar, which, with all other vegetable acids, are, according to Dr. Crell, modifications of the ſame acid, in combination with phlogiſton in different proportions: that of tartar containing moſt; of ſugar, leſs; and of vinegar, leaſt phlogiſton.

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On this theory the myſtery of fermentation is not incomprehenſible; nor the produce of ærial acid in that proceſs, if that acid be a combination of pure acid ſpirit with vital air.

The celebrated author of the Chemical Dictionary is of opinion, that phlogiſton is the matter of light, or pure fire uncombined with any other principle, but fixed as a conſtituent part of inflammable bodies. Lavoiſier, and ſome other modern chemiſts, deny the exiſtence of phlogiſton, ſubſtituting charcoal, or a charcoally principle, in its ſtead. This anti-phlogiſtic ſyſtem will probably be of no long duration.

CHAP. V.

GAS.

THIS word was invented by the celebrated phyſician and chemiſt Van Helmont. It comprehends all volatile, inviſible, and permanently elaſtic fluids. They are called permanently elaſtic, becauſe they cannot be reduced to a liquid ſtate when uncombined, by any degree of cold to which they have hitherto been expoſed. Dr. Hales, Dr. Black, and Dr. Prieſtley have called them *airs*; thus, *fixed air*, *inflammable air*, &c.

&c. and many philoſophers continue to adopt that denomination.

SECT. II.

A I R,

PRoperly ſo called, or *Vital Air*, as it is denominated by ſome French chemiſts, and by Bergman, is diſtinguiſhed from every other ſpecies of gas by being alone capable of ſuſtaining animal life, and the combuſtion of inflammable bodies. It conſtitutes about one third part of the atmoſphere we breathe, mixed with calcareous gas (by ſome called *ærial acid*) phlogiſticated air, water, and an infinite variety of effluvia from volatile matter on the ſurface of the earth.

Chemiſts are not yet acquainted with the means of ſeparating pure air from the atmoſphere; but they have accidentally diſcovered various methods of obtaining it by the application of fire and of mineral acids to metallic calces and to nitre. Red lead, moiſtened with vitriolic or nitrous acid, yields pure air in great abundance by a moderate degree of heat. It is alſo eaſily obtained by a mixture of nitrous acid with almoſt any dephlogiſticated earth, ſuch as the calces of metals, wood-aſhes, magneſia, &c. It may likewiſe be

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extracted, by heat, from vitriols, from alum, and various mineral ſubſtances. Nitre alone, expoſed to a conſiderable degree of heat in a gun-barrel, produces a large proportion of vital air.

This vital, or dephlogiſticated air, as Dr. Prieſtley chuſes to call it, may be procured in large quantities by diſtilling nitre in an earthen retort: two ounces will yield 800 ounce meaſures. It may alſo be obtained very pure from precipitate *per ſe*, red precipitate, or from turbeth mineral. In this proceſs, if we ſuppoſe the precipitate to contain fixed air, the phlogiſton, which is imagined to be a conſtituent part of that air, may revive the mercury, and thus the vital air, its other conſtituent, is ſet at liberty. But, if the vital air exiſt in the precipitate, in a ſtate of ſimple combination, the phlogiſton, neceſſary to its extrication, is ſupplied by the heat employed.

The vapour of vitriolic or nitrous acid, forced through a red hot earthen tube, yields pure air. Alſo, a bubble of atmoſpheric air, confined in a glaſs tube by either of theſe acids, is, by the electric ſpark, conſiderably enlarged and converted into vital air. *Prieſtley.*

Vital air, according to Dr. Higgins, with an acid principle peculiar to each acid, forms all acids; he is alſo of opinion, that with the acid principle of vinegar it conſtitutes ærial acid.

Pure air driven forcibly in a ſtream upon bodies in actual combuſtion, increaſes the heat to a degree capable of melting platina, which could never be effected by any other means.

From the variety of compound bodies from which pure air may be obtained, it is probably not a compoſition generated in the proceſs; but either a ſimple elementary part in them all, or the part of a ſecundary principle. That principle may be water. For, if according to Mr. Cavendiſh's diſcovery, water be a compound of pure air and phlogiſton, the air obtained in theſe experiments may rationally be ſuppoſed to proceed from a decompoſition of the water contained in the nitre and other ſubſtances abovementioned. If this hypotheſis be true, water, and not calcareous gas, imbibed from the atmoſphere, may cauſe the increaſed weight of metallic calces.

Vital air was originally ſuppoſed to conſiſt of nitrous acid and earth, becauſe it was firſt produced by a mixture of theſe. That it contains no acid, is proved by diſtilling nitre and receiving the air in veſſels half full of water, which, upon examination, is found to have imbibed all the acid that was contained in the nitre; conſequently there can be none in the air produced.

When vital air is mixt with nitrous air, a violent efferveſcence, heat, redneſs, and diminution of bulk, is the immediate conſequence. In this experiment the air is ſuppoſed to ſeize the phlogiſton in the nitrous gas. To what cauſe the diminution of bulk of the united fluids is to be aſcribed, is not yet determined. It is greater in proportion to the purity of the vital air employed, and thence Dr. Prieſtley ſuggeſts this experiment as a teſt of the ſalubrity of the atmoſphere in different places. Mr. Kirwan is of opinion, that, in this proceſs, the vital air uniting with phlogiſton, forms calcareous gas, fixt air, or ærial acid, as it is called by ſome philoſophers. Mr. Cavendiſh ſeems to have proved, by the deflagration of inflammable with vital air, that water is the reſult of an union of theſe two fluids. Dr. Prieſtley thinks that this air is not only an element of water and of fixed air, but of all acids, and of many other ſubſtances.

SECT. III.

CALCAREOUS GAS,

CALLED *fixed air*, or *ærial acid*, is that ſpecies of elaſtic fluids which, in a fixed ſtate, is found to be a conſtituent part of all earths and ſtones that may be burnt to lime; the moſt common of which are limeſtone, chalk, and marble. The ſhells of oyſters, lobſters, crabs, of every other ſpecies of teſtaceous animals, and

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of birds eggs, alſo contain a large proportion of this gas combined with calcareous earth, from which it may be expelled by burning in an open fire, as in making lime, or by diſſolving them in any acid. Alkalis, fixed and volatile, yield a conſiderable quantity of this gas by the ſame means of decompoſition. It likewiſe forms about a fifteenth part of the atmoſphere we breathe, and may be extracted in ſmall quantities, by fire, from various animal, vegetable, and foſſile ſubſtances. Some modern chemiſts, particularly Fontana and Metherie, deny the exiſtence of this ærial acid in atmoſpheric air, and ſupport this opinion by experiments; but we certainly know that lime, whether dry or diſſolved in water, recovers its ærial acid when expoſed to the atmoſphere, in which, therefore, it muſt neceſſarily exiſt.

This calcareous gas is the acid which in chalibeate waters holds the iron in ſolution, that falls to the bottom of the veſſel when the water is expoſed to the open air, to ſome part of which the gas has a ſtronger attraction than to iron. It is alſo this gas which gives ſpirit and acidity to Pyrmont, Spa, and many other mineral waters.

Calcareous gas is not only copiouſly produced by the mixture of acids with alkaline and calcareous earths, but alſo by vinous and putrefactive fermentation. When wine or beer are fermenting, or working, as it is called, it floats, to a confiderable height, over the liquor, and may be taken up and poured from one veffel into another. It is deftructive to the life of fmall animals, and extinguifhes flame.

It is this mephetic air which miners call choak-damp, and which floats on the furface of the earth in the *Grotto del Cane*, near Naples, in Italy.

The diftinguifhing property of calcareous gas is, by its union with alkaline earths, to render them mild; for as foon as they are deprived of it they become cauftic.

The opinion that calcareous gas is a compound of vital air, and phlogifton, is founded on fome plaufible experiments; neverthelefs, they are not fufficient to eftablifh the fact. Be that however as it may, this calcareous gas, fixed air, or atmofpheric acid, certainly poffeffes the general properties of a weak acid. 1. It communicates to water an acid tafte.—2. It changes the blue juices of flowers to red.—3. It faturates alkalis and abforbent earths, rendering them mild, but may be expelled by ftronger acids.—4. United with water, it diffolves metals and earths.—5. It precipitates fulphur diffolved in lime-water, or in a folution of fixed or volatile alkali; alfo filiceous earth from the liquor of flints, in which flint is diffolved in a folution of fixed alkali.

Dr. Prieſtley's preſent opinion concerning the compoſition of this gas, which he perſiſts in calling *fixed air*, is, that it conſiſts of phlogiſticated (not inflammable) and dephlogiſticated air, without water; and that the laſt of theſe airs conſtitutes more than three fourths of this compound. This celebrated philoſopher produced fixed air by heating, with a burning lens, a mixture of red precipitate and iron ſhavings, or charcoal; and by melting iron, or burning charcoal or ſulphur in pure air: but he obtained it alſo by heating iron in vitriolic acid air. Whence the vital air in this laſt proceſs?

According to Dr. Higgins, the ærial acid, when in a fixed ſtate, conſiſts of vital air and the acid principle of vinegar, and is rendered volatile by the acceſſion of fire.

Bergman is of opinion, that this ærial acid is compoſed of nitrous acid and phlogiſton. Probably it is a combination of vital air with an acid *ſui generis*.

SECT. IV.

INFLAMMABLE GAS, OR AIR,

WHICH the modern *Antiphlogiſtics* conſider as an element, is an elaſtic fluid, which, being

being brought into contact with actual fire, explodes, or burns ſlowly, according to the circumſtances of the experiment. Like other inflammable bodies, it will not take fire without an admixture of air. Mr. Cavendiſh found by experiment, that about an equal quantity of each produced the loudeſt exploſion; he alſo found, that it is at leaſt ten times lighter than common air; and this diſcovery naturally produced the idea of air-balloons: it being obvious that a ball of a light ſubſtance, inflated with inflammable air, muſt riſe in a denſer medium.

This inflammable gas has long been known to exiſt in ſubterraneous cavities, particularly in coal mines, where it frequently kills the miners, who call it *fire-damp*. Modern philoſophers extract it from metals by various chemical proceſſes, particularly by diſſolving iron, tin, or zinc, in vitriolic or marine acids diluted with water. It may alſo be obtained by a ſolution of theſe metals in cauſtic alkaline liquids, fixed or volatile. It is immiſcible with water.

Inflammable gas iſſues from animal and vegetable matter in a ſtate of putrefaction. *Ignes Fatuis* are probably this gas inflamed.

The moſt ſingular property of this fluid is, that being deflagrated with vital air in a cloſe veſſel, it produces water. For this accidental diſcovery we are obliged to Mr. Cavendiſh. The phenomenon is aſcribed to the mixture of phlogiſton

giſton with vital air, and thence it is concluded that water is compoſed of phlogiſton and vital air. M. de la Metherie, editor of the Journal de Phyſique, accounts for the production of water, in Mr. Cavendiſh's experiment, by ſuppoſing that both vital and inflammable air contain water; which they depoſit in the combuſtion, in conſequence of a ſuperior attraction between the other conſtituent parts of each. But if, as Mr. Cavendiſh ſuppoſes, phlogiſticated air conſiſt of nitrous acid and phlogiſton, is it not poſſible that the water produced is a mere clyſſus of nitre?—For, in the proceſs for obtaining that clyſſus, the nitrous acid ſeems to be deſtroyed, as nothing remains after the detonation but the fixed alkali of the nitre and pure water.

Inflammable air, according to Dr. Higgins, is compoſed of the acid principle of vinegar and fire. But alkaline gas is alſo inflammable, and convertable by heat into inflammable air. Does not this fact ſeem to contradict the ſuppoſition that an acid is a component part of inflammable air? Poſſibly there may be an acid and an alkaline inflammable gas. That which exhales from putrifaction may be of the latter ſpecies.

Inflammable air is, by Dr. Prieſtley, ſuppoſed to conſiſt of phlogiſton, water, and the element of *heat*. He produced it in great abundance, by forcing the ſteam of water through a red-hot tube filled with the ſhavings or turnings of iron. In

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this proceſs he ſuppoſes the water entering the iron expels its phlogiſton, which, with part of the water, forms inflammable air.

Minium and other metallic calces confined in this air, are by means of a burning lens, reſtored to their metallic form. Charcoal may, in the ſame manner, be converted into inflammable gas; but not without the preſence of water.

SECT. V.

PHLOGISTICATED AIR OR GAS.

THIS ſpecies of air ſeems not to have been ſufficiently diſtinguiſhed by philoſophers from inflammable air. That phlogiſton is a conſtituent part of both is obvious; they are nevertheleſs eſſentially different. Inflammable air contains phlogiſton; but phlogiſticated air, properly ſo called, is not inflammable. They differ probably in one of their conſtituent parts. If phlogiſton and water, or pure air, or vegetable acid, conſtitute inflammable air, phlogiſton and ærial acid may form phlogiſticated air. We cannot ſuppoſe phlogiſticated air to conſiſt of phlogiſton and vital air; becauſe the union of theſe two fluids forms water.

Phlo-

Phlogiſticated air is produced by the inflammation of oil, tallow, wax, or other inflammable matter, in cloſe veſſels containing atmoſpheric air; and if this phlogiſticated air be brought into contact with lime water, it immediately loſes its tranſparency, and a mild calcareous earth is precipitated. What is the cauſe of this precipitation? It is evidently the re-union of its original gas with the lime, of which gas it was deprived by calcination: for lime is ſoluble in water, but calcareous earth is not. But if lime cannot be reduced to calcareous earth by any other means than its re-union with calcareous gas, this gas muſt have been obtained from the phlogiſticated air, of which therefore it muſt have been a conſtituent part.

Lime may alſo be precipitated from the water in which it is diſſolved by breathing into it: therefore the fluid iſſuing from animal lungs is probably phlogiſticated air.

Lime is not precipitated from lime-water by inflammable air; and that air, by its union with phlogiſticated air, is rendered not inflammable; therefore they are not the ſame fluid.

Phlogiſticated air is in part abſorbed by water; but inflammable air is not, without violent agitation.

Phlogiſticated air extinguiſhes flame: inflammable air, by the application of flame, is inflamed.

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In mixing nitrous with atmoſpheric air over lime-water, a precipitation of the lime is produced. Is not this owing to a decompoſition of the phlogiſticated air in the atmoſpheric fluid? The nitrous acid unites with the phlogiſton, to which it has a predominant attraction, and the ærial acid, by an equal propenſity, unites with the lime.

If this hypotheſis be admitted, there will be no difficulty in reconciling the experiments, which ſeem to prove, with thoſe that diſprove, the exiſtence of fixed air in the atmoſphere. It may exiſt in atmoſpheric air combined with phlogiſton in the form of phlogiſticated air, and not in a ſeparate ſtate.

Phlogiſticated air is by thoſe modern philoſophers who deny the exiſtence of phlogiſton, ranked among the elements.

SECT. VI.

NITROUS GAS,

BY Dr. Prieſtley called *nitrous air*, is diſtinguiſhed from all the other permanently elaſtic fluids, by its ſingular property of producing, when mixt with atmoſpheric air in a cloſe veſſel, a red cloud; heat, and a diminution in the bulk

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of the mixture. Thefe fluids, in order to produce the greateft diminution, are to be mixed in the proportion of one part nitrous gas to two parts of air; but the diminution is greateft when the air is moft pure. When the point of faturation is exactly hit, the air is fuppofed to be diminifhed to about a fourth of its original bulk, and the nitrous gas totally deftroyed. By what means this diminution is effected, is not yet determined."

Nitrous air, or gas, was generally fuppofed to confift of nitrous acid and phlogifton; but it is now believed to contain no acid, and that its conftituent parts are phlogifton and dephlogifticated nitrous vapour.

Nitrous air may be dephlogifticated by expofing it to the ruft of iron; or by diftilling a folution of copper in weak nitrous acid, mixed with fhavings of iron. The air produced will be a mixture of phlogifticated air and dephlogifticated nitrous gas. By agitating this mixture in water, the latter will be alone abforbed, and by heating the water, may be obtained pure. This dephlogifticated nitrous gas will fuffer a candle to burn in it; neverthelefs, it is fatal to animals.

Nitrous air may be converted into phlogifticated air, by heating iron or charcoal in it, or by any other phlogiftic procefs.

Nitrous gas may be obtained by diffolving iron, copper, filver, mercury, befmuth, nickel, or antimony in nitrous acid; alſo from various vegetable and animal matters containing phlogiſton.

Nitrous gas extinguiſhes flame, and is deſtructive to animal life. It is abſorbed by water, by all acids, and by oils.

Dr. Prieſtley hath diſcovered other elaſtic fluids which are not condenſable by cold. He calls them acid and alkaline airs, from the acids and alkalis from which they are obtained. But as they are nothing more than acid and alkali volatilized by heat; are again reducible by mixture with water to their former liquid form; and as they ſerve only to perplex young chemiſts, it may be as well to take no farther notice of them at preſent.

I have in this chapter deſcribed five diſtinct ſpecies of air, or gas, viz. vital or pure air, calcareous, inflammable, phlogiſticated, and nitrous. My young reader will, without much difficulty, by conſidering this chapter a ſecond time with attention, remember the peculiar properties of each; but, recollecting that they are all produced from the ſame ſubſtances and by the ſame means, his ideas will be ſtill confuſed; he muſt therefore be informed that theſe ſeveral kinds of gas are extricated at different times of the proceſs, and by different degrees of heat: for example, in diſtilling a ſolution of zinc in nitrous acid, the firſt air produced is *phlogiſticated*, the ſecond *inflammable*, and finally *vital*.

But in order to diſpel, as much as poſſible, the miſt which ſtill involves this recent branch of chemiſtry, let us look back a little on the compoſition and produce of theſe ſeveral gaſes.

Vital air is a ſimple element: with inflammable air, it forms water; with an acid, it forms calcareous gas.

Calcareous gas, or fixed air, or aerial acid, is compoſed of vital air and an acid *ſui generis*.

Inflammable air, according to Dr. Prieſtley, conſiſts of phlogiſton, water, and the element *heat*; according to Dr. Higgins, of pure air, fire, and an acid.

Nitrous air is compoſed of phlogiſton, and dephlogiſticated nitrous vapour.

Water is compoſed of vital air and phlogiſton or inflammable air.

Phlogiſticated air is compoſed of phlogiſton and aerial acid.

To theſe may be added another permanently elaſtic fluid, to which philoſophers have given the name of *Hepatic air*, becauſe by the addition of an acid, particularly the marine, it is obtained from *heper ſulphuris*, which is a liver coloured combination of ſulphur with alkali or with earth. The properties of this gas are—It ſmells like rotton eggs; mixt with pure or with nitrous air, it becomes inflammable; it is miſcible with water in a certain proportion; it turns ſilver or mercury black; it is ſomewhat heavier than atmoſpheric air; it reddens the infuſion of turnſol; it precipitates from water in the form of ſulphur. Mr. Kirwan, in conſequence of many ingenious and apparently deciſive experiments, believes this gas to be ſulphur brought into an aeriform ſtate by the matter of heat. It is this gas which impregnates the waters of Aix la Chapelle, Harrogate, &c.

Such is the preſent ſtate of our aerial philoſophy, which is yet in its infancy. Future experiments, by producing new lights, may poſſibly render it more ſatisfactory.

There remains yet a very natural queſtion which the young chemiſt wiſhes to aſk before we quit theſe elaſtic fluids. "Suppoſe, he will ſay, that by the ſolution of a metal, or by any other proceſs, I have produced one of theſe gaſes, how am I to know which of them it is?"—If it be *calcareous gas*, water will abſorb a quantity of it equal to its own bulk, and it will precipitate all the lime diſſolved in lime-water. If it be *phlogiſticated air*, it will produce theſe effects but in a ſmall degree; beſides, this air is generally obtained by inflammation. If it be *nitrous gas*, on being mixed with common air, it will exhibit a turbed redneſs, and a conſiderable diminution of bulk. If it be *vital air*, a candle will burn in it with an enlarged and brighter flame. If it be *inflammable air*, it will explode by the application of a lighted candle, or burn with a white or blue flame.

The annexed Table exhibits what I conceive to be the preſent opinions of the moſt celebrated philoſophical chemiſts of this age. By *preſent opinions*, I mean thoſe that I have been able to collect from the lateſt of their writings which I have ſeen. The opinions of the preſent hour may be very different. Many of the ſquares are left vacant, becauſe the column comprehends a matter, concerning the principles of which, the author whoſe name is oppoſite to ſuch vacant ſquare, has, to the beſt of my recollection, declared no opinion.

A TABLE

A TABLE OF PHILOSOPHICAL OPINIONS.

AUTHORS.	*Fire.*	*Pure Air.*	*Water.*	*Earth.*	*Metal.*	*Calx of Metals.*	*Acid.*	*Fixed Air.*	*Inflammable Air*	*Phlogiſticated Air.*	*Nitrous Air.*	*Phlogiſton.*
M. Cavendiſh.			Pure Air and Phlogiſton.							Nitrous Acid and Phlogiſton.		
Encyclopedie.		Acid and Fire.	Acid baſis of Pure Air and Phlogiſton.						Phlogiſton and Fire.		Radical Nitrous Acid and Phlogiſton.	
Dr. Higgins.		Principle of Nitrous Acid and Fire.	Pure Air and Phlogiſton.			Earth, Phlogiſton, and Pure Air.		Vegetable Acid principle, and Pure Air.	Pure Air, Acid and Fire.		Nitrous Acid and Fire.	
M. Kirwan.								Pure air and Phlogiſton.	Phlogiſton.	Pure Air ſuperſaturated with Phlogiſton.		Inflam. Air.
M. Lavoiſier.		Oxygen. princip. and Fire.	Inflammable & Pure Air.		An Element.	Metal and Pure Air.	Radical Acid and Pure Air.	Pure air and charcoal.	An Element.	An Element.	Pure and phlogiſticated Air.	Hath no exiſtence.
M. Macquer.	Light.							Phlogiſton & Pure Air.				Fixed Light.
M. Metherie.		An Element.	An Element.	An Acid.	Metallic Acid and much Inflammable Air.	Metallic Acid and Inflammable Air.	Pure Air, Fire, Water, and Inflammable Air.	Pure Air and Fire.	Pure Air, Fire, and Water.	Pure Air and Inflammable Air.	Pure Air, Fire, and Inflammable Air.	
Dr. Prieſtley.		Earth and Nitrous Acid						Phlogiſticated and dephlogiſticated Air.	Phlogiſton, Water, and the Element of Heat.	Pure Air and Phlogiſton.	Phlogiſton, Nitrous Acid, and Pure Air.	
M. Scheele and Bergman.	Phlogiſton and Pure Air.	Nitrous Acid with much Phlogiſton.			Metallic Earth or Acid, and Phlogiſton.	Metal and Water.	Radical Acid and Water.		Phlogiſton and the Matter of Heat.		Nitrous Acid with Phlogiſton.	
M. Volta and Crell.		Fire and Water.	An Element.		Metallic Earth and Phlogiſton.	Metallic Earth			Phlogiſton & Water.		Nitrous Acid and Phlogiſton.	

CHAP. VI.

ACIDS

ARE immediately diſtinguiſhed by their ſour taſte. They are likewiſe characterized by the following general properties. They change the tinctures and infuſions of blue flowers to red. Syrup of violets and tincture of turnſol are generally uſed for this purpoſe. They effervefce and unite readily with alkalis fixt and volatile; alſo with earths, and with metals, forming a great variety of neutral ſalts. From their great attraction to water, they are generally fluid; mixed with water, they produce heat; with ice, cold. Acids unite with earths and alkalis in preference to every other ſubſtance. See the tables of attraction.

Acids are mineral, vegetable, and animal.

SECT. II.

MINERAL ACIDS.

1. VITRIOLIC ACID, is ſo called from its having been formerly extracted by diſtillation from green vitriol. It is now more copi-

ouſly and advantageouſly obtained from ſulphur. It is commonly called oil of vitriol, from its oily appearance when poured from one veſſel into another.

This acid, when pure, is perfectly pellucid and without colour; but its attraction to water and to phlogiſtic matter is ſuch, that, by what means ſoever it be obtained, it is found coloured and diluted: for chemical purpoſes therefore it muſt be concentrated and purified by diſtillation.

The ſpecific gravity of concentrated vitriolic acid is double that of water: thus, if a pint of water weigh one pound, a pint of vitriolic acid weighs two.

Vitriolic acid with ponderous earth, forms *ponderous ſpar*.

With fixed vegitable alkali, *vitriolated tartar*.

With marine alkali, *Glauber's ſalt*.

With lime, *ſelenites and gypſum*,

With magneſia, *Epſom ſalt*.

With volatile alkali, *vitriolic ammoniac*.

With clay, *alum*.

With metallic calces, *vitriols*.

With ſpirit of wine, *æther*.

With phlogiſton, *ſulphur*.

Theſe ſeveral compounds are here arranged according to the table of attractions, where the reader will find all the metallic calces ſpecified. See alſo the general table of compoſition.

Vitriolic

Vitriolic acid being mixed with an equal quantity of cold water, a violent boiling and a great degree of heat are immediately produced. No hypothefis hitherto imagined is equal to a *perfectly* fatisfactory explanation of this extraordinary phenomenon. No decompofition takes place. The refult is a mere vitriolic acid diluted with water, which may be again feparated from the acid by diftillation, and if again united, the fame effect will be produced. Modern chemiftry will tell us, that the heat produced by this mixture is caufed by the extrication of fpecific heat, from the water; for that the mixture when cold poffeffes lefs fpecific heat than the water, and about the fame degree as the acid before mixture; but the experiments for determining the fpecific heat of fluids, by the quantity of ice they will melt, are exceedingly fallaceous. Spirit of wine, whofe fpecific heat is much greater than that of vitriolic acid, produces no fuch effect when mixed with water. If it be a fuperflux of fpecific heat, a mixture of water with vinegar fhould produce a ftill greater degree, unlefs it can be proved that fpecific heat is accumulated in the mixture. Some philofophers afcribe the production of heat in this mixture to the violent friction of the particles againft each other during the ebulition: but when the ebulition is over, and the mixture returns to the common heat of the atmofphere, no greater degree of heat can be produced by the moft violent

lent agitation; nor indeed is there any experiment to prove, that the friction of fluid particles against each other will produce the least augmentation of heat.

Vitriolic acid mixed with oil or any other inflammable matter, may, by heat, be rendered volatile, and if received into a vessel inverted in quicksilver, will remain uncondensed. This elastic gas is called, by Dr. Priestley, *vitriolic acid air*. It is eagerly absorbed by water, forming *volatile acid of sulphur*.

II. Marine Acid is so called, because it is generally extracted from sea-salt, which consists of this acid and fossile alkali. It is easily obtained by distillation from sea-salt mixed with vitriolic acid, to which the fossile alkali having a superior attraction, unites and forms Glauber's salt; and the marine acid being set at liberty, passes over into the receiver.

The marine, or muriatic acid, commonly called spirit of salt, is so volatile as to rise in white fumes when exposed to the air. These fumes are called by Doctor Priestley *marine acid air*, which is an elastic fluid not condensible by cold. Of this air, or gas, water will absorb about one third of its own bulk, and this combination forms a strong spirit of salt. Hence philosophers tell us, that marine acid consists of marine acid air and water; but marine acid air is not a constituent part of marine acid, but the acid itself volatilized

tilized

tilized by the phlogifton which is one of its conftituent parts. Spirit of falt therefore is a compofition of acid, phlogifton and water.

The properties of marine acid are thefe.

1. It is of a pale yellow colour, and emits white fumes.

2. It has a peculiar fmell, fomewhat refembling that of faffron.

3. Its fpecific weight is to water as 19 to 16.

4. With vegetable fixed alkali it forms *digeftive falt of fylvius.*

5. With foffile alkali, *common falt.*

6. With volatile alkali, *fal ammoniac.*

7. With lime, *fea falt with a calcareous bafis.*

8. With magnefia, *fea falt with a bafis of magnefia.*

9. With metallic calces, *various metallic falts.*

10. With nitrous acid, *aqua regia*, which diffolves gold and platina.

11. With vinous fpirit, *æther.*

The attraction of marine acid to alkalis and abforbent earths is weaker than that of the vitriolic or nitrous, either of which will confequently decompofe the falts formed of thefe alkalis and earths with the marine acid. Metallic calces, on the contrary, prefer this to either of the other acids.

III. Fluor Acid. Fluor, from which this acid is obtained, is a kind of fpar of various colours, in which minerals are generally found involved,

volved, and is thence called their matrix. These spars are called fluors, because they promote the fusion of ores: they consist of calcareous earth and a peculiar acid, which may be separated from the earth by distilling fluor with oil of vitriol, by which calcareous earth is more powerfully attracted. The vitriolic acid uniting with the lime suffers the fluor-acid united with phlogiston to rise in a volatile state, which being condensed by its union with water constitutes the acid in question.

The most singular property of the fluor-acid is its power of dissolving siliceous earth, or flint, which it extracts even from glass, and most powerfully when in its volatile state, then called *fluor-acid air*. When absorbed by water, this gas deposits part of the flint in the form of a white powder.

This acid differs also from the vitriolic, nitrous, and marine acids, in preferring calcareous earth to alkalis. Fluor-acid saturated with vegetable alkali, is decomposed by lime-water.

IV. Acid of Arsenic. The semi-metal called *arsenic*, is simply an acid coagulated by phlogiston, from which the acid may be separated by distillation with marine and nitrous acid, the latter of which seizes the phlogiston of the arsenic, and the acid concretes at the bottom of the retort.

This

This acid combined with vegetable alkali is, like the fluor-acid, decompofed by lime-water. In prefering lime to alkalis, therefore, it differs effentially from the vitriolic, the nitrous, and the marine acid.

V. Acid of Borax, commonly called *fedative falt*, is a peculiar fpecies of acid which, united with marine alkali, forms borax. That it poffeffes the properties of an acid, is evident from its turning tincture of turnfol, &c. green; from its faturating alkalis, and diffolving lead, copper, iron, tin, &c.

This acid prefers lime to foffile alkali, from which therefore it may be feparated, by boiling borax with lime-water. Probably this acid is the fame with that of phofphorus, but combined with a fmall quantity of alkaline earth.

VI. Acid of Amber, is obtained by diftilling amber with an acetous liquor and oil. It forms neutral falts with alkalis, earths, and metals. It prefers earths to alkalis, particularly that which is called *ponderous*.

Two other mineral acids have been difcovered by the celebrated Scheele, viz. the acid of Molybdæna, and of Tungften. There is nothing very fingular in their properties, as far as they are yet known. Scheele fuppofes thefe acids to be in a ftate refembling that of white arfenic.

SEC-

SECT. III.

VEGETABLE ACIDS.

I. ACID of SUGAR, may be extracted not only from ſugar, but from honey, gum-arabic, and from tartar, by boiling them with nitrous acid. The nitrous acid uniting with the phlogiſton, in which the ſaccharine acid was involved, flies off in red fumes, and leaves the acid required in the remaining liquor, from which, by evaporation, priſmatic cryſtals are obtained.

The ſuperior attraction of this acid is to lime, with which it forms a compound inſoluble in water. Hence its uſe in diſcovering the ſmalleſt quantity of calcareous earth diſſolved or ſuſpended in that fluid. It may be obtained from a great variety of vegetables.

II. ACID of TARTAR. Tartar is a vegetable concrete, which ſeparates ſpontaneouſly, but ſlowly, from wine, red or white, adhering to the ſides of the caſk. It conſiſts of the vegetable fixt alkali ſuperſaturated with the acid in queſtion, which in many reſpects differs but little from vinegar and other vegetable acids. It differs, however, from vinegar in its attraction to lime, ponderous earth, and magneſia, in preference to alkalis.

Cream of tartar, which is tartar waſhed from impurities by boiling in water, contains about one third of this acid more than was neceſſary to ſaturate the alkali, which ſuperfluous acid may be obtained by ſaturating a ſolution of tartar, in boiling water, with chalk. The ſolution muſt then be evaporated to dryneſs, and the remaining powder digeſted in a large quantity of weak vitriolic acid. Having ſtood about twelve hours, the liquor muſt be poured off and again evaporated. The reſiduum is the acid required.

The acid of tartar with vegetable alkali forms *ſoluble tartar*.

With mineral alkali, *Rochelle ſalt*.

With volatile alkali, *vegetable ammoniac*.

With antimony, *tartar emetic*.

III. Acid of Sorrel. This acid is procured by a difficult chemical proceſs from ſalt of ſorrel, which conſiſts of vegetable alkali ſuperſaturated with this acid. Its peculiar properties are not yet aſcertained; it differs however from the acid of tartar in taking lime from the vitriolic acid, and in being entirely ſeparated from vegetable alkali by chalk. It is probably the ſame as the acid of ſugar.

IV. Acid of Lemon. Chemiſts have hitherto diſcovered no properties peculiar to this vegetable acid. Whether it prefers lime, magneſia, and ponderous earth to alkalis, is not determined.

V. Acid

V. Acid of Benzoin. Of this acid very little is known, except that it exiſts in the reſinous ſubſtance called *Benzoin*, and that it may be obtained tolerably pure by adding lime to its ſolution in boiling water, and then decompoſing that combination with marine acid. It combines readily with alkalis, and, with the mineral, affords cryſtals that are not deliqueſcent. A ſolution of theſe neutral ſalts may be decompoſed by lime, magneſia, or clay.

VI. Acetous Acid, or Vinegar, is produced by continuing the vinous fermentation. In its attractions it prefers alkalis to lime, contrary to the other vegetable acids, from which it alſo differs in its weaker attraction to earths and metals, and in not being altered by diſtillation.

Vinegar may be concentrated, that is, rendered ſtronger, or more ſour, by freezing. The ice on the ſurface is mere water, which thus ſpontaneouſly ſeparates from the acid. Strong vinegar may alſo be obtained by ſaturating this acid with alkalis, earths, or metallic calces, and then decompoſing theſe acetous neutral ſalts by means of vitriolic acid, which, from its ſuperior attraction to alkalis, &c. unites with theſe, and releaſes the vinegar highly concentrated.

The acetous acid, according to Dr. Higgins, is a combination of a peculiar acid principle, vital air, water, and phlogiſton; which acid principle is a conſtituent part of fixable air, of in-

inflammable air, of charcoal, and other inflammable bodies.

From the experiments of Dr. Crell (*Journal de Physic*, October 1785.) it seems highly probable that the vegetable acids differ not essentially from each other: those of tartar, vinegar, and sugar, he found to be modifications of the same acid. I have mentioned this before in the article *Phlogiston*.

Vinegar, in common with other acids, dissolves earths and metallic substances.

With fixed vegitable alkali, it forms *regenerated tartar*.

With fossile alkali, *a chrystallizable salt*.

With volatile alkali, *vegetable ammoniac*.

With copper, *verdigrease*.

With lead, *cerus* or *white-lead, and sugar of lead*.

With spirit of wine, *æther*.

SECT. IV.

ANIMAL ACIDS.

BY animal acids are understood those which are procured from animal matter.

I. Nitrous Acid, hath hitherto been considered as a mineral production, and arranged accordingly among the mineral acids. It is, however, certainly the produce of animal matter. This, and every other acid, in the opinion of Dr. Higgins, is compoſed of a certain acid principle and vital air. If this be true, the copious production of vital air from nitrous acid is eaſily underſtood.

Nitre, commonly called ſaltpetre, conſiſts of nitrous acid and vegetable fixed alkali. Now, in order to obtain the acid ſeparate, ſome ſubſtance muſt be employed to which the alkali has a ſtronger attraction. In the table of attractions we find, under the head *Fixt Alkali*, that vitriolic acid precedes nitrous acid. Hence we conclude, that vitriolic acid will decompoſe nitre by uniting with the alkali, and that conſequently the acid will be ſet at liberty. This really happens. In diſtilling nitre with oil of vitriol, with clay, with any kind of vitriol, or neutral ſalt containing vitriolic acid, the acid of nitre will quit its alkaline baſe and paſs over into the receiver. It is ſuppoſed to be a compound of nitrous vapour, phlogiſton, pure air, and water.

Nitrous acid, when ſtrong and ſmoking, is generally called *ſpirit of nitre*, or *Glauber's ſpirit of nitre*; when leſs concentrated, *aqua fortis*. The ſmoking ſpirit is called by Bergman, *Phlogiſticated nitrous acid*.

Smoking ſpirit of nitre is of a reddiſh flame colour, emitting fumes of the ſame tint. Its

weight

weight is to water as 18 to 12. When mixt with water, a conſiderable degree of heat is produced, and the mixture becomes blue or green.

Nitrous acid with vegetable alkali forms *nitre*.

With foſſile alkali, *cubic nitre.*

With volatile alkali, *nitrous ammoniac.*

With abſorbent earths, *delequeſcent neutral ſalts.*

With ſilver, *lunar cauſtic.*

With mercury, *red precipitate.*

With marine acid, *aqua regia.*

With ſpirit of wine, *æther.*

The primary attraction of this acid, according to Bergman, is to ponderous earth, to which ſucceed alkalis, abſorbent earth, and metals.

By means of nitrous acid combined with metallic and inflammable ſubſtances, a variety of elaſtic fluids have been produced; but whence theſe fluids proceed remains matter of diſpute.

Nitrous acid, volatilized by heat, becomes a permanently elaſtic fluid; but as it diſſolves quickſilver, and is abſorbed by water, it is with difficulty preſerved and its properties not eaſily inveſtigated. It ſeems, however, to differ in nothing from phlogiſticated nitrous acid, or ſmoking ſpirit of nitre.

II. Acid of Sugar of Milk. Sugar of milk is procured from clarified whey by evaporation. This ſugar, being analized, yields about a ſeventh part of *acid of ſugar*, and ſomewhat more than a fifth of another acid, called *acid of ſugar of milk.*

This acid appears in the form of a white powder, which requires ſixty times its weight of boiling water to diſſolve it.

The acid of ſugar of milk attracts earths in preerence to alkalis, with which it forms ſalts not readily ſoluble in water. Its combinations with earths are ſcarce ſoluble at all.

III. Acid of Milk, is procured by evaporating whey, ſpontaneouſly ſeparated, to about an eighth of its quantity. But whey contains a ſmall quantity of lime united with phoſphoric acid, with which it is ſuperſaturated, and is, for that reaſon, diſſolved; for phoſphoric acid merely ſaturated with lime, falls to the bottom of the veſſel. In order, therefore, to precipitate this phoſphoric ſalt, the remaining portion of the whey muſt be ſaturated with freſh lime, which muſt be precipitated by the acid of ſugar, for lime prefers this acid to every other. Finally, by the addition of highly rectified ſpirit of wine, the acid of milk is obtained pure.

This acid forms deliqueſcent ſalts with earths and alkalis. It is not known to form cryſtals with any metal except zinc.

Its firſt attraction is to ponderous earth; to this ſucceed the alkalis in their uſual order: after theſe, lime, magneſia, clay, metals.

IV. Acid of Ants. This acid is procured by diſtilling millions of theſe inſects, either without addition or with water. It reſembles vinegar in

many

many reſpects; but differs from it in forming cryſtals with magneſia, iron, and zinc.

The attractions of this acid are not determined; mean while they are ſuppoſed to coincide with thoſe of vinegar.

V. Acid of Fat. This acid is obtained by repeated diſtillation of animal fat. The neutral ſalts which it forms with earths and alkalis differ very little from thoſe of vinegar. In its attractions it prefers earths to alkalis.

VI. Acid of Phosphorus. Phoſphorus is a ſpecies of ſulphur (procured, by a troubleſome proceſs, from urine) conſiſting of a peculiar acid and phlogiſton. It is luminous in the dark, and burns with a cold flame when expoſed to the air. The acid of phoſphorus, like that of ſulphur, is obtained by ſimple combuſtion. This acid may likewiſe be ſeparated from the earth of calcined bones, by diſſolving the earth in nitrous acid, and precipitating it with vitriolic acid.

Phoſphoric acid unites with abſorbent earths in preference to alkalis: in other reſpects it poſſeſſes the properties of acids in general. With alkalis it forms microcoſmic ſalt.

Iron, zinc, and arſenic are completely ſoluble in phoſphoric acid. In a high degree of concentration, it may be combined with eſſential oils; and, with ſpirit of wine, probably a phoſphoric æther may be produced.

VII. Perlate Acid, like the phoſphoric, obtained from urine, and ſuppoſed, by the Swediſh chemiſts, to differ eſſentially from that acid, is probably no other than phoſphoric acid united with a little foſſile alkali. Future experiments, inſtead of increaſing, may poſſibly reduce the preſent catalogue of peculiar acids.

VIII. Acid of Prussian Blue. Pruſſian blue hath been generally ſuppoſed to conſiſt of iron united with phlogiſton. The Swediſh chemiſts have diſcovered that the tinging matter is of an acid nature, becauſe it unites with alkalis, earths, and metals, and forms with each a ſort of neutral compound.

This acid is obtained by boiling Pruſſian blue with a ſolution of fixed alkali, and by precipitating the ſalt thus formed, by the addition of ſpirit of wine. This ſalt, conſiſting of the tinging acid of Pruſſian blue, ſaturated partly with alkali and partly with iron, is called *Pruſſian*, or *phlogiſticated alkali*, which, being diſtilled with vitriolic acid, is decompoſed. The acid required, being thus diſengaged by the ſuperior attraction of the vitriolic to the iron and alkali, paſſes over and unites with the water in the receiver.

The acid of Pruſſian blue is ſuppoſed, by Bergman, to conſiſt of ærial acid (calcareous gas, or fixed air) volatile alkali and phlogiſton. It is volatile, and in its attractions ſeems to prefer alkalis to earths.

CHAP.

CHAP. VII.

A L K A L I.

THE general properties of alkalis are these:

1. They have a peculiar urinous taste.

2. They change the syrup of violets, and other blue infusions and tinctures of vegetables, to green.

3. They unite with effervescence with all acids, which they prefer to every other substance, and with them form various neutral salts. Their attraction to acids is in the following order: vitriolic, nitrous, marine, of fat, of flour, of phosphorus, of sugar, of tartar, &c. See the table of attractions.

Alkalis, in their natural state, are combined with calcareous gas, and are then called *mild*; when deprived of this gas they become *caustic*, and are then called *pure* alkali. By causticity is meant the violent action of these alkalis, thus deprived of their calcareous gas, upon the skin and flesh of animals, which they corrode and consume like actual fire.

This operation is explained by supposing it to be an extraction of calcareous gas from the animal body.

Alkalis are either *fixed* or *volatile*.

Fixed alkali is *vegetable* or *fossile*.

SECT. II.

VEGETABLE ALKALI,

IS procured by washing the ashes of burnt vegetables, whether herbs or wood, with water, and by evaporating the lexivium to dryness. Tartar, burnt in an open fire, yields the same salt, which differs in no respect from that procured from wormwood or from any other plant, except certain plants which grow near the sea.

This alkali, when exposed to a moist air, liquifies, and is then called *oil of tartar.* In this property it differs from mineral or fossile alkali. Oil of tartar is nothing more than a solution of vegetable alkali in water, which it attracts from the atmosphere. Consequently this oil, as it is called, may be immediately produced by dissolving the alkali in a small quantity of water. During the solution heat is produced.

Vegetable alkali alone sustains a considerable degree of heat without alteration; but mixed with calcareous, argillaceous, silicious, or metallic earths, and exposed to a sufficient fire, it fuses and converts them into glass.

Quicklime, which is calcareous earth deprived of its gas by burning, when mixt with a solution of fixed alkali, immediately seizes the calcareous gas of the alkali, and thereby renders it caustic.

Fixed

Fixed alkali diſſolved with certain phlogiſtic matters conſtitutes a liquid, called phlogiſticated alkali, of conſiderable uſe in the precipitation of metals. Bergman's method of preparing this liquid, is by adding Pruſſian blue to a ſolution of fixed alkali, prepared by burning cream of tartar and nitre in a hot crucible. This is alſo called Pruſſian alkali, on account of the Pruſſian blue uſed in the preparation.

Vegetable alkali, with vitriolic acid, forms *vitriolated tartar.*

With marine acid, *digeſtive ſalt of Sylvius.*

With nitrous acid, *nitre.*

With vegetable acids, *regenerated tartar.*

With ſulphur, *liver of ſulphur.*

With oils, *ſoap.*

Iron and copper are eaſily diſſolved in a ſolution of vegetable alkali; but other metals require a previous ſolution in acids.

Vegetable alkali may be obtained ſufficiently pure for chemical purpoſes, by deflagrating nitre with charcoal or with tartar. In this operation the acid evaporates, and the alkali remains.

SEC-

SECT. III.

MARINE, MINERAL, OR FOSSILE ALKALI.

IT is called marine alkali, becauſe it is the baſis of ſea-ſalt; mineral or foſſile, becauſe it is not produced in the animal or vegetable kingdoms.

The uſual method of obtaining this alkali is by burning plants which grow near the ſea, particularly *kali*, a plant which grows plentifully on ſome parts of the Spaniſh coaſt. It is imported into this kingdom under the name of *ſoda*, or *barrilla*, and is ſuppoſed to have been the *natron* of the ancients. It poſſeſſes all the general properties of vegetable alkali, and differs from it only in forming with acids different neutral ſalts.

With vitriolic acid it forms *Glauber's ſalt.*
With nitrous acid, *cubic nitre.*
With muriatic acid, *common ſalt.*
With vegetable acid, *Rochelle ſalt.*

SECT. IV.

VOLATILE ALKALI,

IS eaſily known by its penetrating pungent ſmell. It is procured by diſtillation from all animal ſubſtances, and from ſome vegetables, par-

particularly thoſe of the cruciform kind. It is produced by diſtillation from ſo many various ſubſtances, that nothing concluſive concerning its compoſition can be inferred from the means of its production; but from its properties it appears to be an alkaline ſalt volatilized by phlogiſton.

Volatile alkali, by a moderate degree of heat, may be converted into a permanent gas, called, by Dr. Prieſtley, *alkaline air*, which is ſuppoſed to conſiſt of inflammable and phlogiſticated air. This alkaline air may be changed into pure inflammable air by the electric ſpark, or by being heated in a retort.

Alkaline gas poſſeſſes the property, ſimilar to that of inflammable gas, of reviving mercury and lead by the electric ſpark; but it differs from the latter in being abſorbed by water, with which it forms a ſtrong alkaline ſpirit, called ſpirit of hartſhorn, or ſpirit of *ſal ammoniac*.

Volatile alkali is moſt eaſily obtained by diſtilling ſal ammoniac mixed with fixed alkali, calcareous earth, or with quicklime: if with fixed alkali, or calcareous earth, the alkali produced will be mild; if with lime, it is cauſtic, becauſe the lime deprives it of its fixed air. The nature of this proceſs is eaſily conceived when we recollect that *ſal ammoniac* conſiſts of marine acid and volatile alkali. The earth or lime uniting with the acid, ſets the alkali at liberty. When abſorbent earth is uſed, the volatile alkali ſublimes in in a concrete ſtate; but with lime it is always fluid, becauſe it is cauſtic; for cauſtic volatile alkali will not concrete. Cauſticity depends on a deprivation of fixed air.

Volatile alkali with vitriolic acid, forms *vitriolic ammoniac.*

With nitrous acid, *nitrous ammoniac.*

With marine acid, *ſal ammoniac.*

With ſulphur, *Hoffman's tincture of ſulphur.*

With ſpirit of wine, *dulcified ſpirit of ſal ammoniac.*

With eſſential oils and ſpirit of wine, *ſpiritus volatilis aromaticus.*

With oil of amber, *eau de luce.*

Liquid volatile alkali diſſolves copper completely, and immediately aſſumes a beautiful blue colour: hence a few drops of it will diſcover the ſmalleſt quantity of that metal in mineral waters, or other liquids. It alſo precipitates other metals from acids, and re-diſſolves them. It poſſeſſes the ſingular property of precipitating gold from *aqua regia*, which precipitate, when heated to a certain degree, fulminates with a violent exploſion, and is thence called *aurum fulminans.*

Volatile alkaline ſpirit, commonly called ſpirit of hartſhorn, is generally diſtilled from bones previouſly prepared by boiling them in water. It is afterwards rectified, that is, freed from its burnt oil, by repeated diſtillation.

The

The attractions of volatile alkali are nearly the ſame with thoſe of fixed alkali.

CHAP. VIII.

EARTHS.

PONDEROUS EARTH is a recent diſcovery. Hitherto it hath been always found combined with vitriolic acid, and conſtituting a peculiar kind of ſpar, called *ſpathum ponderoſum*, from its great weight. It may be ſeparated from the acid by the phlogiſton of oil or charcoal in what is called the *dry way*: that is, mixing either of theſe with the ſpar, and expoſing the mixture to a hot fire in a crucible. In this proceſs, the phlogiſton unites with the acid, forming ſulphur, and the ponderous earth is left in a cauſtic ſtate, its fixed air being diſſipated by the heat. But in order to obtain it pure, it muſt be diſſolved in nitrous acid, and precipitated by mild fixed alkali. In this operation, the precipitation is effected by a double attraction. The alkali ſaturates the acid, whilſt its fixed air unites with the ponderous earth, which falls to the bottom in its mild and natural ſtate. The ſeparation of pon-

ponderous earth from nitrous acid cannot be effected by caustic fixed alkali; for though this acid, in equal circumstances, will unite with caustic alkali in preference to every other substance, nevertheless, when united to ponderous earth, the attraction of fixed air to the latter is required to produce a separation.

But this ponderous spar may be more easily decomposed by calcination in a strong heat with twice its weight of fixed alkali, which, uniting with the vitriolic acid, will form vitriolated tartar. This with the superfluous acid may be washed off, and a mild ponderous earth will remain.—Or, in the moist way, by boiling the spar, mixt with half its weight of fixt alkali, for some hours.

This earth is called by Mr. Kirwan, in his *Elements of Mineralogy*, Barytes. It resembles lime in taste, but requires 900 times its weight of water to dissolve it. It is the only earth which decomposes vitriolated tartar, and which may be precipitated by the Prussian alkali from the nitrous and marine acids. Its specific gravity exceeds 4,000. Some philosophers believe it to be a metallic earth.

Ponderous earth has some properties in common with calcareous earth, but differs from it in forming, with vitriolic acid, ponderous spar. With nitrous and marine acids, it forms crystals that are scarce soluble: from these it may be separated

parated by the leaſt drop of vitriolic acid, by which it is moſt powerfully attracted. For this reaſon a few drops of a ſolution of ponderous earth in any other acid, will immediately diſcover the ſmalleſt admixture of vitriolic acid in water, or in any other fluid.

The attraction of ponderous earth to other acids, is in the following ſucceſſion: acid of ſugar, of amber, of fluor, &c. See the table of attractions.

Ponderous earth, in its natural ſtate, is combined with fixed air, and therefore, like calcareous earth, produces an efferveſcence when diſſolved by acids.

SECT. II.

LIME

IS pure calcareous earth; that is, calcareous earth ſeparated from its gas, by burning, or by ſolution in acids. Marble, limeſtone, calcareous petrefactions, calcareous ſpar, ſtalactites, tophi, chalk, and every kind of ſtone that will burn to lime, conſiſts principally of this earth combined with calcareous gas; alſo the ſhells of fiſhes and of eggs.

This

This earth combined with vitriolic acid conſtitutes ſelenites, gypſum, plaiſter of Paris, alabaſter; with fluor acid, fluor; with Tongſten acid, Tongſten; with the nitrous and marine acids, deliqueſcent ſalts; with vegetable acids, a kind of ſoluble tartar.

Lime in the temperature of 60, requires near 700 times its weight of water to diſſolve it.

Lime in its natural ſtate, that is, combined with fixed air, efferveſces with all acids, with which it forms various neutral ſalts. This efferveſcence is produced by the extrication of the *fixed air*, called by modern chemiſts, *the aerial acid*, to which it has leſs attraction than to any other acid. Its firſt attraction is to the acid of ſugar, then to that of ſorrel. To theſe ſucceed the vitriolic, the tartareous, &c.

Lime, though incapable of fuſion when alone, acts as a flux to all other earths. It melts with borax or microcoſmic ſalt. In fuſion it combines ſo intimately with the marine acid as to be inſeperable by heat alone. Fuſed with calx of iron, it forms a black maſs of a metallic appearance; with calx of copper, a metallic maſs of a red colour; with calx of lead, a yellow glaſs; with calx of tin, a yellow glaſs; with calx of biſmuth, a powder, or greeniſh glaſs, according to the proportion of each ſubſtance; with calx of antimony, a ſemi-tranſparent yellow maſs; with zinc, a glaſs glafs of a deep yellow colour. Thefe feveral combinations are fo hard as to ftrike fire with fteel. *Berlin Mem.* 1781.

SECT. III.

CLAY,

BY chemifts called *argillaceous earth*, is diftinguifhed from other earths by its tenacity and plaftic property when moiftened with water. It is never found perfectly pure, but commonly mixed with a large proportion of flint. It is moft eafily obtained pure from alum, which is a combination of clay and vitriolic acid. From this acid the clay may be feparated by the intervention of alkaline falts, or of any other fubftance which attracts the vitriolic acid more powerfully than clay.

Pure clay alone is not fufible in the ftrongeft fire; but may be eafily fufed by mixing it with lime, borax, or microcofmic falt. When burnt it becomes fo hard as to ftrike fire with fteel.

Clay, fufed with calx of iron, forms a black mafs imperfectly fufed, but hard enough to ftrike fire with fteel; with copper, a brown mafs imperfectly fufed, or powder, according to the proportion of the two ingredients; with lead, a powder, un-

 lefs

leſs in the proportion of four parts of the calx to one of clay, in which caſe a glaſs of a deep yellow is produced; with tin, a powder, or grey maſs, that will ſtrike fire with ſteel; with beſmuth, antimony and zinc not fuſible.

Clay is ſoluble in acids, particularly the vitriolic, with which it forms alum.

Its attractions are in the following ſucceſſion: vitriolic, nitrous, marine, ſaccharine acid, &c.

SECT. IV.

FLINT,

CALLED *vitrifiable*, *cryſtalline*, or *ſiliceous earth*, is diſtinguiſhed by its peculiar hardneſs; by its ſtriking fire with ſteel; by its being inſoluble in acids, except fluor acid.

This earth, though called vitrifiable, is incapable of fuſion or vitrification without the addition of other earths, or of alkaline ſalts. Being fuſed in a crucible with three times its quantity of fixed alkali, the vitrious maſs becomes ſoluble in water, and the ſolution is called *liquor of flints*. When no more alkali is uſed than is ſufficient to fuſe the flint, the reſult is the glaſs made in glaſs-houſes for various purpoſes.

Powdered flint, fuſed with calx of iron in equal quantity, or with a leſs proportion of flint, forms a maſs a maſs that will ſtrike fire with ſteel; externally of a lead colour, but black and poliſhed in the fracture. If the proportion of calx exceed that of the flint, the maſs is friable. Flint fuſed with calx of copper, in any proportion, forms a black powder or friable maſs; with a triple or quadruple proportion of calx of lead, a greeniſh glaſs; with calx of tin, in equal or exceſſive proportion of calx, a white or yellowiſh vitrious maſs, not very hard; with calx of biſmuth, four parts to one of flint, glaſs of a deep yellow; with calx of antimony in equal or greater proportion of calx, white or yellowiſh glaſs; with calx of zinc, in exceſs, a white opake maſs that will ſtrike fire with ſteel.

Flint hath been generally ſuppoſed inſoluble in water; but Mr. Kirwan ſays, that 10,000 parts of water may diſſolve one of this earth. *Mineral*, p. 8.

SECT. V.

MAGNESIA,

COMMONLY called *magneſia alba*, like calcareous earth, is ſoluble in acids with effervеſcence; but differs eſſentially in not burning to lime. It effervеſces with acids becauſe, before calcination, it is combined with fixed air. It differs from lime in forming, with vitriolic acid, a bitter neutral ſalt, called *Epſom ſalt*; in not being ſoluble in water after calcination; in being, in ſome degree, ſoluble in water before calcination *; when calcined, in depriving *volatile* alkali only, of its fixed air; in not cryſtallizing with vinegar; in not being precipitated from other acids by the vitriolic.

Magneſia fuſed with above an equal proportion of calx of iron, produces a hard black maſs imperfectly fuſed; with calx of copper, a grey hard maſs imperfectly fuſed; with calx of lead, in the proportion of four to one of earth, a hard yellowiſh maſs; with calx of tin, a whitiſh porous maſs that will ſtrike fire with ſteel; with calx of biſmuth, a grey powder, or white friable maſs; with calx of antimony, in the proportion of four to one of magneſia, an opaque hard maſs of a metallic appearance; with calx of zinc, in the proportion of three or four to one of earth, a hard, porous, unpoliſhed, brown maſs.

Theſe experiments require a great degree of heat.

Magneſia, in the ſtrongeſt heat, will neither melt alone nor with any other ſingle earth, except lime; but it will melt with a mixture of flint and clay; alſo with borax, or microcoſmic ſalt.

Mag-

* It requires about 6792 times its weight of water to diſſolve it. *Kirwan's Mineralogy*, p. 6.

Magnesia is seldom found, in a natural state, unmixed with other matter. It is found combined with the nitrous acid in all nitrous earths; with the marine acid in sea water; and with the aerial acid in various mineral waters: it is also a constituent part of a variety of stones.

Magnesia is generally obtained by precipitation, with fixed alkali, from the last lixivia of nitre or of sea salt; but that which is precipitated with salt of tartar from a solution of Epsom, or *bitter purging salt*, is most pure.

CHAP. IX.

METALS.

METALLIC bodies are, perfect metals, imperfect metals, and semi-metals.

Perfect metals are, gold, platina, silver, mercury.

Imperfect metals are, lead, copper, iron, tin.

Semi-metals are, bismuth, nickel, arsenic, cobalt, zinc, antimony, manganese, molybdena.

Metallic bodies differ essentially from all other natural bodies in being more ponderous.

All metallic bodies are composed of phlogiston and an earth or calx peculiar to each. Now phlogiston being the same in all metals, their various properties must necessarily depend on some peculiarity in the calx of each metal: the calces of metals, therefore, rather than the metals themſelves, are the objects of chemical inveſtigation. By *calx* is meant the metal deprived of its phlogiſton, whether by means of fire, or by ſolution and precipitation.

Dr. Higgins is of opinion, that metals in calcination, or in ſolution, do not part with their phlogiſton, but that they imbibe pure air, which unites with the phlogiſton into a ſtate approaching to water. Hence the ſuperior weight of metallic calces. In reducing theſe calces to a metallic ſtate, the phlogiſtic matter employed, he aſſerts, communicates nothing to the metal, but uniting with the vital air, forms aerial acid and water.

Metals in general are ſoluble in acid menſtrua, and are thence precipitated by alkaline ſalts; becauſe, acids having a ſuperior attraction to alkalies than to metallic calces, they unite with the former, and conſequently the calx falls to the bottom of the veſſel.

Metals may be precipitated, from their ſolution in acids, by other metals, and ſuch precipitates are not calces, but the metal revived or *reduced*, as it is expreſſed by chemiſts; that is, reſtored to its metallic appearance. If iron, for example, be put into a ſolution of ſilver, of copper, of tin, &c. theſe metals will be precipitated in their metallic form, and the iron will be diſſolved in the acid; but if zinc be added to this ſolution, the iron, attracting phlogiſton from the zinc, will fall to the bottom, and the calx of zinc will occupy its place with the acid.

SECT.

SECT. II.

PERFECT METALS,

ARE ſo called, becauſe they cannot be calcined or in any reſpect altered by fire, tho' ever ſo long continued.

1. Gold, called, by the ancient chemiſts, the king of metals, is not only the moſt valuable, but the moſt ponderous and moſt ductile of all metals. One ounce of gold will gild a ſilver wire twelve hundred miles in length. It is beat by the hammer ſo thin as to float in the air; and ſo great is its tenacity, that a gold wire one tenth of an inch in diameter will ſuſtain a weight of 630 pounds.

Gold is deemed inſoluble in either acids or alkalies ſimply applied; but it is ſoluble in *aqua regia* and in *hepar ſulphuris.*

Aqua regia is a mixture of nitrous and marine acid. The firſt of theſe acids has no further ſhare in diſſolving gold than by depriving the marine acid of its phlogiſton, which marine acid, thus dephlogiſticated, attracts phlogiſton from the metal, and thereby renders it ſoluble; for metals are not ſoluble in acids until they are deprived of a part of their phlogiſton: dephlogiſticated marine acid, therefore is the real ſolvent of gold. But, in a letter from Dr. Crell to M. D'Arcet, we learn that by diſtilling vitriolic acid with manganeſe, an acid is obtained that will alone diſſolve gold, ſilver, and mercury.

Gold, thus reduced to a calx, becomes eaſily ſoluble by moſt other acids, by alkalies, and by æther, which takes this metal from all acids.

In the dry way, that is, melted in a crucible, gold readily unites with all other metals.

Gold is alſo ſoluble, in the dry way, by liver of ſulphur, which is a combination of ſulphur with fixed alkali. From this compound, diſſolved in water, the gold may be precipitated, together with the ſulphur, by any acid, and may be finally ſeparated from the ſulphur by fire.

Gold, diſſolved in *aqua regia*, may be precipitated, by alkalis, earths, and the calces of all metals except platina. The precipitate, by means of cauſtic mineral alkali, is almoſt black; by mild mineral alkali, yellow.

The calx of gold precipitated from *aqua regia* by means of volatile alkali, poſſeſſes the ſingular property of fulminating when expoſed to a moderate degree of heat: it is called *aurum fulminans*. The cauſe of this phenomenon is the ſudden eruption of the elaſtic fluid, which, combined with phlogiſton, conſtitutes volatile alkali. In this operation, the alkali is inſtantaneouſly decompoſed (by the calx, when heated to a certain degree, ſnatching its phlogiſton) and the elaſtic fluid conſequently releaſed. A cubic inch of *au-*

rum

rum fulminans generates, by explosion, about one thousand cubic inches of this gas.

A cubic foot of gold weighs 1326 French pounds*. Weighed in water, it loses one nineteenth part, and sixty-four parts of the twentieth, supposing it divided into one hundred: its specific gravity therefore is called 19,64. In other words, gold weighs about nineteen times and an half heavier than the water that would run over the edge of a vessel quite full, on dropping a lump of gold into it; or than a lump of ice of the same size.

Gold, not being soluble by sulphur or arsenic, is never found, like other metals, mineralized, so as to constitute a proper ore of gold. It is sometimes discovered, in small quantities, in the ores of silver, copper, lead, &c. but it is generally found in what is called a native or virgin state, inclosed in stones of various kinds, particularly in quartz, or mixed with sand at the bottom of rivers.

Gold mixed with sand may be easily separated by mechanical means; if it be inclosed in earths or stones, it may be separated by first reducing them to a fine powder, and dissolving it in nitrous acid. If the earth be calcareous it will dissolve, and the gold will fall to the bottom. If the matrix be gypseous or siliceous, dissolve the powder

* The French pound is to the English Troy pound as 21 to 16.

powder in *aqua regia*, and precipitate the gold with a ſolution of green vitriol. Gold may be ſeparated from pyrites, after torrefaction, by *aqua regia*. *Kirwan Mineral.*

According to Bergman, the elective attractions of gold, in the moiſt way, are æther, marine acid, aqua regia, nitrous acid, &c.; in the dry way, mercury, copper, ſilver, lead, &c.

II. Silver is the ſecond perfect metal. Like gold, it is capable of ſuſtaining the greateſt degree of heat without alteration or diminution. It loſes the eleventh part of its weight in water. A cubic foot of ſilver weighs 720 French pounds. A ſilver wire one tenth of an inch in diameter, will ſupport 340 pounds. Except gold, it is the moſt ductile of all metals.

Silver may be diſſolved by vitriolic or marine acid, but not without the aſſiſtance of a conſiderable degree of heat and concentration.

The proper ſolvent for ſilver is nitrous acid, which diſſolves it very readily without heat; but if to this ſolution either of the above acids be added, the metal quits the nitrous, and uniting with the other, falls to the bottom of the veſſel in the form of a white powder, conſiſting of very minute cryſtals. If precipitated by cauſtic mineral alkali, or by phlogiſticated alkali, a yellowiſh brown calx will be the reſult.

If a ſolution of ſilver in nitrous acid be properly evaporated and left to cryſtallize, we obtain a me-a metallic ſalt called *lunar cryſtals,* and theſe cryſtals, by fuſion, form the cauſtic called *lapis infernalis.*

Silver combined with vitriolic acid, is called *lunar vitriol;* with the marine acid, after fuſion, *luna cornea.*

The ſolution of ſilver in nitrous acid is ſingularly uſeful in the examination of waters, in which a few drops of it produce a cloud and precipitation, if the water contain vitriolic acid, marine acid, alkali, earth, or metal, whether ſimple or combined. The decompoſition which cauſes the cloud in the water, is produced by the ſuperior attraction of theſe ſeveral ſubſtances either to ſilver or to the nitrous acid in which it is diſſolved. Silver prefers either of the other two acids to the nitrous, and all acids prefer alkalis and earths to metals; and thus, when any of theſe are uncombined, the decompoſition is eaſily accounted for. But it is not ſo eaſy to comprehend the power which ſeparates the ſilver from the nitrous acid when the water to be tried contains a neutral ſalt. In this caſe the effect is produced by what is called a double attraction.

Let us ſuppoſe that the water holds in ſolution ever ſo ſmall a quantity of Epſom ſalt, which conſiſts of vitriolic acid and magneſia. A few drops of the ſolution of ſilver immediately produces a cloud, which evidently indicates a decompoſition. How can this poſſibly happen?—for we know

know that the magnefia is more powerfully attracted by the vitriolic than by the nitrous acid, and that the vitriolic acid prefers magnefia to filver; but though neither the nitrous acid nor the filver can alone decompofe the Epfom falt, yet the attraction of filver to the vitriolic acid, and of nitrous acid to magnefia, acting at the fame time, produce a force fuperior to that which held the conftituent parts of the two neutral falts united. Thus the nitrous acid uniting with the magnefia forms a frefh neutral falt, which remains diffolved in the water, and the filver united with the vitriolic acid, falls to the bottom.

Silver is fometimes found in its natural and malleable ftate combined with a fmall proportion of gold, or with copper; but it is generally found mixed with other metallic matters, mineralized with fulphur and arfenic, from which it is feparated by what is called cupellation, a procefs founded on its indiftructibility by fire.

Silver may alfo be feparated from its ores in the moift way, by pulverizing and then diffolving them in nitrous acid, and afterwards precipitating the filver with marine acid, which will take it from any other menftruum.

Mr. Kirwan (*Mineral.* p. 240) enumerates 18 fpecies of filver ore, viz.

1. *Native*, in various forms, mixt in ftones of various kinds.

2. *Vitri-*

2. *Vitrious*, in large lumps ſeparate or involved in quartz, ſpar, &c. It is one of the richeſt, 100 parts containing 75 of ſilver.

3. ***. Yellowiſh white, mineralized by a ſmall proportion of arſenic.

4. ***. Soft and of a metallic appearance when cut; mineralized by a large proportion of arſenic.

5. *Red ore.* Heavy, ſhining, diaphanous, or opake; mineralized by arſenic and ſulphur; 100 grains contain 60 of ſilver.

6. *Black ore*, mineralized by ſulphur with a very ſmall proportion of arſenic and iron.

7. *Arſenico-martial ore*, mineralized by arſenic, with a large proportion of iron; hard, white, ſhining, fibrous, poor.

8. *White ore*, mineralized by arſenic, ſulphur, with very little copper and leſs iron. Heavy, ſoft, opake. Spec. grav. 5,000 yields about 20 per cent. of ſilver.

9. *Grey ore.* Arſenic and ſulphur, with much copper and iron. It yields from one to twelve per cent. Moſt common of all ſilver ores.

10. *Brown ore.* Arſenic, ſulphur, copper, iron, antimony. The greateſt part is copper. Of ſilver from 1 to 5 per cent.

11. *Plumoſe ore.* Sulphur, arſenic, iron, antimony. It is of various colours, reſembling hair or wool. Very poor.

12. *Co-*

12. *Cobaltic ore.* Sulphur, arſenic, cobalt, iron. The maſs is of various colours, but whether brown, or black, or white, it is diſtinguiſhed by roſe-coloured particles of cobalt. Yields about 45 per cent.

13. *Buttermilk ore.* Sulphur, antimony, and barytes. In thin pellicles on granular ſpar.

14. *Combuſtile ore.* It is a coal that leaves about 6 per cent. in its aſhes.

15. *Corneous ore.* With vitriolic and marine acids, a little iron, and ſometimes with vitrious ore. This ſcarce and valuable ore is white, or grey, or yellow, or brown, or green, or purple, or black; often cryſtalized in a cubic form; ſometimes friable. Yields about 70 per cent.

16. *Gooſe-dung ore.* Uncertain mineralization.

17. *Foliaceous ore.* It is found in mountain cork, but not worth finding.

18. *Imaginary.* Mineralized by ſulphur, arſenic, and biſmuth.

Both gold and ſilver may be refined, that is ſeparated from the imperfect metals, and other extraneous matter, by the action of fire alone, becauſe the ſubſtances with which they are combined are calcined or vitrified by continued heat; but by the addition of lead the operation is conſiderably accelerated: that metal promotes the calcination of the extraneous matter, and riſing with it to the ſurface, runs off, leaving the perfect metal pure.

But

But though gold and silver may be thus separated from all other matter, they cannot, by this process, be separated from each other; because they equally resist the action of fire and of lead: to effect this separation, therefore, we must have recourse to other chemical means.

Gold, we know, is soluble only in *aqua regia*; but silver will dissolve in the nitrous or in the marine acid separately applied, or with sulphur in the dry way. The nitrous acid is the best menstruum, and is therefore most commonly employed. This process is called *parting*. The gold falls to the bottom, and the silver, dissolved in the acid, may be obtained either by distillation, or by putting the solution into a copper vessel. The nitrous acid having a greater attraction to copper than to silver, the latter is consequently precipitated.

The first attraction of silver is to the marine acid: to this succeed the acid of fat, of sugar, of vitriol, &c. Volatile alkali dissolves the calx of silver. In the dry way, silver prefers lead to every other metal.

III. Platina, a metal but lately discovered, is ranked among the perfect metals, because it is not destructable by fire; and it was thought to differ from every other metallic substance in not being fusible alone in the hottest furnace; but M. Lavoisier, in the year 1782, succeeded in melting it by means of a current of pure air.

Pla-

Platina is found in the gold mines of Spaniſh America, in ſmall angular grains, mixed with a ſpecies of black ſand, which is attracted by the magnet, but neither ſoluble in acids nor fuſible. Theſe grains of Platina reſemble iron filings, but are ſomewhat whiter.

Platina approaches very near to gold in its ſpecific gravity, and reſembles that metal in being only ſoluble in *aqua regia*, from which, like gold, it may be ſeparated by æther, by alkalis, and by moſt other metals.

Platina may be precipitated from its ſolution in *aqua regia* by ſal-ammoniac; a property peculiar to this metal. *Lewis.*

It differs eſſentially from gold in being neither fuſible nor malliable, unleſs combined with other metals by fuſion, with ſome of which it readily unites, particularly with zinc.

The attraction of Platina to acids is nearly ſimilar to that of gold, except that when precipitated from its ſolution, it is ſoluble in the acid of ſugar, of ſorrel, of lemons, of ants, and of vinegar.

Such were the chemical hiſtory and properties of platina from its firſt diſcovery down to the year 1786; but we now learn that M. Chabanon, profeſſor of chemiſtry in Spain, has diſcovered a method of fuſing and caſting it in large maſſes, which may be as eaſily wrought as gold or ſilver; and that its ſpecific gravity is 24,000.

IV. MER-

IV. Mercury is considered, by the generality of chemists, as an intermediate substance between the perfect and imperfect metals; nevertheless, it certainly possesses the essential and distinguishing property of perfect metals, namely indestructability by fire. Except gold and Platina, it is the heaviest of all metallic substances, and, like these, it is not at all affected by the moisture of the atmosphere.

A cubic foot of mercury weighs 947 French pounds, of which it loses no more than one fifteenth when weighed in water.

Mercury differs principally from the other perfect metals in being fusible in a less degree of heat, that of the atmosphere being sufficient to keep it in a state of fusion; but in extreme cold weather, in a very cold climate, with the addition of artificial cold produced by the mixture of spirit of nitre with snow, mercury has been actually fixed and rendered malliable. In this state it possesses all the essential properties of a perfect metal.

Mercury differs from the other perfect metals in its volatility. It evaporates with a degree of heat little superior to that of boiling water; but this evaporation affects no alteration in the metal: for, if it be distilled in close vessels, the condensed vapour is precisely the same with the mercury submitted to distillation.

This metal being digested over a strong heat, without the addition of any other matter, and continued for a considerable length of time, may be converted into a reddish powder, called *precipitate per se*; but this powder is easily restored to its former fluid state by heat alone.

If mercury be distilled with vitriolic acid, and the mass which remains in the retort be thrown into hot water, part of it dissolves, and the remainder falls to the bottom. This precipitate is called *Turbeth mineral.*

Mercury is readily dissolved by the nitrous acid. If the salt formed by this union be evaporated by heat, there will remain a mercurial powder, which is called *red precipitate.* Mercury dissolved in any acid, may be precipitated white, by phlogisticated alkali.

Marine acid sublimed with mercury forms *corrosive sublimate*, and if to this salt about three times its quantity of mercury be added, triturated together and afterwards sublimed, *mercurius dulcis*, or *calomel*, will be the result.

Mercury, dissolved in any of the acids abovementioned, may be precipitated by earths and alkalis, to which acids have a stronger attraction, and this precipitate becomes soluble in vegetable acids, which have very little effect on mercury in its natural state. It is also soluble in alkaline solutions after a previous solution in acids.

But, though mercury is most readily dissolved in nitrous acid, it is more powerfully attracted by the

the vitriolic or marine acids. Hence the presence of these acids, or any of their combinations, are immediately discovered by a few drops of the solution of this metal in the nitrous acid; and hence its utility in examining waters which are supposed to contain Glauber's salt, Epsom salt, selinites, gypsum, alum, vitriol, or common salt.

Mercury may be disengaged from its solution in acids by most other metallic substances. If, for example, a clean plate of copper be immersed in a solution of corrosive sublimate, which is a combination of mercury with marine acid, the acid will unite with the copper, and the mercury will cover the surface of the plate, which will appear to be converted into silver.

Mercury may be easily amalgamated, that is, combined or allayed with most metallic substances, except iron: its combination with tin is particularly useful in covering the surface of mirrors. It unites most readily with gold, and is therefore generally used in extracting that metal from the heterogeneous matter in which it is frequently involved.

The acid of fat disengages mercury from the marine, and consequently from every other acid. To this attraction may probably be ascribed the extinction of mercury by trituration with lard or grease of any kind, from which it is not entirely recoverable.

Mercury unites intimately with ſulphur by trituration only, but more perfectly by fuſion. If this combination, which is called *Ethiops mineral*, be *ſublimed*, that is, volatilized by fire in cloſe veſſels, a red powder, called *cinnabar*, is produced; which, when finely ground, is called *vermillion*.

Mr. Kirwan enumerates ſix ſpecies of mercurial ores, viz.

1. *Native*, flowing from ſtones, or diffuſed among clay.

2. *Calciform*, mineralized by aerial acid; in hard lumps of a brown-red colour.

3. *Vitriol and marine ſalt of mercury*, mineralized by vitriolic and marine acid; of a ſpar-like appearance, bright and white, or yellow, or black.

4. *Native cinnabar*, mineralized by ſulphur; of a red colour, in friable maſſes or cryſtallized, or intermixed with clay or ſtones, or with the ores of ſilver, copper, or martial pyrites.

5. *Black ore*, mineralized by ſulphur with copper; of a dark grey colour and glaſſy texture.

6. *Pyritous ore*, containing mercury, ſilver, iron, cobalt, ſulphur, and arſenic; a friable maſs of a light grey colour.

By what means mercury may be ſeparated from ſulphur and other ſubſtances with which it is combined in theſe ores, is eaſily imagined, if we attend to its properties above enumerated. It is moſt frequently obtained from *native cinnabar*, by diſtillation with iron filings, which ſulphur prefers

to

to mercury. Many other metals, alkali, or earths, would effect the ſame purpoſe.

SECT. III.

IMPERFECT METALS,

ARE ſo called, becauſe, though, like the perfect metals, they are malliable, ductile, and fixed in the fire, they are nevertheleſs deprived of their phlogiſton, and conſequently reduced to a calx, in a ſufficient degree of heat.

I. LEAD, called *Saturn* by the ancient chemiſts, except gold, platina, and mercury, is the heavieſt of all metallic ſubſtances: it is alſo the ſofteſt, leaſt ductile, leaſt elaſtic, and leaſt ſonorous of all metals. A cubic foot of lead weighs 828 French pounds, and, weighed in water, loſes about a twelfth part of that weight.

The calx of lead expoſed, for ſome time, to the flame of a furnace inſufficient to melt the calx, is converted into *red lead*, called *minium*. But if the heat be ſufficient to fuſe the calx, it becomes *litharge*, which is a powder conſiſting of ſmall ſcales reſembling *talk*. This powder is uſed in various arts, particularly in glazing earthen ware, making ſome ſorts of glaſs, &c. A yet greater degree of heat converts the calx of lead into a perfect glaſs, called the glaſs of lead, which being readily fuſible, is frequently uſed as a flux in the ſcorification of ores.

The calx of lead may immediately be reduced, that is, reſtored to its metallic appearance and properties, by melting with a ſmall quantity of fat, or any other phlogiſtic matter.

Lead is ſoluble in all acids, but its moſt powerful attraction is to the vitriolic, which conſequently ſeparates it from any other acid. Diſſolved by vinegar, it conſtitutes *white lead*, uſed by painters in oil. *White lead* completely ſaturated with vinegar by digeſtion, and afterwards evaporated and cryſtallized, forms the ſalt called *ſugar of lead*. A white calx of lead may be obtained by precipitation with alkali, mild or cauſtic, from its ſolution in any acid.

Lead may, by fuſion, be eaſily united with any metal except iron: nevertheleſs, the calces of theſe two metals unite in vitrification.

Lead, combined with tin, conſtitutes the ſolder uſed by tin-men and plumbers. This combination, calcined, is uſed for glazing earthen ware, and is alſo the foundation of white enamels.

There are nine ſpecies of lead ore, viz.

1. *Native*: very rare: ſometimes contains ſilver, or copper.

2. *Calciform*, mineralized by the aerial acid. Of this ſpecies there are five varieties, viz.

Lead

Lead ſpar, lead ochre, native ceruſs; with iron and earth.

Red, brown, or *yellow*; with more iron.

Green, cryſtallized in needles or in powder: with iron, ſeldom copper.

Bluiſh, ſometimes cryſtallized; with copper.

Black, moſt rare, ſometimes cryſtallized.

Theſe ores are eaſily reduced by ſimple fuſion with any phlogiſtic matter.

3. *** mineralized by vitriolic acid; a white heavy calx.

4. *** mineralized by the phoſphoric acid; green, containing iron.

5. *Galena*, mineralized by ſulphur; with ſulphur and a little iron; moſt common; lead colour, cubic, often mixt with quartz, and ſometimes containing about one per cent. of ſilver.

6. *Antimoniated lead ore.* In appearance it differs from galena only in its texture being thready, whereas that of galena is plated. It yields a ſmall quantity of ſilver.

7. *Pyritous lead ore*; ſulphur, ſilver, and much iron; brown. It is a mixture of galena with brown pyrites.

8. *Red lead ſpar:* ſulphur, arſenic with ſilver. Lately diſcovered in Siberia.

9. *Stony or ſandy lead ores.* Diffuſed through calcareous earths. The means of ſeparating this metal from theſe ores may be eaſily conceived by

attending to its properties. Vide, *Kirwan's Mineralogy*, p. 300.

II. Copper, by chemiſts called *Venus*, is harder and more ſonorous than ſilver, but ſomewhat leſs malliable and ductile. Its tenacity is ſo great, that a wire, the tenth of an inch in diameter, will ſuſtain a weight of 375 pounds. In water it loſes almoſt a ninth part of its weight.

Copper diſſolves in all acids and in alkaline ſolutions. In the former the ſolution is green, and in the latter blue. When long expoſed to the air, it contracts a green ruſt, which is a partial calcination of its ſurface by the aerial acid. This ruſt may be revived by heat with the addition of any phlogiſtic matter.

To diſſolve copper in the vitriolic acid requires a conſiderable degree of heat and concentration in the acid. The ſalt obtained from this ſolution by cryſtallization is called *blue vitriol*.

Copper diſſolved in vegetable acids and cryſtallized forms *verdigreaſe*.

This metal may be ſeparated from its ſolution in any acid by alkalis or calcareous earths. The green powder thus precipitated, is uſed for painting upon China ware, and for imitating emeralds, &c. in melting it with glaſs. The greeniſh precipitate of copper, by phlogiſticated alkali, from nitrous acid, is more than five times the weight of the copper diſſolved. *Bergman on Precipitates*, p. 398.

Acids

Acids having a ſtronger attraction to iron than to copper, the firſt of theſe metals will immediately precipitate the latter. If therefore a plate of iron be ſuſpended in a ſolution of copper in any acid, part of the iron will be diſſolved, and the copper, in its metallic ſtate, will cover the ſurface of the iron-plate, ſo as to give it the appearance of a perfect tranſmutation.

Copper, like the other imperfect metals, may, by heat alone, be reduced to a perfect calx, which by the addition of phlogiſton may be again revived.

Copper being more powerfully attracted by acids than ſilver or mercury, eaſily precipitates theſe metals, and, in conſequence of this property, it is uſed, in the operation of *parting*, to precipitate ſilver from its ſolution in the nitrous acid.

Copper readily unites with ſulphur, the acid of which, in a degree of heat ſufficient to expel the phlogiſton, converts the metal to *blue vitriol.*

Copper allayed with about a fourth part of zinc forms braſs; with tin and with a certain proportion of other metallic ſubſtances, according to the uſes for which it is intended, it conſtitutes bronze for bells, ſtatues, and cannon. The mixed metal called Tombac, Pinchbeck, or Prince's metal, is a compoſition of copper and zinc.

The

The attraction of copper to acids is in the following succession: acid of sugar, of tartar, muriatic, vitriolic, &c.

There have been discovered twelve species of copper ores, viz.

1. *Native*, in various forms, either reddish or grey, or grains or lumps, &c.

2. *Calciform*, mineralized by the aerial acid: red; green, called *mountain green*; blue, called *mountain blue*. These are frequently found crystallized.

3. *Cuprious stones*. *Torquoise* is the tooth of an animal penetrated by the blue calx of copper. *Lapis Armenus*, calcareous earth also coloured by the blue calx of copper.

4. *Vitrious copper ore*, mineralized by sulphur; red, brown, or blue: the richest ore of copper; generally soft; sometimes crystallized.

5. *Azur ore*; by sulphur with about 25 per cent. of iron.

6. *Yellow pyrites*; by sulphur with much iron.

7. *Grey ore*; by sulphur and arsenic with little iron.

8. *Blendose ore*; by sulphur and arsenic, with zinc and iron.

9. *Argillaceous, shistose, or slaty ore*. Vitrious ore combined with slate.

10. *Bituminous ore*; a species of coal found in Sweden.

11. *Copper*

11. *Copper in a foreign form.* In animal and vegetable matter.

12. ***. Mineralized by the vitriolic or marine acids. *Kirw. Min.* p. 256.

Copper is found diſſolved by the vitriolic acid in certain mineral waters, in Ireland and elſewhere.

Theſe ores may be analized by firſt reducing them to a fine powder, diſſolving them in nitrous acid and precipitating with fixed alkali, or with a clean plate of iron.

III. Iron, by chemiſts called *Mars*, is diſtinguiſhed from other metals by its attraction to the magnet. It is the lighteſt metal except tin; it is nevertheleſs the hardeſt, and, except Platina, the moſt difficult of fuſion. Except gold it is the moſt tenacious; for an iron wire, the tenth of an inch in diameter, will ſuſtain 570 pounds. It loſes near one eighth of its weight in water. Its ductility is ſo great that it may be drawn into a wire no thicker than the fineſt hair.

Iron is ſoluble in all acids, and ruſts more than any other metal in a moiſt atmoſphere, probably by the action of the aerial acid. This ruſt, which is a real calx of iron, that is, iron deprived of its phlogiſton, may be revived by fuſion with any inflammable matter.

Iron may be alſo, in ſome degree, calcined by water. If filings of iron be immerſed in water, they will in time be reduced to a fine powder called

called *Martial Ethiops*. This is probably the effect of the aerial acid in the water.

Iron diffolved in vitriolic acid produces *inflammable air*, which, by the application of a lighted candle to the mouth of the bottle, will immediately explode. This folution, by evaporation and cryftallization, forms *green vitriol*.

Iron with the nitrous, marine, or vegetable acids, forms deliquefcent falts.

This metal may be precipitated from its folution in acids by alkaline falts or calcareous earth. Iron diffolved in vitriolic acid, and precipitated by an alkali, faturated with phlogifton, forms *Pruffian Blue*.

Alkalis alfo act as powerfully upon iron as upon other metals, after having been previoufly diffolved by acids.

Iron precipitates all metals, except zinc, from their folution in any acid. This precipitate is almoft fix times as heavy as the iron diffolved.

Any folution of iron is, by the addition of vegetable aftringents, particularly galls, converted into ink.

Sulphur unites with iron in preference to any other metal: hence the great ufe of iron in extracting other metals from their ores by fufion.

The calx or ruft of iron is always of a yellowifh red or brown colour. It is ufed not only in medicine, but in painting in oil, in ftaining glafs,

and

and in various other arts. All earths of this colour contain the calx of iron.

Iron will unite with all metals except lead and mercury. It is capable of receiving, by cementation, a ſuperabundant proportion of phlogiſton; and of being, by that means, converted into a harder metal called *ſteel*.

Calx of iron, in fuſion, will melt four times its weight of lime, half its weight of clay, a third of flint, and a fourth of magneſia. *Achard. Berl. Mem.*

Mr. Kirwan is of opinion that, in fuſion, the attractions of earths with calx of iron, take place as in the following table. *Mineral.* p. 15.

Lime.	*Magneſia.*	*Clay.*	*Flint.*	*Iron.*
Iron,	Lime,	Iron,	Iron,	Lime,
Clay,	Iron.	Lime,	Lime,	Clay,
Magneſia,		Flint.	Clay.	Flint,
Flint.				Magneſia.

Iron is rarely found *native*, that is, in a mallible ſtate; nor is it, like moſt other metals, generally found diſtinctly mineralized by ſulphur and arſenic; but as a calx, that is, as an earth capable of being reduced to iron by the addition of of phlogiſton, it is univerſally diſtributed, particularly through the foſſil kingdom, there being ſcarce an earth or ſtone from which iron may not be extracted.

The preſence of iron in any earth or ſtone may be certainly diſcovered by diſſolving it, after previous calcination, in vitriolic acid, and by adding to the ſolution a lixivium of fixed alkali that has been calcined with the blood of any animal, which ſaturates the alkali with phlogiſton. If the matter thus examined contain iron, a blue precipitate, called *Pruſſian blue*, will be formed.

Iron is frequently found in mineral waters diſſolved by the vitriolic or the aerial acid. It is immediately diſcovered by the addition of any vegetable aſtringent, particularly the tincture of galls, which gives the water a purple tinge; or by the precipitation of Pruſſian blue by means of phlogiſticated alkali.

The acid of ſugar, or of tartar, will precipitate iron from the vitriolic, and conſequently from any other acid.

Mr. Kirwan enumerates 26 ſpecies of iron ore, viz.

1. *Native.* A maſs of malliable iron weighing 1600 lb. has been diſcovered in Siberia: it is found alſo in many other places.

2. *Steel ore:* brown calx mixt with iron in its metallic ſtate. Dark ſteel colour, ſolid, ſhining, magnatic.

3. *Mag-*

3. *Magnet.* Like the laſt in appearance.

4. *Black glimmer,* conſiſts of brown calx and black-lead.

5. *White or ſparry ore:* brown calx of iron, white calx of manganeſe, and mild calcareous earth. White only when freſh dug.

6. *Magnetic ſand.* Found in Virginia.

7. *Hæmatites:* red calx indurated with clay and manganeſe. Colour red, or brown, or yellow, or purple: hard and of a metallic appearance. In ſome countries it forms whole mountains. It yields from 40 to 80 per cent.

8. *Ochre.* Hæmatites in a friable ſtate, mixt with a conſiderable proportion of clay. Yellow, red, or brown.

9. *Red glimmer.* Red calx, with black-lead, called *plumbago.* Differs from black glimmer in not being magnetic before roaſting.

10. *Torſten.* Indurated red calz, with a ſmall proportion of brown. Bluiſh black, or yellowiſh grey.

11. *Emery.* Suppoſed to be a mixture of the red and white calces, with tripoli.

12. *Grey ore.* Red calx, with *ſiderite*; of a metallic appearance and hard: not at all magnetic.

13. *Argillaceous ore.* Red or yellow calx, with clay.

14. *Red calcareous ore.* In powder, in many parts of England. Uſed in painting.

15. *Sili-*

15. *Siliceous ore.* Jaſper, garnet, baſaltes; alſo ſand found in France.

16. *Muriatic ore.* Sermentine, *i. e.* magneſia and flint overloaded with iron.

17. *Martial calamine.* Yellow, red, or brown. Quartz, clay, iron, and zinc.

18. *Marcaſſite.* Mineralized by ſulphur and arſenic.

19. *Martial pyrites.* Mineralized by ſulphur. Yellow or brown.

20. *Miſpickel.* Mineralized by arſenic. Like ſilver in appearance.

21. *Combuſtible ore:* with plumbago and pit-coal.

22. ***. Mineralized by vitriolic acid.

23. *Iron blend.* A ſtone of an iron-grey colour.

24. *Wolfram.* A brown or black ſtone, generally found in tin mines.

25. *Native Pruſſian blue.* Clay mixt with iron. Generally found in bogs.

26. *Terre Verte.* Iron mixt with clay. It is uſed as a pigment.

Iron may be completely ſeparated from any of theſe ores, by repeated boiling in marine acid and precipitating with Pruſſian alkali. In the dry way, by fluxing them with a mixture of eight parts pounded glaſs, one of calcined borax, and one-half of charcoal.

IV. TIN

IV. Tin loſes not more than one-ſeventh of its weight in water: it is therefore the lighteſt of all metals. It is neither remarkably ductile nor tenacious; but it may be fuſed and calcined in a moderate degree of heat. By an increaſe of fire the calx of this metal becomes beautifully white and refractory: it is uſed, with the addition of other vitrifiable matter, for glazing the ſurface of earthen ware; and, calcined with lead, it forms a ſubſtance called *putty*, of ſingular uſe in poliſhing glaſs. Nitre fuſed with tin accelerates its calcination.

Tin is in ſome degree ſoluble in all acids, except the aerial. I except the aerial acid, becauſe it contracts no ruſt in contact with air or water.

Vitriolic acid, aſſiſted by heat, diſſolves tin entirely.

Nitrous acid calcines this metal; that is, it deprives it of its phlogiſton, and any alkali precipitates the earth in a white calx.

The marine acid, with the aſſiſtance of heat, diſſolves tin completely. It is alſo ſoluble in *aqua regia*. It may be precipitated, as a calx, from any of theſe ſolutions, by water only, if the ſolution be ſufficiently diluted.

The ſolution of tin in *aqua regia*, added to a tincture of cochineal in water, changes it from a crimſon to a ſcarlet colour. This effect is the foundation of all ſcarlet dyes.

Tin, in fusion, readily unites with all metals, but entirely destroys their ductility. Combined with copper, it forms a hard and sonorous compound called *bell-metal*; with lead, it constitutes *solder*; with bismuth, zinc, lead, and regulus of antimony in small proportions, it forms pewter; and with mercury, the silver or coating for mirrors.

The calx of tin is soluble both by fixed and volatile alkalies.

The acid of fat, and of tartar, precipitate the calx of tin from the vitriolic or the marine acid. In the dry way, the attractions of tin are in the following order: zinc, mercury, copper, antimony, gold, silver, lead, iron, &c.

Tin, mixed with lead, is constantly used for covering the inside of copper vessels; for which purpose nothing more is required than that the surface of the copper should be perfectly clean, and the tin applied in a state of fusion. It is also used for covering thin plates of iron, to which it readily adheres by simple immersion in the melted metal. Iron thus coated is the tin-ware in common use.

Tin, though sometimes found pure, is generally calciform. Its ores commonly consist of the calx of tin, iron, clay, or flint: they are called *tin-stone*, which is a heavy blackish mass; or *tin-grains*, which somewhat resemble garnets. These ores

ores may be tried, or *assayed*, as it is termed, by first washing out the lighter matters with water, then evaporating the arsenic (which proceeds from the matrix) by roasting, and finally separating the iron by a magnet.

Mr. Kirwan enumerates three species of tin ore, viz.

1. *Native*, found in Cornwall.

2. *Calciform*. Of this there are four varieties, viz.

Tin spar, or white tin ore.

Opake, brown or black ore.

Garnet ore.

Tin stone.

3. ***. Mineralized by sulphur.

SECT. IV.

SEMI-METALS,

ARE so called, because, notwithstanding their metallic appearance and other metallic properties, they are neither malliable, nor ductile, nor fixed in the fire. They differ from *perfect metals* in the want of these three properties, and from *imperfect metals*, in being capable of sublimation or evaporation by heat.

I. Bismuth in appearance reſembles the regulus of antimony, though ſomewhat leſs white. It loſes, in water, about a ninth of its weight, and is conſequently the heavieſt ſemi-metal.

Biſmuth is perfectly ſoluble in the nitrous acid only. From this ſolution it may be precipitated by alkalis; but water alone will produce a precipitate more white. This powder is uſed as a paint for the ſkin; but the ſkin of ladies thus painted will become black if expoſed to any phlogiſtic *effluvium*, becauſe the calx of Biſmuth attracts phlogiſton with great avidity. This property is the cauſe of the phenomenon produced by applying a ſolution of liver of ſulphur to a letter written with a ſolution of Biſmuth, called *ſympathetic ink.*

Biſmuth readily unites, in fuſion, with all metals except zinc and arſenic, rendering them fuſible in a leſs degree of heat. Tin, by a ſmall addition of biſmuth, becomes more hard and ſonorous: this combination is called pewter. Biſmuth is alſo an ingredient in the compoſition of which printers' types are caſt; and, together with lead and tin, is combined with mercury in foils for mirrors.

A ſolution of biſmuth in the nitrous acid may be decompoſed by the acid of ſugar, of fat, of ſorrel, of tartar, of phoſphorus, and of arſenic, to all which it has a ſuperior attraction. In the dry way, the attractions of biſmuth ſucceed in the

the following order: lead, ſilver, gold, mercury, antimony, tin, copper, &c.

Biſmuth is more frequently found native than any other metallic ſubſtance. It is alſo found mineralized by the aerial acid in form of calx; mineralized by vitriolic acid, by ſulphur, by ſulphur and iron. It may be ſeparated from its ore by melting it with pounded glaſs and calcined borax.

II. NICKLE, notwithſtanding the contrary opinion of ſome French chemiſts, is now generally conſidered as a diſtinct ſemi-metal. It is contained in an ore found, though rarely, in ſome parts of Germany, called *cupfer-nickel*. This ore is generally of an orange colour, and with a ſmooth ſurface: it contains ſulphur, arſenic, cobalt, and iron; from all which the ſemi-metal in queſtion is with great difficulty ſeparated in a ſtate of ſufficient purity for accurate inveſtigation.

After the moſt elaborate attempts to obtain this ſemi-metal perfectly pure, it ſeems impoſſible to diveſt it entirely of a certain proportion of iron, of which metal it may poſſibly be only a modification, and this inſeparable union with iron makes it impoſſible to determine preciſely the ſpecific gravity of nickel: it is commonly about 8,000. It is always magnetic.

Nickle diſſolves in all the acids, and theſe ſolutions are green. It is ſoluble alſo in volatile alkali, and the ſolution is blue. From a ſolution in acids, a greeniſh white calx may be precipitated by fixed alkali.

Nickel is eaſily fuſed with other metals, but more difficultly in proportion to its purity.

Nickel gives to glaſs an hyacinthine colour: in its attractions, it prefers the acid of ſugar to every other.

III. ARSENIC is a ſemi-metal compoſed of a peculiar acid and phlogiſton. White arſenic, which is the calx of this ſemi-metal, differs only from the regulus, in containing leſs phlogiſton.

Arſenic is produced by nature in its metallic or reguline ſtate, or calciform; but moſt frequently, mineralized by ſulphur. Its combination with ſulphur is yellow, called *orpement*; or red, which is denominated *realgar*, or *ſandarach*. This difference of colour is occaſioned merely by the proportion of ſulphur combined with the arſenic.

Arſenic, when combined with ſulphur, may, in part, be ſeparated by ſublimation, becauſe the latter is more volatile; but the ſeparation will not be compleat without a ſecond ſublimation with the addition of ſome ſubſtance which, by retaining the ſulphur, will ſet the arſenic free. Fixed alkali, or mercury, will anſwer this purpoſe.

This ore of arſenic may be analyſed by digeſtion in marine acid, with the gradual addition of the nitrous; ſeparating the ſulphur by filtration,

and

and precipitating the regulus by zinc, adding ſpirit of wine (*Bergm.*). This regulus loſes about an eighth part of its weight in water. Its colour is at firſt white and bright, but it ſoon grows black in the air.

White arſenic differs from other metallic calces in being ſoluble in water, and this is not ſurprizing when we recollect that it is nothing more than an acid combined with a ſmall proportion of phlogiſton. This calx may be reduced to regulus of arſenic by an additional quantity of phlogiſton.

Arſenic, combined with ſulphur, is preſent in the ores of moſt metallic ſubſtances, particularly in the ore of cobalt, and in that of iron called *white pyrites*. Its volatility renders it eaſily ſeparable by ſublimation, and its preſence is immediately diſcovered by the garlic-ſmell of its fumes.

Regulus of arſenic parts with its phlogiſton in ſo moderate a degree of heat that it cannot be fuſed alone; but, added to other metals in fuſion, it unites with many of them, rendering thoſe which melt with difficulty, more readily fuſible. Tin, which of itſelf is eaſily fuſed, is, by arſenic, rendered more refractory, but it acquires a permanent and brilliant whiteneſs.

White arſenic contains about one fifth part of phlogiſton, which when ſeparated, leaves the acid pure. This acid may, by heat alone, be again converted into white arſenic, which, when ſaturated with phlogiſton, regenerates regulus of arſenic.

White arſenic, though a real calx, contains no fixed air: and though calces do not unite with metals, yet white arſenic readily unites with metals in fuſion, becauſe it is reduced by the phlogiſton of the metal.

A ſolution of white arſenic in water, changes the tincture of turnſol red; but, like other metallic ſolutions, makes ſyrup of violets green.

Orpiment, which is arſenic combined with ſulphur, when boiled in water with double its weight of quick-lime, forms a liquor of ſingular uſe in diſcovering any quantity of lead diſſolved in wine. A few drops of this liquor, mixed with pure wine, produces a yellow precipitate; but if adulterated with lead, the precipitate will be dark, brown or black.

Regulus of arſenic is ſoluble in vitriolic, nitrous, and marine acid, aſſiſted by heat; the laſt of theſe muſt boil before it has any effect.

Regulus of arſenic precipitates gold and platina from *aqua regia*; alſo ſilver and mercury from the vitriolic or nitrous acids.

Native regulus of arſenic always contains iron: for if to its ſolution we add phlogiſticated alkali, Pruſſian blue is produced.

Iron, mineralized by arſenic, may be ſeparated by digeſtion in marine acid, which, diſſolving the iron, precipitates the arſenic.

Arſenic, combined with ſulphur and ſilver, conſtitutes the mineral called *red ſilver-ore*, which may be decompoſed by *aqua fortis*. This acid diſſolves the ſilver and the arſenic, leaving the ſulphur to fall to the bottom.

Orpiment, boiled in water with cauſtic fixed alkali, forms a liquor called ſympathetic ink, the fumes of which, applied to inviſible words written with vinegar of litharge, will render them legible though many ſheets of paper be interpoſed.

White arſenic diſſolved in water with vegetable alkali, added to a ſolution of blue vitriol, precipitates a beautiful green paint that mixes readily either with oil or water.

The attractions of arſenic, in the moiſt way, are in the following ſucceſſion: marine acid, acid of ſugar, vitriolic acid, nitrous acid, &c. In the dry way, nickel, cobalt, copper, iron, ſilver, tin, lead, gold, platina, zinc, antimony.

IV. Cobalt is frequently found in mines, mixed with other metals, in what is called a native ſtate; that is, not mineralized by any acid, or by ſulphur *. It is alſo found combined with ſulphur, or mineralized by the acid of vitriol or of arſenic. It is likewiſe found in the form of a black calx.

Native

* Mr. Kirwan ſays, that native cobalt has not yet been found; that, what paſſes for ſuch, is mineralized by arſenic. *Mineral.* p. 335.

Native cobalt generally contains iron, arſenic, and nickel, from which it may be ſeparated by diſſolving the maſs in *aqua regia*, and evaporating the ſolution to dryneſs; by diſſolving this powder in vinegar, and precipitating the cobalt by means of mild vegetable alkali.

Cobalt diſſolved in any acid, or in volatile alkali, produces a red colour. Precipitated from theſe ſolutions by fixed alkali, the powder is of a reddiſh aſh colour. By theſe properties it is ſufficiently diſtinguiſhed from nickel, and alſo in not uniting, in fuſion, with ſilver, biſmuth, or lead.

The ore of cobalt is a heavy mineral of a metallic appearance, which, when expoſed to a moiſt air, is covered with a reddiſh efflorescence. It is found chiefly in Saxony and in the Pyrenean mountains. The means of obtaining the regulus of cobalt from this mineral is, firſt to expel the ſulphur and arſenic by roaſting; then to waſh out the earthy and ſtony matter with water, and finally to fuſe the remainder with black flux and ſea-ſalt. If there be any biſmuth in the maſs, which frequently happens, it will be found at the bottom of the crucible, and may be ſeparated from the cobalt by the ſtroke of a hammer.

According to Mr. Kirwan, there are five ſpecies of cobalt ore, viz.

1. *Black ochre of cobalt*, mineralized by the aerial acid.

2. *Red*

2. *Red ochre*, mineralized by vitriolic or arsenical acid.

3. *Grey ochre*, mineralized by arsenic with scarce any iron.

4. *White ore*, mineralized by sulphur and arsenic, with iron.

5. *White ore*, mineralized by a small proportion of sulphur, with much iron.

The regulus of cobalt is soluble in all acids; but its first attraction is to the acid of sugar, which precipitates it from any other acid in the form of a pale rose-coloured powder. Its specific gravity is 7,700.

Regulus of cobalt, when melted with any vitrifiable matter, becomes a beautiful blue glass called *smalt*, which, when ground to a fine powder, is called *azure*: it is used to colour starch, also in painting and enamelling.

The calx of cobalt, obtained by roasting the mineral, and thereby expelling the sulphur and arsenic, is called *zaffre*. That which is commonly sold is brought from Saxony: it is of a grey colour, and is a compound of the calx of cobalt, and a vitrifiable earth. It is used for painting on china and earthenware before they are baked or glazed, and, by vitrification in the fire, becomes blue.

Zaffre dissolved in *aqua regia*, and diluted with water, makes a sympathetic ink, which is rendered visible by heat.

Zaffre is alſo uſed to colour glaſs, being the only blue that will ſtand vitrification.

V. Zinc is a white ſemi-metal ſomewhat reſembling ſilver. Its ſpecific gravity is about 7,000. It is leſs brittle than any other ſemi-metal, and may be rendered, in ſome degree, malliable, by heat in cloſe veſſels, with the addition of inflammable matter. It reſembles the perfect metals and tin, in not being liable to ruſt. It differs from tin and lead in not melting till it is almoſt red hot, at which period its ſurface is calcined. If the heat be conſiderably increaſed, it burns with a flame more vivid and brilliant than that of any other inflammable matter. This ſingular property renders zinc an uſeful ingredient in fire-works.

Zinc, when thus kindled in an open crucible, ſublimes in white ſmoke, which condenſing, floats in the air in white flocks. Of theſe flocks, called *flowers of zinc*, a conſiderable proportion fixes to the ſides of the cruſible. They are generally collected from the internal ſurface of the walls of furnaces, in which ores, containing zinc, are ſmelted.

Zinc is ſoluble in all acids, but preferably in that of ſugar. Its next attraction is to vitriolic acid, with which it forms a cryſtallizable ſalt, called *white vitriol*. It may be precipitated white by alkali, mild or cauſtic.

All

All acids prefer zinc to every other metallic ſubſtance, which are therefore precipitated from their ſolutions by this ſemi-metal.

Zinc may, by fuſion, be combined with all metallic ſubſtances, except biſmuth and nickel. With copper, in various proportions, it forms *braſs*, *prince's metal*, *pinchbeck*, &c.

The compound metal brought from China called *tutenag*, which ſo nearly reſembles ſilver, is ſuppoſed to conſiſt principally of zinc, with the addition of copper, iron, and perhaps ſome other ingredient, with which we are unacquainted.

In the dry way, the attractions of zinc are in the following ſucceſſion: copper, antimony, tin, mercury, ſilver, gold, &c.

Whether zinc has ever been found *native* is yet a matter of doubt. The ores of zinc contain this ſemi-metal either in a calcined ſtate, or mineralized by an acid, or by ſulphur, by means of iron.

Calcined zinc, called *lapis calaminaris*, or *calamene*, is a mixture of the calx of zinc with earthy and ferruginous particles.

The acids by which zinc is found mineralized, are the aerial and vitriolic. With the firſt it is called *glaſs of zinc*; with the latter, *vitriol of zinc*, or *white vitriol*, which is generally mixed with copper or iron, or with both.

Zinc, mineralized by ſulphur, is called *pſeudo galena*. It is accidentally mixed with ſilver, lead, copper,

copper, arſenic, &c. *Black Jack* is the name by which it is generally known by the miners in this country. Externally it reſembles the lead ore called *galena*.

Calamine is found in many parts of Europe: in this kingdom, Somerſetſhire, Derbyſhire, and Flintſhire, yield it in great plenty. It is hardly to be diſtinguiſhed from limeſtone, except by its weight, than which it is almoſt twice as heavy. In its natural ſtate it contains about a third of its weight of heterogeneous matter, the greateſt part of which is *fixed air*; this air is expelled by roaſting before the calamine is uſed for making braſs. The ſulphur in black-jack is diſſipated by the ſame proceſs.

Mr. Kirwan enumerates three ſpecies of ore of zinc, viz.

I. *Calciform*, mineralized by aerial acid. Of theſe there are four varieties, viz.

1. *Zinc ſpar*, grey, bluiſh, or yellowiſh. Strikes fire with ſteel.

2. *Tutenago*. From China. White, with red ſtreaks of calx of iron.

3. *Calamine*. Of various colours, forms, and degrees of hardneſs.

4. *Zeolytiform*, mixt with a large proportion of flint. Pearl colour and cryſtallized.

II. *Vitriol of zinc*. Mineralized by vitriolic acid. Found in mines adhering to the roof of the galleries in what is called a ſtalactical form, that

that is, like icicles; or in white powder, on the ſurface of other minerals; alſo in ſome mineral waters.

III. *Blend. Black jack.* Mineralized by ſulphur by means of iron. Of this there are ſeven varieties, viz.

1. *Bluiſh grey*, of a metallic appearance, generally cubical or rhomboidal.

2. *Black*, frequently cryſtallized.

3. *Red*, or *brown*; ſometimes cryſtallized. Gives fire with ſteel.

4. *Phoſphorſcent blend*, greeniſh or red. When ſcraped with a knife in the dark, it emits light.

5. *Greeniſh yellow blend.* Blend, galena, and petrolium.

6. *White blend.*

7. *Yellow blend.* Contains much ſulphur.

VI. Antimony has ſometimes, though very rarely, been found *native*; but it is generally found mineralized by ſulphur, and mixed with earthy and ſtony matter, from which it is ſeparated by fuſion in earthen pots with a hole in the bottom; through this hole the antimony runs as ſoon as it becomes fluid.

The matter thus obtained conſiſts of the metallic part called *regulus of antimony*, combined with ſulphur only. In this ſtate it is generally ſold by the name of *crude antimony*.

The regulus is eaſily ſeparated from the ſulphur by calcination: the ſulphur evaporates, leaving the

the metal in the form of a grey calx. This calx, expoſed to a greater degree of heat, vitrifies, and is then called *glaſs of antimony*.

The calx or glaſs of antimony, melted in cloſe veſſels, with any flux or matter capable of furniſhing phlogiſton, is reduced to a hard, brittle ſemi-metallic ſubſtance, of a dull white colour called *regulus of antimony*.

This *regulus* may be precipitated from crude antimony, by fuſing it with alkaline ſalts, or with iron, copper, tin, lead, ſilver, cobalt, or nickel; all which are preferred by ſulphur to regulus of antimony. Its ſpecific gravity is 6,860.

In the moiſt way, the vitriolic acid cannot diſſolve the regulus of antimony unleſs highly concentrated, and by diſtillation in cloſe veſſels. Nitrous acid calcines this ſemi-metal: marine acids has very little effect on it; but theſe two acids united, in *aqua regia*, diſſolve the regulus readily, and, if crude antimony be employed, precipitate the ſulphur. Alkalis precipitate antimony in the form of a white calx.

The elective attractions of antimony are, according to Bergman, acid of fat, marine acid, acid of ſugar, vitriolic acid, nitrous acid, &c.

VII. Manganese is a ſemi-metal lately diſcovered. It has not yet been found native, nor mineralized by ſulphur, unleſs united with other metals in a proportion exceeding its own quantity.

tity. It is generally found in the form of a black or reddiſh calx, of a metallic appearance.

Mr. Kirwan diſtinguiſhes three varieties of this native calx; viz.

1. *White ore*; cryſtallized, of a ſparry texture, containing a ſmall proportion of iron.

2. *Red ore*, containing more iron, with calcareous earth; or barytes and flint.

3. *Black and brown ore*, containing ſtill more iron and leſs aerial acid than either of the former. *Perigord ſtone* and *black wad* are of this variety. "If half a pound of this laſt mentioned ore be dried before a fire, and afterwards ſuffered to cool for about an hour, and then two ounces of linſeed oil be gradually poured on it, mixing them looſely, like barm with flour, little clots will be formed, and in ſomewhat more than half an hour, the whole will gradually grow hot and burſt into flame." *Kirwan, Min.* p. 351.

Manganeſe may be ſeparated from its ore by ſolution in acids, and precipitation by fixed alkali; but the acid employed muſt be either naturally or artificially phlogiſticated.

The calx of manganeſe, when almoſt totally dephlogiſticated, is black; when united with phlogiſton ſufficient to render it ſoluble in acids, it is white; with a ſtill greater proportion of phlogiſton, it becomes a *regulus*, hard, brittle, ſhining, and more difficult of fuſion than iron. Diſſolved in vitriolic acid and cryſtallized, it yields a ſalt, the grains of which are parallelopipids and pellucid.

The black calx gives to borax, in fuſion, a yellowiſh red colour; to microcoſmic ſalt, a bluiſh red; to glaſs, a red or violet. But mangaueſe is uſed in glaſs-houſes in order to render green glaſs white. This ſingular effect may be thus explained, on a ſuppoſition that the green colour of glaſs is produced by particles of iron combined with the flint and alkaline ſalt of which glaſs is compoſed. The phlogiſton of the iron which cauſed the green colour is abſorbed by the black calx of manganeſe; which calx, by its union with phlogiſton, becomes white, as we have ſeen above, and conſequently the green colour is deſtroyed.

Manganeſe unites in fuſion with all metals except mercury, and it is ſoluble in all acids. Its firſt attraction is to the acid of ſugar.

The black calx of manganeſe differs from the black calces of other metals, in containing a very ſmall proportion of phlogiſton. It poſſeſſes the ſingular property of decompoſing ſal-ammoniac, and of forming a blue ſolution with alkaline ſalts, and a red with acids, which colours diſappear on the addition of phlogiſtic matter.

VIII. Molybdena. This ſubſtance reſembles plumbago, commonly called *black-lead*. Scheele found it to conſiſt of ſulphur combined with a peculiar acid. Mr. Kirwan ranks it among the

ſemi-

ſemi-metals, becauſe it has lately been *reduced*, though the properties of the regulus have not yet been publiſhed.

CHAP. X.

OIL

IS an inflammable fluid not ſoluble in water. When inflamed it flies off in ſmoke, depoſiting ſoot, called *lamp-black*, and when diſtilled it leaves a reſiduum of coal. In theſe properties it differs from ſpirit of wine, which is alſo an inflammable fluid.

The conſtituent parts of all oils are phlogiſton, water, acid, earth, and gas; which may be ſeparated from each other by repeated diſtillation.

All oils are volatile in a certain degree of heat.

The vitriolic and the nitrous acid concentrated unite with oils with violent efferveſcence and great heat. With the latter of theſe acids the mixture becomes red hot, and burſts into flame, provided the oil be thick, and the acid ſtrong.

All oils are the produce either of the animal or vegetable kingdoms.

Oils, combined with alkaline ſalts, form ſoap, and are thus rendered miſcible with water, tho' not perfectly ſoluble. But this union of oil with alkali is not very intimate; nor is the oil at all altered: for the ſoap may be decompoſed by any acid, and the pure oil recovered. The acid uniting with the alkali forms a neutral ſalt, and the oil ſwims on the ſurface of the water.

Oils unite with metals, particularly copper and lead. A ſmall quantity of the calx of lead diſſolved in linſeed oil, forms the drying oil of painters; a larger proportion of this calx boiled with oil of olives conſtitutes the *emplaſtrum commune* of the London *Pharmacopeia*.

Oils are *eſſential*, *expreſſed*, *animal*, *foſſil*.

SECT. II.

ESSENTIAL OILS

RESIDE in aromatic vegetable ſubſtances only, and are generally obtained by diſtillation with water. I ſay *generally*, becauſe thoſe which are contained in the rhind of certain fruits, ſuch as lemons and oranges, may be expreſſed.

Eſ-

Eſſential oils become volatile in the heat of boiling water, and retain the peculiar odor of the vegetable from which they are diſtilled. By theſe properties they are ſufficiently diſtinguiſhed from what are called ſweet oils; alſo by their ſolubility in water, in vinous ſpirit, and by their acrid taſte.

Some eſſential oils are lighter than water, and conſequently, when ſuperabundant, ſwim on its ſurface; whilſt others, being ſpecifically heavier, ſink to the bottom. Of this latter kind are the oils of ſaſſafras, cinnamon, and cloves.

The ſimple waters of the ſhops receive their taſte and ſmell from a ſmall proportion of eſſential oil diſſolved in the water. The ſuperabundant oil ſwims on the ſurface.

Eſſential oils are frequently adulterated with fat oil, or with ſpirit of wine. If with the former, the fraud may be eaſily diſcovered by dropping it into ſpirit of wine, which will diſſolve the eſſential oil only, leaving the fat oil undiſſolved. If it be adulterated with ſpirit of wine, you will detect the fraud, by the addition of a little water, which immediately becomes milky.

SECT. III.

EXPRESSED, or SWEET OILS,

CALLED alſo Fat Oils, are obtained, by expreſſion only, from the ſeeds and kernels of various fruits and other vegetables; particularly from olives, almonds, nuts, linſeed, rape-ſeed, &c.

Theſe oils are not rendered volatile by the heat of boiling water, nor are they inflammable by the mere contact of an inflamed body, unleſs aſſiſted by a wick.

Expreſſed oils, by diſtillation, become acrid and acquire a burnt taſte. When freſh, they are not ſoluble in vinous ſpirit. Theſe oils are beſt adapted to the formation of good ſoap in combination with alkaline ſalts.

SECT. IV.

ANIMAL OILS,

CALLED Fat and Butter, are ſimilar in their chemical properties to the vegetable oils above mentioned, except that they involve a conſiderable proportion of a peculiar acid, called the

the acid of fat, by which they are retained in a ſtate of congelation. Spermaceti and marrow are alſo animal oils.

Theſe oils exiſt in animal bodies uncombined with other animal matter; but the gelatinous parts of all animals contain an oil, to which chemiſts give the name of *animal oil*, or *oil of Dippel*, from the inventor. This oil is obtained by diſtillation in a degree of heat exceeding that of boiling water. It riſes combined with volatile alkali, and conſequently differs eſſentially from the animal oil called *fat* or *butter*, both which are coagulated by an acid. This oil of Dippel is rendered white, thin, and extremely volatile by repeated diſtillations.

SECT. V.

FOSSIL OIL

IS an inflammable ſubſtance combined with various minerals. It is called *Nophtha*, *Petrolium*, *Aſphaltum*, *Barbadoes tar*, according to its denſity.

Naphtha is a fragrant limped oil which is ſaid to iſſue ſpontaneouſly from certain clays in Perſia; it is likewiſe obtained by diſtillation from petrolium. Like æther, it will take gold from *aqua regia.* By long expoſure to the air it thickens and becomes *petrolium.* It will diſſolve reſins and balſams. It is not ſoluble in ſpirit of wine. Its ſpecific gravity is 0,708. *Kirwan's Mineral.* p. 210.

Petrolium differs from naphtha only in being leſs fluid. It is of various colours, and found iſſuing from rocks in various parts of the world. This ſubſtance, by long expoſure to the air, forms Barbadoes tar; combined with a little ſulphur, Aſphaltum. Jet and pit-coal owe their inflammability to this foſſil oil.

CHAP. XI.

A L C O H O L,

ARDENT *ſpirit,* or *ſpirit of wine,* is the produce of what is called the vinous fermentation. It is the fluid which gives what we call ſtrength to brandy, rum, wine, ale, beer, and every other kind of fermented liquor, from any of which it may be obtained by diſtillation.

Vinous ſpirit is miſcible with water in any proportion. It is eaſily inflammable, and conſumes without ſmoke or reſiduum. When perfectly

pure,

pure, it may be diſtilled a thouſand times without decompoſition or alteration.

Alcohol unites with all acids, deſtroying their acidity: they are then called *dulcified*. By diſtillation of alcohol with acids is produced the volatile fluid called *æther*.

Alkaline ſalts, mixed with ardent ſpirit, with the aſſiſtance of heat, is converted into a kind of oil.

Spirit of wine diſſolves eſſential oils and their concretes, viz. balſams and reſins, from which the eſſential oil is, in conſequence of this property, eaſily extracted. It may be ſeparated from the ſolution by the addition of water, which uniting with the ſpirit, ſets the oil at liberty.

By means of this ſolvent power in ſpirit of wine, are obtained all ſpirituous tinctures, ſpirituous diſtilled waters, and extracts from aromatic vegetable ſubſtances.

Spirit of wine diſſolves corroſive ſublimate, ſal-ammoniac, and ſedative ſalt; but has very little effect on moſt other ſalts. It does not diſſolve gums or gelatinous matters; theſe are ſoluble in water; it is therefore very uſeful in ſeparating them from that fluid.

If to a ſolution of any cryſtallizable ſalt in water, a ſufficient quantity of ſpirit of wine be added, the ſalt will immediately ſhoot into cryſtals; becauſe the water, preferring an union with the ſpirit,

ſpirit, relinquiſhes the ſalt which it held in ſolution.

Pure ſpirit of wine is a combination of water, phlogiſton, and (according to Dr. Crell) vegetable acid. From the experiments of that philoſopher we learn, that ſpirit of wine, by long digeſtion with acid of tartar, is changed to vinegar; the ſame tranſmutation will happen if ſpirit of wine be boiled with vitriolic acid and manganeſe; or diſtilled twenty times with cauſtic alkali. Its firſt attraction is to water. It diſſolves æther and alkaline ſalts fixed and volatile.

CHAP. XII.

WATER.

WATER hath already been conſidered as a phyſical element. We are now to ſpeak of its chemical uſe and properties.

Water, when perfectly pure, has no colour, taſte, nor ſmell. Whatſoever may be its conſtituent parts, it ſeems incapable of decompoſition or tranſmutation.

Water is a conſtituent part of all animal, vegetable, and even foſſil bodies (except metals and flints) and may be extracted by diſtillation.

Water

Water diſſolves all ſaline bodies, gums, gelatinous matter, air, and gas.

Water unites readily with ſpirit of wine in any proportion. It alſo diſſolves æther and eſſential oils in a certain proportion. It has no effect on the perfect metals; but other metallic ſubſtances are corroded by water in contact with atmoſpheric air. Is not this the effect of the aerial acid?

Water diſſolves expreſſed and animal oils when combined with alkaline ſalts in the form of ſoap; but this ſolution is imperfect.

River waters, waters iſſuing immediately from ſprings, or drawn from wells, are never entirely free from heterogeneous matter, either in a ſtate of ſolution or ſuſpenſion. The matter contained in theſe waters is either animal, vegetable, or mineral, according to the ſtrata through which they paſs.

The ſalt moſt generally diſſolved in theſe waters is formed by the union of calcareous earth with vitriolic acid: it is called *ſelenites*, or *gypſum*. Waters thus impregnated are called *hard*: they curdle ſoap, becauſe the acid in the ſelenites and the alkali in the ſoap uniting, produce an immediate decompoſition, leaving the oil and lime in a ſtate of inſolubility.

Water containing ſelenites becomes inſtantly turbid by the addition of a few drops of a ſolution of ſilver, or of mercury, in nitrous acid. In this

this experiment a double attraction takes place; The ſilver quits the nitrous to unite with the vitriolic acid, and the lime quits the vitriolic acid to unite with the nitrous.

The waters of ſprings, rivers, lakes, &c. frequently contain flint, lime, clay, or magneſia in a ſtate of ſuſpenſion. Atmoſpheric air, and aerial acid, are preſent in all theſe waters in different proportions.

Snow water contains a ſmall quantity of a ſalt compoſed of marine acid and lime, together with a very little nitrous acid; without either common or fixed air. Rain water contains the ſame neutral ſalt and acid, with a variety of ſuch other heterogeneous matters as float in the atmoſphere.

Waters, in general, are moſt pure which are moſt tranſparent and leaſt heavy.

Waters are examined either by precipitation or evaporation. By the firſt method, the colour of the water is changed, or its tranſparency diſturbed; by the latter, the ſalts are cryſtallized and other matters ſeparated from the water.

SECT. II.

MINERAL WATERS.

ARE impregnated with ſaline or metallic matters in quantity ſufficient to affect the taſte.

Acids are ſometimes preſent in mineral waters in an uncombined ſtate; but moſt frequently united to earths, alkalis, or metals.

Alkalis are alſo ſometimes found diſengaged; but generally in combination with the aerial or other acids.

Lime and magneſia frequently occur combined with acids.

Clay in combination with vitriolic or muriatic acid is ſometimes, though rarely, diſcovered in the examination of waters.

Terra ponderoſa is ſometimes found united with marine acid; alſo manganeſe.

Iron is the metal moſt generally diſſolved in mineral waters: the acids which hold it in ſolution are either vitriolic or aerial.

Copper in mineral waters is always diſſolved in vitriolic acid.

Sulphur is found in waters either ſuſpended, or in vapour, or diſſolved by means of its union with alkali.

These various impregnations are thus detected. If water, containing the smallest proportion of disengaged acid, be mixed with the aqueous tincture of turnsol, or with syrup of violets diluted, the mixture immediately becomes red. If the water be alkaline, it will become green.

The smallest quantity of lime dissolved in water, is easily discovered by dropping into it a solution of the acid of sugar, which takes lime from all other acids, and carries it to the bottom of the vessel in the form of an insoluble powder.

Magnesia alba is immediately discovered and disengaged from the acid with which it is combined in mineral waters, by the mixture of a solution of fixed alkali. The alkali uniting with the acid forms a new salt, which remains dissolved in the water, and the magnesia falls to the bottom.

If either lime or magnesia be held in solution by aerial acid (fixed air) a solution of silver in nitrous acid will produce a cloud in the water, and a precipitation of the calx of that metal.

Clay, like other earths, is precipitated by alkaline solutions, because acids universally prefer alkalis to earths.

If any mineral water contain *terra ponderosa*, a few drops of concentrated vitriolic acid, will form with it a *spathum ponderosum*, which not being soluble, will precipitate.

Iron,

Iron, in mineral waters, is inftantly difcovered, by a tincture of any vegetable aftringent, which ftrikes a purple or black colour, according to the quantity of iron. The tincture of galls, either in fpirit of wine or in water, is generally ufed for this purpofe. The fmalleft portion of iron may be detected by phlogifticated alkali faturated with acid.

Phlogifticated alkali is prepared by boiling four parts of Pruffian blue with one of alkali, in water. It muft then be faturated and filtred. A fingle drop of this liquor gives a blue tinge to the water, if it contain iron.

Water containing copper is immediately tinged blue by volatile alkali. Copper is precipitated by iron: if a polifhed plate of iron be immerfed in water containing copper, the iron will apparently be tranfmuted into that metal. In this experiment the vitriolic acid unites with the iron, and leaves the copper on the furface of the plate.

Water containing *hepar fulphuris*, or hepatic vapour, is eafily known by its fmell, refembling that of a foul gun. Thefe waters become milky by the addition of ftrong nitrous acid. If they contain fulphur in a ftate of fufpenfion, or otherwife, a folution of lead in nitrous acid turns the water black. If the water be impregnated with fulphurious, or hepatic vapour, only, a fmall piece of of white arſenic dropped into it will become yellow: uniting with the ſulphur, it is converted into orpiment.

Water containing fixed air, is immediately rendered turbid by a few drops of lime-water. The fixed acid air, or gas, uniting with the lime converts it into calcareous earth, which is not ſoluble in water.

Alkaline ſolutions precipitate all earth and metals when diſſolved in water, in conſequence of their union with any acid; becauſe acids prefer alkalis to metallic ſubſtances.

Water containing vitriolic acid in combination with any alkali, earth, or metal, becomes turbid on the addition of a few drops of a ſolution of *terra ponderoſa* in the marine acid. The vitriolic acid immediately quits its baſis, and uniting with the *terra ponderoſa* forms a *ponderous ſpar*, which is ſoluble only in a very ſmall proportion. Vitriolic neutral ſalts, diſſolved in water, may be precipitated by ſpirit of wine; for they are not ſoluble in this menſtruum.

If water contain fixed alkali, a ſolution of lime, in marine acid, will produce a cloud and precipitation. The calcareous gas in the alkali, uniting with the lime, converts it into calcareous earth, which, not being ſoluble in water, falls to the bottom. If the water, inſtead of fixed alkali, contain Epſom ſalt, a mutual decompoſition will

take

take place. The marine acid will unite with the magnesia, and the vitriolic, in combination with the lime, will fall to the bottom in the form of *gypsum*.

Alum, dissolved in water, is instantly discovered by a few drops of an alkaline solution, mild or caustic. The vitriolic acid of the alum unites with the alkali, and the clay falls to the bottom.

Water, containing common salt, or any other combination of marine acid with alkalis, earths, or metals, becomes turbid on the addition of a diluted solution of silver in the nitrous acid. The marine acid quits every other basis, and, uniting with the silver, precipitates in the form of a white mucilage. If the water contain any sulphur dissolved by alkali, the precipitate will be brown.

Water containing lime, or magnesia, dissolved by fixed air, will also precipitate silver from its solution in the nitrous acid, or lead dissolved in vinegar.

The volatile spirit and acidulous taste of many mineral waters, particularly Pyrmont, Spa, and Seltzer waters, is owing to their impregnation with *fixed air*. This air may be separated and collected, by boiling the water in a Florence flask, with a bladder fastened to the neck, or any other convenient apparatus of the like nature.

The fixed contents may be separated from the water by evaporation to dryness. By digesting this reſiduum firſt in ſpirit of wine, then in cold water, and afterwards boiling it in a large quantity of diſtilled water. The ſalts peculiarly ſoluble in theſe menſtrua, will be ſeparately held in a ſtate of ſolution, and the inſoluble contents may be obtained by filtration.

The matter diſſolved in the ſpirit of wine, is lime or magneſia combined with nitrous or muriatic acid, both which ſalts may be decompoſed by diluted vitriolic acid. If it be lime, *gypſum* will precipitate; if magneſia, Epſom ſalt will be generated, which can only be obtained by evaporation.

The ſalts diſſolved in the cold water, may be ſeparately obtained by the uſual method of cryſtallization. Theſe ſalts may be alkaline; ſalts compoſed of acid and alkali; ſalts with an earthy baſis; metallic ſalts; or mixed ſalts.—Alkaline ſalt is known by its lexivious taſte, and whether it be vegitable or foſſil, may be determined by uniting it with diſtilled vinegar, which, with the former, produces a deliqueſcent ſalt; with the latter, foliated cryſtals.—Neutral ſalts compoſed of vitriolic acid, and any baſis whatſoever, may be decompoſed by *terra ponderoſa* diſſolved in marine acid; if of nitrous acid, the vitriolic will expel it, and the fume will be red; if of marine acid, [the fume with vitriolic acid will be grey. The ſpecies of neutral ſalt may be generally known by the figure of the cryſtals. If the acid be be *vitriolic*, and there be any doubt whether the basis be mineral alkali or magnesia; if it be the latter, a bit of the salt dropped into lime-water, will instantly render it turbid.—If the acid be the *marine*, the species of alkali may be discovered by dropping the acid of tartar into a saturated solution of the salt: if it be the vegetable alkali, a genuine *tartar* will precipitate; if mineral alkali, no decomposition will take place.—If the basis of the marine acid be calcareous earth, vitriolic acid will decompose it, and form gypsum; if magnesia be the basis, the same acid will produce Epsom salt; if clay, alum will be the result.—If copper be the basis, the solution of the salt in water turns blue on the addition of volatile alkali; if iron, tincture of galls will strike a purple or black colour.

The solution, in boiling water, will generally contain gypsum only, which may be separated from the water by crystallizing.

SECT. III.

NEUTRAL SALTS,

WHEN perfectly crystallized, may be distinguished from each other by their peculiar form.

I. VITRIOLIC.

Vitriolic acid with *vegetable alkali*, called *vitriolated tartar*. Cryſtals, an hexagonal priſm, terminated at both ends by an hexagonal pyramid.

Vitriolic acid with *mineral alkali*, called *Glauber's ſalt*. Cryſtals, hexagonal priſms, with two oppoſite ſides broader than the reſt, and terminated by the continuation of two narrow ſides inclining towards each other like the roof of a houſe.

Vitriolic acid with *lime*, called *gypſum*. Cryſtals, octaedral, with the ends deeply truncated.

Vitriolic acid with *magneſia*, called *Epſom ſalt*. Cryſtals, tetragonal priſms, terminated by quadrangular pyramids.

Vitriolc acid with *clay*, called *alum*. Cryſtals, octaedral.

Vitriolic acid with *copper*, called *blue vitriol*. Cryſtals, flat hexagonal priſms, and truncated.

Vitriolic acid with *iron*, called *green vitriol*. Cryſtals, ſparry.

II. NITROUS.

Nitrous acid with *vegetable alkali*, called *nitre*, or *ſaltpetre*. Cryſtals, hexagonal priſms, with hexagonal pyramidal ends, generally obliquely truncated.

Nitrous acid with *lime*. Deliquiſcent: taſte acrid and bitter: ſoluble in vinous ſpirit.

Nitrous acid with *magneſia.* Cryſtals, tetragonal truncated priſms, which ſpeedily deliquiate: taſte acrid and bitter: ſoluble in alcahol, but in a far leſs proportion than the laſt.

III. MARINE.

Marine acid with *vegetable alkali*, called *digeſtive ſalt of Sylvius.* Cryſtals cubic; ſometimes truncated quadrangular priſms: decrepitates in the fire and fuſes: taſte, ſalt and acrid.

Marine acid with *mineral alkali*, called *common ſalt.* Cryſtals cubic. Diſtinguiſhable from the laſt, and from every other neutral ſalt, in having no diſagreeable taſte. Decrepitates in the fire and fuſes.

Marine acid with *lime.* Deliqueſcent: very bitter: ſoluble in an equal weight of boiling ſpirit of wine.

Marine acid with *magneſia.* Deliqueſcent; bitter: requires five times its weight of vinous ſpirit, in a moderate heat, to diſſolve it.

CHAP. XIII.

ATTRACTION.

ALL bodies which are the objects of Chemiſtry, diſcover a propenſity to unite with other bodies: they are drawn together by mutual attraction; but this attraction differs from gravitation in not acting proportionably to the quantity of matter. This property, from a ſuppoſed ſimilitude in the principles of certain bodies, hath been called *affinity*, but improperly; for many bodies which unite moſt eagerly are totally diſſimilar in their nature and properties.

Chemical attraction differs alſo from gravitation in not acting indiſcriminatly: on the contrary, bodies, in chemical attraction, prefer one body to all others; after that a ſecond, then a third, &c. Hence this attraction hath been called *elective*, but with equal impropriety, for it is an act of invariable neceſſity.

Chemiſts, in order to facilitate this important branch of the ſcience, have conſtructed tables of attraction, divided into a number of columns, conſiſting of ſigns or ſymbols of ſubſtances capable of combination. For an explanation of theſe ſigns, ſee *Plate* I.

Symbols,

Chemical Symbols

ACIDS.

- vitriolic
- nitrous
- marine
- of Fluor
- ...... Arsenic
- ...... Borax
- ...... Sugar
- ...... Tartar
- ...... Sorral
- ...... Lemon
- ...... Benzoin
- ...... Amber
- .... Sugar of Milk
- ...... Vinegar
- ...... Milk
- ...... Ants
- ...... Fat
- Phosphorus
- Prussian blue
- Aerial
- phlogisticated vitriolic acid
- dephlogisticated marine acid
- Aqua regia

ALKALI.

- Fixed
- .... vegetable
- .... mineral
- volatile

EARTH.

- ponderous
- calcareous
- argillaceous
- siliceous
- of magnesia

- Water
- Pure air
- Fire
- Phlogiston
- Sulphur
- Spirit of wine
- Æther
- Oil essential
- .... expressed

METALS.

- Gold
- Platina
- Silver
- Mercury
- Lead
- Copper
- Iron
- Tin
- Bismuth
- Nickle
- Arsenic
- Cobalt
- Zinc
- Antimony
- Manganese
- Metallic calx

Symbols, ſigns, or characters, were invented by Alchemiſts, principally with a deſign to vail in myſtery a ſcience, the ſole object of which was the tranſmutation of baſer metals into gold. Theſe ſigns were found convenient by ſucceſſive chemiſts; they have therefore been retained, with ſome variations and occaſional augmentations. Moſt of them are mere arbitrary figures, without any meaning or alluſion that can aſſiſt the memory. It would be no difficult taſk to invent a new ſet of characters, that would be much more eaſily remembered.

I have deviated a little from the ſymbols in Bergman's table of attractions, for the following reaſons.—To the ſigns of alkalis and earths he adds an almoſt inviſible *p*, denoting the purity of theſe ſubſtances; in other words, to ſignify that they are not combined with aerial acid, and are conſequently in a cauſtic ſtate. This mark of diſtinction becomes totally unneceſſary, when it is underſtood that every ſubſtance ſignified in theſe tables is, by ſuppoſition, in its ſtate of the greateſt ſimplicity, and that mild earths and alkalis are compound bodies, whoſe principles may be eaſily ſeparated.

Bergman, in order to diſtinguiſh *vegetable* from *mineral* alkali, adds a minute *v* or an *m* to the ſymbol. Now theſe alkalis are much more readily and obviouſly diſtinguiſhed by a dot *within*, and a ſtroke *beneath* the angle annexed to the circle; the dot indicating *vegetable*, and the ſtroke *mineral* alkali. But indeed this diſtinction is of very little conſequence in a table of chemical attractions, as the vegetable conſtantly precedes the mineral. One example of the contrary occurs in the column of *water*; but it is merely conjectural.

The ſymbol of platina, invented, I believe, by Bergman, being an union of that of gold and of ſilver, ſeems to imply a compoſition of theſe two metals. But platina reſembles gold in ſpecific gravity only, and ſilver ſometimes in colour: this reſemblance, however, muſt have induced the inventor to unite the characters of the two perfect metals. The figure I have ſubſtituted for that of Bergman, takes leſs room, and is more readily formed.

I have reſtored the old ſign of zinc, becauſe, being formed of the firſt and laſt letters of the word, it is more immediately underſtood and remembered.

Bergman uſes the ſame ſymbol for lime and metallic calx; but, as they differ very eſſentially from each other, I have made an obvious difference in their ſigns.

Let it be obſerved, that the principal objects of chemiſtry are placed at the head of each column, and that the ſeveral ſubſtances with which they may be combined, are arranged, according to their attractive power, under each head; ſo that

that if the ſubſtance at the head of the column be combined with any ſubſtance below it, they may be ſeparated by any of the intermediate ſubſtances in the ſame column: thus, if a metallic ſubſtance be combined with an acid, it may be ſeparated by the addition of an alkali, which will unite with the acid, and the metal will fall to the bottom.

It is obvious that the attractions above mentioned cannot be effected unleſs the bodies that are to act upon each other, be in a ſtate of fluidity. Theſe bodies muſt therefore either be diſſolved in ſome liquid, or fuſed by fire. The firſt is called the *moiſt*, the ſecond the *dry* way: it ſeems more ſcientific to diſtinguiſh them by the terms *ſolution* and *fuſion*.

Geoffroy, in the year 1718, firſt publiſhed a table of chemical attractions, conſiſting only of a ſmall number of ſymbols. Other chemiſts have, at different times, made ſome additions. For the laſt and moſt extenſive table of attractions, we are indebted to the celebrated Swediſh chemiſt Bergman. This table, which contains no leſs than 59 columns, is a valuable acquiſition to chemiſtry; nevertheleſs, the columns are ſo obviouſly multiplied, without any reaſon or utility, that I have not ſcrupled to reduce them to 36. Large plates, which require to be many times folded, are very inconvenient in books that are in frequent uſe: I have, therefore, for conve-

niency

niency and perſpicuity, ſubſtituted three diſtinct tables under the ſeveral titles of *acids*, *alkalis*, and *earths*; *inflammables*; *metals*.

In Bergman's table, the acids occupy 25 columns, the firſt ſeven of which I have comprized in one, becauſe ſix of them are no more than a repetition of the firſt, and therefore totally unneceſſary; eſpecially the three columns of phlogiſticated and dephlogiſticated acids: that of *aqua regia* is equally ſuperfluous, being a mere copy of the other ſix. The other columns are concentrated for the ſame reaſon.

SECT. II.

ATTRACTIONS IN SOLUTION.

TAB. I. *Acids, Alcalis, and Earths.* PLATE II.

THIS table conſiſts of twelve columns, the firſt ſeven of which comprehend twenty diſtinct acids: that called *perlatum*, which occupies the twenty-third column in Bergman's table, is here omitted, becauſe it is now diſcovered to be the ſame as the phoſphoric acid.

The firſt general obſervation that occurs, on the inſpection of this table, is that, contrary to a former

Chemical Attractions

in Solution

1	2	3	4	5	6	7	8	9	10	11	12	13
Acids							Alkali & Earths					
Acid of Vitriol Nitre Salt	Vinegar Acid of Milk Ants	Aerial Acid	Acid of Amber	Acid of Prussian Blue	Acid of Flour Sugar Tartar Sorrel	Acid of Arsenic Borax Lemon Fat Benzoin Sug of Milk Phosphor	Alkali	Terra ponderosa	Lime	Magnesia	Clay	Flint
							+⊕	+⊕	+⊕	+⊕	+⊕	+𝓕
							+⦶	+⊕	+⊕	+🜂	+⦶	⊖√
							+⊖	+⊖⊖	+⊕	+⊕	+⊖	
							+8	+𝓕	+⊤	+𝓕	+⊕	
⫲	⫲	⫲	⫲	⊖√	ψ	ψ	+𝓕	+⊕	+⊖⊖	+8	o+o	
⊖√	⊖√	ψ	ψ	⊖√	⫲	⫲	+🜂	+🜂	+🜂	o—o	+𝓕	
ψ	⊖√	⊖√	ψ	ψ	ψ	ψ	+⊕	+⊚	+⊚	+⊚	+8	
ψ	ψ	ψ	⊖√	⫲	⊖√	⊖√	+⊤	+⦶	+⦶	+⊖⊖	+⊕	
⊖√	ψ	⊖√	⊖√	ψ	⊖√	⊖√	o—o	+⊖	+⊖	+⦶	+⊤	
∀°	∀°	∀°	∀°	∀°	∀°	∀°	+⊕	+8	+8	+⊖	+⊖⊖	
Ƶ	·	·	·	·	·	·	+⊖⊖	+C	𝓕	+⊕	+⊚	
♂	·	·	·	·	·	·	+C	+⊤	o+o	+⊤	+C	
⦶	·	·	·	·	·	·	+𝑓	o+o	+𝑓	+C	+🜂	
☊	·	·	·	·	·	·	+⊚	+𝑓	+⊚	+𝑓	+𝑓	
⚲	·	·	·	·	·	·	+o♀o	+⊚	+C	+⊚	+⊚	
♄	·	·	·	·	·	·	⁜	+o♀o	+o♀o	+o♀o	+o♀o	
♃	·	·	·	·	·	·	⊚	⁜	⁜	⁜	⁜	
♀	·	·	·	·	·	·	+⌂	+⌂	+⌂	+⌂	+⌂	
♉	·	·	·	·	·	·	+☿	+☿	+☿	+☿	+☿	
☿	·	·	·	·	·	·	+⦶	+⦶	+⦶	+⦶	+⦶	
o—o	·	·	·	·	·	·	△	△	△	△	△	
♀	·	·	·	·	·	·	🜍	🜍	🜍	🜍	🜍	
☽	·	·	·	·	·	·	▽	▽	▽			
☉	·	·	·	·	·	·	◎	◎	◎			
⊙	·	·	·	·	·	·	🜂	🜂	🜂	🜂		
▽	·	·	·	·	·	·						
∇ˢ	·	·	·	·	·	·						
🜍	·	·	·	·	·	·	⫲					

former axiom in chemiſtry, all acids, except that of *Pruſſian blue*, prefer earths to alkalis. There are who contend, that the nitrous and marine acids prefer cauſtic alkali to ponderous earth; but this opinion has not been adopted.

From a curſory view of theſe ſeven columns of acids we alſo learn, that metallic ſubſtances may be precipitated from their ſolution in acids by any ſoluble earth or alkali; that all acids prefer other earths and alkalis to clay; and fixed to volatile alkali.

In the firſt column, metallic ſubſtances follow the alkalis and earths, according to their reſpective powers of attraction. Bergman has thought fit to exclude them, and to ſubſtitute their calces, becauſe theſe only are diſſolved in acids, obſerving, at the ſame time, that acids do not diſſolve one metallic calx in preference to another. In this view, a ſingle ſymbol of metallic calx, at the bottom of each column, would have been ſufficient; but the ſubjects of chemical attraction are not the calces of metals, but the metals themſelves, which are generally ſelected by acids in the order in which they are diſpoſed in the firſt column. The metallic ſymbols are not repeated in the other ſix columns of acids, becauſe their order of attraction to all acids is the ſame. The dot in the centre of a ſquare, ſignifies the repetition of the ſymbol of the preceding column, in the ſame horizontal line.

I have

I have admitted but one ſymbol of fixed alkali: Bergman diſtinguiſhes the vegetable from the mineral, I think unneceſſarily; becauſe the latter is univerſally precipitated by the former in acid ſolutions. This may be eaſily remembered.

That theſe tables may be perfectly comprehended, it is neceſſary to obſerve, that the horizontal black lines, which divide one ſymbol from another, indicate a degree of certainty in the order of attraction, and that where the lines are omitted, the reſpective powers of attraction are not ſufficiently eſtabliſhed by experiment. Theſe horizontal lines conſtitute the only difference between the ſixth and ſeventh column.

In former tables of affinity, particularly in that of Gellert, phlogiſton occupies the firſt place in all the columns of acids, and indeed there are many experiments in chemiſtry which ſeem to authorize this arrangement. Nevertheleſs, Bergman aſſigns to it the very laſt place in the humid way; becauſe phlogiſton is incapable of decompoſing neutral or metallic ſalts, by attracting the acid, and becauſe acids do not combine with the phlogiſton of charcoal without a certain degree of heat. Metals, it is true, yield to acids as much of their phlogiſton as is neceſſary to render them ſoluble. This he alſo aſcribes to the heat excited by the ſolution. If it be true that the attraction between acids and phlogiſton be the weakeſt, ſulphur, which is a combination of vitriolic acid

with

with phlogiſton, might be decompoſed by any of the intermediate ſubſtances in our firſt column. This is by no means the caſe.

In the firſt column, the ſymbol of volatile alkali is placed below abſorbent earths: in former tables of attraction it ſtood above them. Their attraction to the vitriolic, the nitrous, and the marine acids, is indeed ſo nearly equal, that the ſmalleſt variation in circumſtances will cauſe either to precipitate the other It is, however, certainly true, that if a ſolution of ſal-ammoniac with cauſtic magneſia, be kept in a cloſe phial for a few days, a ſmell of volatile alkali will be very perceptible: the alkali, therefore, muſt in part have given place to the abſorbent earth.

Clay, the ſign of which is placed above the metals, has no juſt title to this pre-eminence, their powers of attraction being equal. The pureſt clay, which is generally uſed in chemical experiments, is that earth which is the baſis of alum. After its ſeparation from the vitriolic acid, it muſt be digeſted for a conſiderable time in alkaline water, and then well waſhed.

Water, in the columns of acids, is placed below the metals, becauſe, though it diſſolves vitriols, it reſtores them unaltered. If its attraction to acids were ſuperior to that of metals, vitriols would be decompoſed in the ſolution.

The eighth column, in this table, includes the three alkalis, which in Bergman's table of attractions

tions occupy columns 26, 27, and 28. This was certainly a needleſs repetition of ſigns, as the arrangement of one is the ſame with the other two.

Columns 9, 10, 11, 12, 13, are the ſame as Bergman's 29th, 30th, 31ſt, 32d, and 33d. They comprehend the five earths, which require ſeparate columns, becauſe they differ from each other in their powers of attraction.

Flint, which ſtands at the head of the 13th column, hath, till lately, been thought inſoluble in any acid; but we are now convinced by experiment, that fluor acid, evaporated by heat, extracts flint from glaſs veſſels and diſſolves it. Cauſtic fixed alkali will diſſolve powdered flint, even in the moiſt way.

SECT. III.

Table II. *Inflammables.* Plate III.

THIS table, conſiſting of eight columns, comprehends water and inflammable ſubſtances. The firſt column requires explanation. In Geoffroy's table, ſpirit of wine occupies the firſt place, which is followed by neutral ſalts without diſtinction. But though ſpirit of wine

pre

Chemical Attractions

in Solution

Inflammibles. &c.

1	2	3	4	5	6	7	8
Water	Phlogiston	Sulphur	Liver Sulph	Spirit of Wine	Æther	Essent. oil	Exp. oil
⊖v	+⦶	♅ ♄	♅ ☉	▽	▽s	∴	∴
⊖⌃	+⊕	−♃	−☽	∴	∴	▽s	∴
▽s	+🜍	−☽	−☿	⊖⌃	◎	◎	⊖v
⊖⌃ 🜂	∘+∘	−☿	−∘—∘	⊖v	▽	⊖v	⊖⌃
⊖v ⊕	+🜂	−∘—∘	−♁	⊖v🜂	🜂	🜂	🜂
+⊕	♅ ☉	−♁	−♉	🜂			
∴	−☉	−♂	−♀				
⊖v⊕	−☽	⊖v	−♃				
▽ ⊕	−☿	⊖⌃	−♄				
♂+⊕	−∘—∘	♅	−⚲				
☿+⊖	−♁	♅	−♌				
	−♉	♅	−⏀				
	−♀		−♂				
	−♃						
	−♄						
	−⚲						
	−♌						
	−⏀						
	−♂						
	−Z4						
	▽						

prefers water to alkalis, as appears from the fifth column of this table, yet water prefers fixed alkali to ſpirit of wine, which it will dephlegmate. Whether volatile alkali has the ſame power, is doubtful.

In Bergman's table, the column of *water* is ſucceeded by that of *vital air*, in which column we find *phlogiſton* only. This column of *vital air*, I have entirely omitted, until we are better acquainted with its attractions.

In the ſecond column of this table, the nitrous acid precedes the vitriolic, becauſe it will decompoſe ſulphur with the aſſiſtance of a moderate degree of heat; and the three acids are placed above the metals; becauſe, in diſſolving theſe, they take from them a part of their phlogiſton. It is well known to chemiſts, that gold, diſſolved in *aqua regia*, may be precipitated by the addition of any other metal: hence it was naturally concluded, that the attraction between gold and *aqua regia* was the weakeſt. But the real cauſe of this precipitation, is the ſuperior attraction between the calx of gold and phlogiſton, which, therefore, quits the inferior to unite with the ſuperior metal. Hence the former arrangement of metallic ſubſtances is here reverſed. In this column, the *calces*, and not the metals themſelves, are properly ſignified by their reſpective ſymbols.

In Bergman's table, after the column of phlogiston, follows that of *the matter of heat*; but as I consider heat to be a mere quality of fire, and as the experiments which support this column appear to me insufficient, I chuse to omit it, until this *matter of heat* shall be better established.

In the third column of this table, the arrangement differs materially from former tables of attraction, in some of which fixed alkali occupies the first place, in others iron. This new disposition is probably right; but the experiments on which it is founded are not perfectly conclusive. This is also true of col. 4.

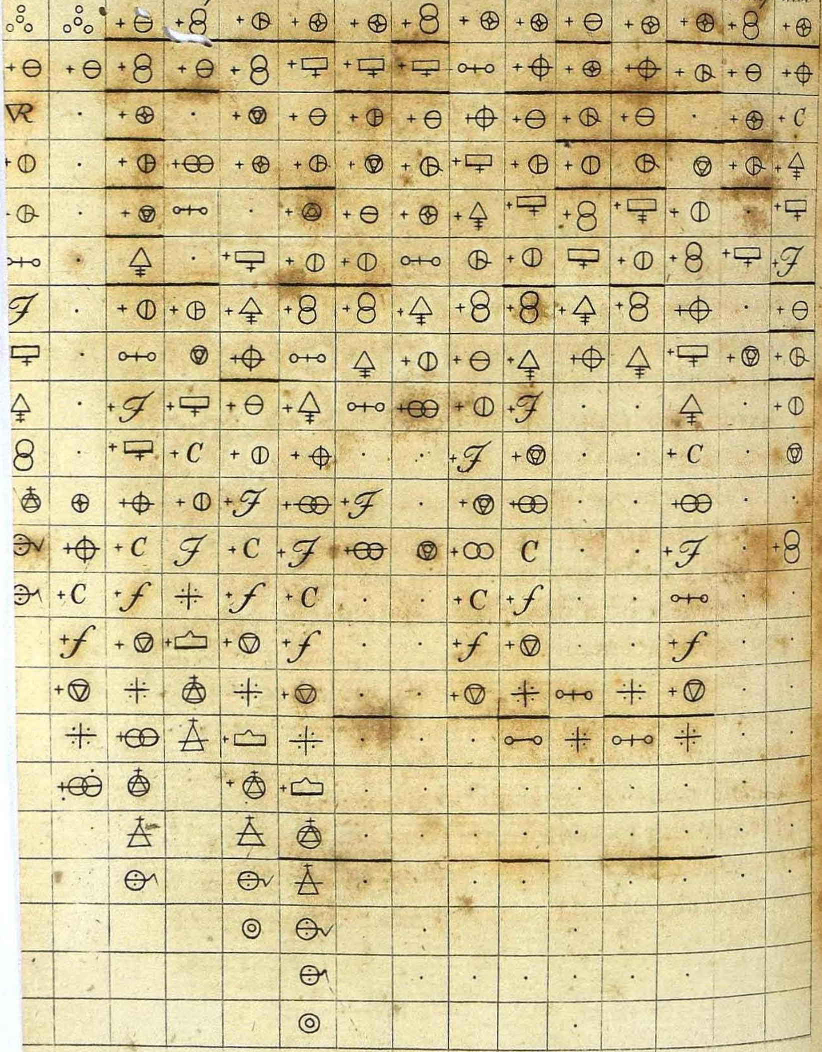
Col. 5. Water occupies the first place in this column, because it separates æther from spirit of wine in some degree. Whether pure alkalis, or *hepar sulphuris* should be uppermost, is not quite certain. Sulphur obtains a place in this column, because, in a volatile state, it is soluble in vinous spirit.

The remaining three columns are not yet confirmed by experiment.

Chemical Attractions in Solution

Metallic Substances

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Gold	Platina	Silver	Mercury	Lead	Copper	Iron	Tin	Bismuth	Nickle	Arsenic	Cobalt	Zinc	Antimony	Manganise



SECT. IV.

TABLE III. *Metallic Subſtances*. PLATE IV.

COL. 1. Gold hath generally been ſuppoſed incapable of ſolution, except in *aqua regia*, which is a mixture of nitrous and marine acid; but there is now no doubt that it may alſo be diſſolved in dephlogiſticated marine, and in nitrous acid. The other acids are placed here, becauſe the calx of gold is ſoluble in them after precipitation from thoſe above mentioned. Alkalis are ſuppoſed to diſſolve gold in ſome degree, becauſe, when they are added to a ſolution of this metal beyond the point of ſaturation, the ſolution retains a yellow colour. Æther is placed at the head of the column, becauſe it certainly takes gold from all the acids.

Col. 2. Platina differs from gold only in being, in the ſtate of a precipitate, ſoluble in a greater variety of acids.

The other columns in this table require no particular explanation; but it is neceſſary to obſerve, that the ſeries of the ſeveral acids is by no means poſitive, and that many experiments are yet wanting to conſtitute a complete table of chemical attractions, in the *moiſt* or *humid* way, as it is generally called; or in *ſolution*, as I rather chuſe to call it.

SECT. V.

TABLE IV. *Attractions in Fusion.* PLATE V.

THIS table of attractions, *in the dry way*, as it is uſually called, hath been hitherto ſubjoined to that *in ſolution*; but as I have conſiderably reduced the number of columns, an entire ſeparation becomes neceſſary.

In *col.* 1. comprehending vitriolic, nitrous, and marine acids, phlogiſton occupies the firſt place, becauſe, with a ſufficient degree of heat, neutral ſalts, compoſed of theſe acids, are deprived of their acid principle by charcoal.

Col. 2. The ſix acids at the head of this column, according to Bergman, poſſeſs the ſame powers of attraction; but this arrangement wants confirmation by experiment. The ſame may be obſerved with regard to columns three and four. Bergman's conjectures are founded on probability; but we muſt not forget that they are only conjectures.

Col. 5. Here the acids of phoſphorus, borax, and arſenic, are ſuperior to other acids on account of their fixity. As to the earths, the gradation is not determined. I have made no diſtinction between the vegetable, mineral, and volatile alkali, becauſe their powers of attraction are the ſame.

In

Chemical Attractions in Fusion

Acids				Alkali &c Inflammables						Metallic Substances														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Vitriol Nitrous Marine	𝓕 ⌓ ○+○ ⊽ 8 △≑	Acid of Amber	Acetous of Milk of Ants	Alkali	Earths	Flint	Phlogiston	Sul-phur	Hepar Sulph	Gold	Plati-na	Silver	Mer-cury	Lead	Copper	Iron	Tin	Bis-muth	Nick-le	Arse-nic	Co-balt	Z[illegible]	Anti-mony	Manga-nese
△+	Ψ	Ψ=	Ψ=	+△≑	·	⊖v	Ψ= ◎	⊖v	Ф	☿	○—○	♄	☉	·	·	○|○	Ƶ	♄	♂	○|○	♂	♀	♂	♀
Ψ=	·	Ψ	⊖v	+⌓	·	+⌓	−☉	♂	♂	♀	☉	♀	☽	·	·	☊	☿	☽	☊	·	○|○	♁	♀	♂
⊖v	Ψ=	Ψ=	Ψ	○+○	·	+△≑	○+○	♀	♀	☽	♀	☿	◎	♀	○—○	Ф	♀	☉	○—○	♀	○—○	♃	·	☉
Ψ	⊖v	·	Ψ=	+⊕	·	Ψ= ♄	Ψ= ☽	♃	·	♄	♃	♉	♄	☿	♂	○—○	♁	☿	♀	♂	♀	☿	♄	☽
Ψ=	ΨH	·	·	+⌽	·		−○—○	♄	·	♉	·	♃	♃	♉	Ф	♀	☉	♁	☉	☽	☉	☽	○|○	♃
ΨH	⊖˥	·	·	+⊖	·		−♁	☽	·	♃	Ƶ	☉	Ƶ	♃	Ƶ	☉	☽	♃	·	·	◎	·	☽	
⊖˥	·	·	·	+8	·		−♉	☊	○	♁	·	♁	♉	♁	·	☽	♄	♀	♁	♄	♃	☊	♉	
⊽				+𝓕	·		−♀	○|○	♁	♂	○|○	♂	♀	◎	·	♃	♂	◎	·	☉	♁	○—○	Ƶ	
				−○○−	·		−♃	♉	☊	◎	☊	Ф	♁	○—○	♃	♁	Ф	○|○	♉	◎	Ƶ	◎	☉	
·				+𝑓	·		−♄	♁	○|○	Ƶ	Ф	Ƶ	○—○	Ƶ	♄	◎	○|○	♂	♄	Ƶ		♉	◎	
				+⊽	·		−○|○	☿	♉	○|○	♂	○—○	♂	○|○	·	♉	○—○	Ƶ	☽	♁		♄	☿	
				°○+○	·		−☊	○—○	☿	○—○	♄	○|○		♂	♉	♄	◎		Ƶ			○|○	○—○	
				⸭	·		−Ф		○—○	☊	☽	◎			☊	☿	♉					♂	☊	
				Ψ=	⊖v		−♂			Ф	☿				·		☊							
				Ψ	△≑		−Ƶ			⊖ △≑	·	·	·	·	·	·	·	·	·	·	·		·	·
				Ψ=	Ψ= ♄							△≑	·	·	·	·	·	·	·	·	·			
				⊽																				
				△+																				

In *col.* 7, fixed alkali occupies the firſt place, becauſe flint is moſt readily fuſed by that ſalt.

In *col.* 8, the calx of platina ſtands firſt, becauſe it is moſt difficult of calcination, and conſequently adheres moſt obſtinately to its phlogiſton. The acid of arſenic precedes the calx of ſilver, becauſe, in fuſion, it diſſolves, and conſequently dephlogiſticates, a part of that metal.

Col. 9. Fixed alkali is doubtleſs entitled to the firſt place in this column, as it readily unites with ſulphur, forming what is called *ſaline hepar.* Gold, platina, and zinc are omitted, becauſe it refuſes to unite with them.

In *col.* 10, manganeſe ſtands firſt, but its title to this pre-eminence is not clear; the proper places of gold, antimony, mercury, and arſenic, are alſo not poſitively determined.

Col. 11—25. Concerning theſe fifteen columns of metallic ſubſtances, it is neceſſary to obſerve, that the diſpoſition reſts, very frequently, on probability, and that much is left for future experiments to determine.

SECT. VI.

SINGLE ATTRACTIONS.

CHEMICAL attractions are single or double. When a body composed of two principles is decomposed by a simple substance uniting with one of these principles, and thereby forming one new compound, it is effected by *single* attraction. If two compound bodies, each of two principles, be mutually decomposed by an exchange of principles, it is the result of *double* attraction. In some examples of double attraction, two new compounds will be produced; in others, but one; the two remaining principles not uniting.

Decomposition and Combination by Single Attraction.

IF, to a solution of Epsom salt, in water, we add caustic fixed alkali, the magnesia, which in the Epsom salt was united with vitriolic acid, will fall to the bottom of the vessel, and the neutral salt, called *vitriolated tartar*, formed by a combination of the vitriolic acid with the alkali, will be dissolved in the water. The vitriolic acid parts with magnesia, because it has a preferable attraction to alkalis. See *Plate* VI. *Fig.* 1.

In

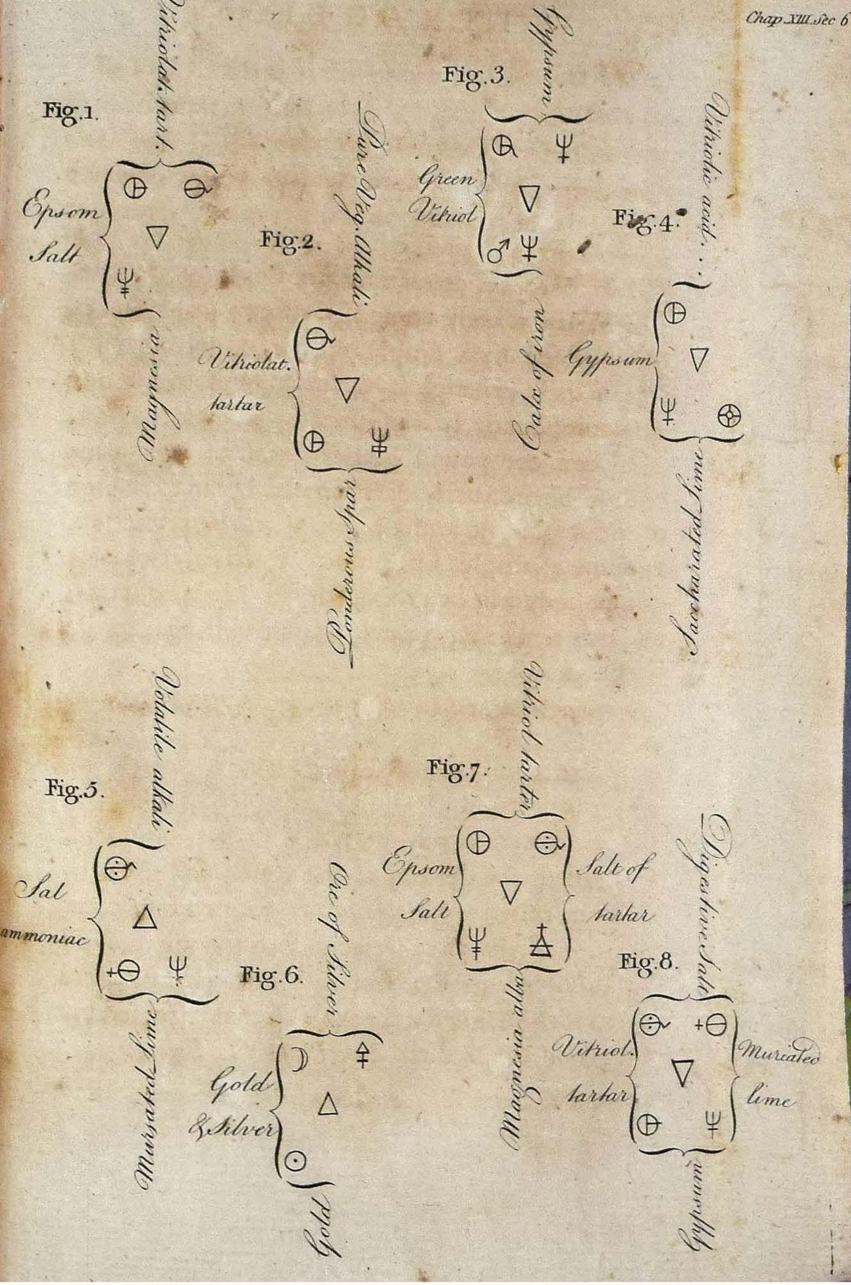


Fig. 1.
Vitriolat. tart.
Epsom Salt
Magnesia
Fig. 2.
Pure Veg. Alkali
Vitriolat. tartar
Ponderous earth
Fig. 3.
Gypsum
Green Vitriol
Calx of iron
Fig. 4.
Vitriolic acid
Gypsum
Saccharated Lime
Fig. 5.
Volatile alkali
Sal ammoniac
Muriated Lime
Fig. 6.
Ore of Silver
Gold & Silver
Gold
Fig. 7.
Vitriol. tartar
Epsom Salt
Salt of tartar
Magnesia alba
Fig. 8.
Digestive Salt
Vitriol. tartar
Muriated lime
Gypsum

In this ſcheme, the chemical ſymbol of water in the centre, ſhews that the ſolution is made in that fluid. The two ſymbols within the perpendicular bracket, denote the two principles which compoſe Epſom ſalt; that which is on the right hand, under the horizontal bracket, is the ſymbol of fixed alkali. The half-bracket under magneſia, having one point turned downwards, ſhews that magneſia is precipitated; and the central points of the horizontal bracket turning upwards, indicate the ſolution of vitriolated tartar in the water.

Vitriolated Tartar and Ponderous Earth.

If to a ſolution of vitriolated tartar, in water, ponderous earth be added, the earth uniting with the acid will fall to the bottom in the form of ponderous ſpar, and the vegetable alkali will remain diſſolved. See *Plate* VI. *Fig.* 2.

In this figure the two component principles, as in the former, are placed above each other within the perpendicular bracket, and the ponderous earth on the right hand, within the lower horizontal bracket. The central points of that bracket turning downwards, indicate the precipitation of ponderous ſpar, formed by the union of vitriolic acid and ponderous earth; and the point of the upper horizontal bracket turning upwards, ſhews that the alkali, which, in the vitriolated tartar, was combined with the vitriolic acid, remains diſſolved.

Green Vitriol and Lime.

If, to a ſolution of green vitriol in water, calcareous earth, deprived of its fixed air by burning, be added, the vitriolic acid, quitting the iron and uniting with the lime, will form gypſum; which, together with the calx of iron, will fall to the bottom. See *Plate* VI. *Fig.* 3.

In this figure the lime is ſeen on the right hand oppoſite the acid with which it unites, and both precipitations are indicated by the whole and half-bracket turning downwards.

Gypſum and Acid of Sugar.

If, to water, containing lime combined with vitriolic acid, the ſmalleſt quantity of the acid of ſugar be added, it will inſtantly unite with the lime, and fall to the bottom, the vitriolic acid being diluted in the water. See *Plate* VI. *Fig.* 4.

In this figure, the acid of ſugar ſtands alone on the right hand, oppoſite the lime with which it unites, and the precipitation is indicated by the middle points of the bracket turning downwards. The ſolution of the vitriolic acid is known by the point of the half bracket turning upwards.

Sal-

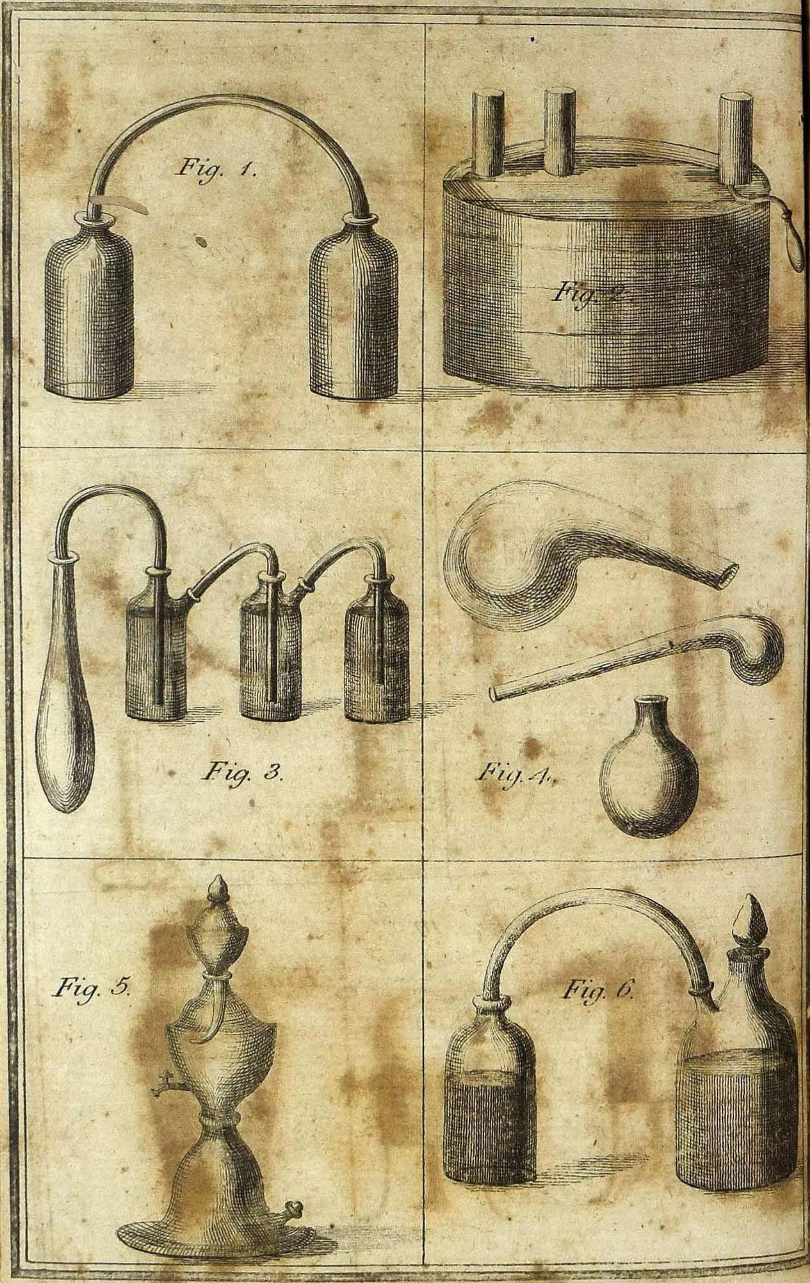
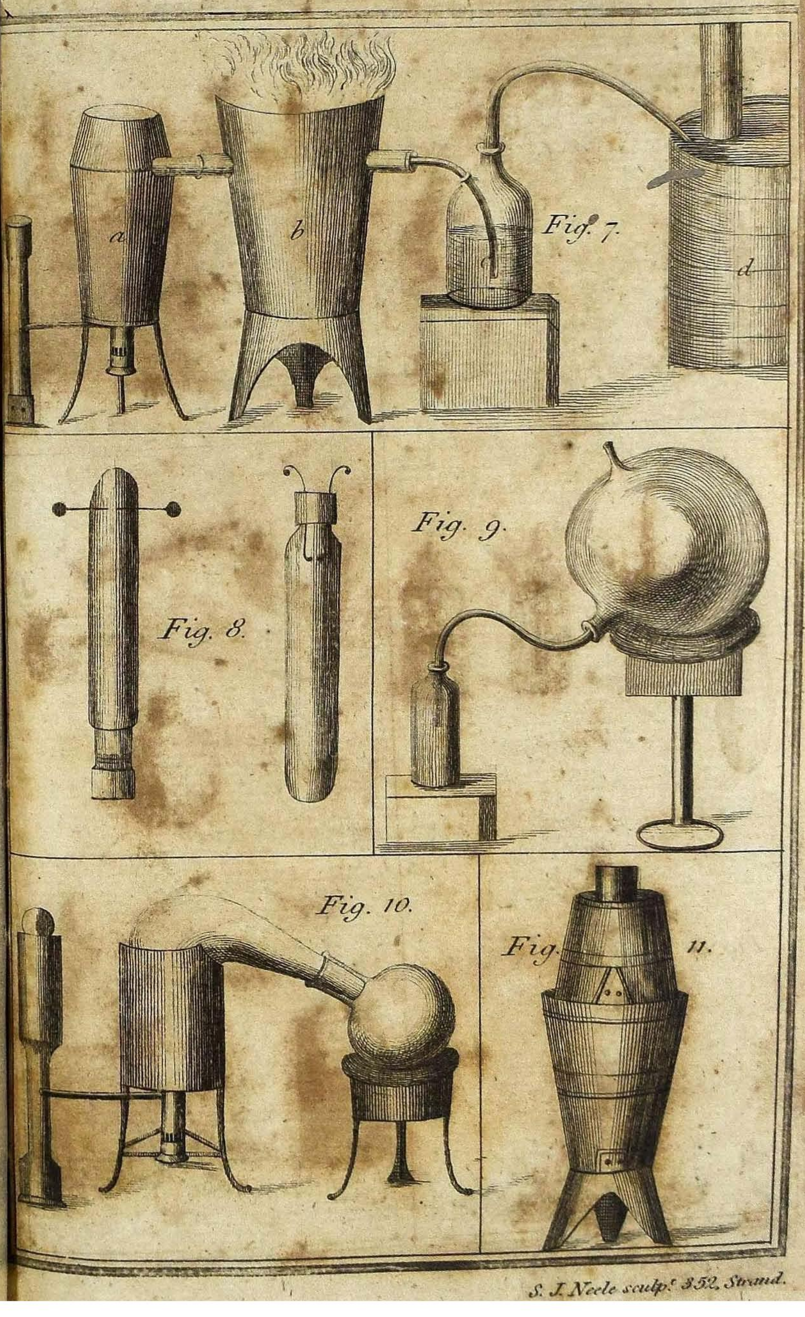


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.



S. J. Neele sculp.t 352, Strand.

Sal-ammoniac and Quicklime.

If ſal ammoniac, which is a combination of volatile alkali with marine acid, be diſſolved in water, and diſtilled with quicklime in a retort, the alkali, quitting its baſis, will paſs over into the receiver, and the marine acid, uniting with the lime will remain. See *Plate* VI. *Fig* 5. This proceſs is eaſily underſtood from the foregoing example.

Gold and Silver with Sulphur.

If gold, alloyed with ſilver, be fuſed in a crucible with ſulphur, the ſulphur will unite with the ſilver, and leave the gold pure. See *Plate* VI. *Fig.* 6.

In this, as in the laſt example, the ſymbol of heat in the centre of the figure indicates *the dry way*.

SECT. VII.

DOUBLE ATTRACTION.

Epſom Salt and Salt of Tartar.

If, to a ſolution of Epſom ſalt in water, we add a ſolution of ſalt of tartar, which is a combination

nation of pure vegetable fixed alkali with calcareous gas, the gas uniting with the pure earth of magnefia, falls to the bottom, and the pure alkali combining with the vitriolic acid, and forming vitriolated tartar, remains diffolved. See *Plate* VI. *Fig.* 7.

In this figure, the vitriolic acid and the magnefia are feen within the bracket on the left hand; the fixed alkali and the fixed air within that on the right, the two fubftances which unite in the folution facing each other. The middle points of the lower horizontal bracket turning downward, indicate the precipitation of magnefia alba, and thofe of the upper horizontal bracket pointing upwards, fhew us, that vitriolated tartar remains diffolved in the water.

Vitriolated Tartar, and muriated Lime, commonly called Sea Salt with an Earthy bafis.

If thefe two falts be diffolved in water, a double decompofition and combination will refult. The vitriolic acid will quit the vegetable alkali to unite with the lime, and the vegetable alkali will unite with the marine acid.

How can this poffibly happen?—for we fee, by the table of attractions, that the vitriolic acid prefers alkali to lime, and that vegetable alkali prefers vitriolic acid to every other fubftance. Very true; but we alfo learn, from the fame table of of attractions, that marine acid prefers vegetable alkali to the lime with which it is united, and that lime prefers vitriolic to marine acid: ſo that, though the union between vitriolic acid and vegetable alkali cannot be broken by marine acid or lime alone, yet both pulling at the ſame time, one at the acid, the other at the alkali, effect the decompoſition, and are themſelves ſeparated in the conflict. In other words, the ſum of the attractions which unite the principles in the two *new* compounds, is greater than the ſum of the attractions by which the principles in the *old* were held together. See *Plate* VI. *Fig* 8.

In this figure, the *gypſum* precipitates, and the *digeſtive ſalt of Sylvius* is diſſolved in the water. Examples of this kind frequently occur in chemiſtry.

Hitherto we have proceed-d on general principles, and theſe principles may be ſafely admitted, becauſe they are founded, not in theory, but on the firm baſis of experiment. Nevertheleſs, we muſt not forget that, in chemiſtry, as in other ſciences, general dogmata admit of ſome exceptions; that, in making experiments, patience, perſeverence, neatneſs, and a ſtrict attention to external circumſtances, are indiſpenſibly neceſſary; particularly the temperature of the atmoſphere and of the menſtrua employed.

To guard againſt deception, it is very neceſſary to be aware of double attractions where ſingle have

have generally been ſuppoſed, as in the caſe of one metal being precipitated by another, from an acid menſtruum, and in many other inſtances.

In mixing one ſalt with the ſolution of another, we are to remember, that no ſign of decompoſition may appear, though it ſhould really take place; becauſe the new compoſition may be equally ſoluble in the fluid, which therefore remains tranſparent.

In adding one ſubſtance to the ſolution of another, we muſt be careful not to draw falſe concluſions from precipitations, which may happen from a want of a ſufficient quantity of water to diſſolve both.

It is alſo neceſſary to remember, particularly in fuſion, that three, or even four, ſubſtances will combine ſo intimately as to conſtitute an apparently homogeneous maſs.

In experiments made with a deſign to determine relative powers of attraction in ſolution, it is very neceſſary to remember, that neutral ſalts admit of an exceſs of acid, or of their alkaline baſis; and that this exceſs hath produced phenomina by which ſome expert chemiſts have been deceived.

TABLE OF COMPOSITION.

	Vegetable Alkali.	*Mineral Alkali.*	*Volatile Alkali.*	*Barytes.*	*Lime.*	*Magneſia.*	*Clay.*	*Calx of Gold.*	*Calx of Platina.*	*Calx of Silver*	*Calx of Mercury.*	*Calx of Lead.*	*Calx of Copper*	*Calx of Iron.*	*Calx of Tin.*	*Calx of Biſmuth.*	*Cx. of Nickle.*	*Cx. of Arſenic*	*Cx. of Cobalt.*	*Calx of Zinc.*	*Cx. Antimony*	*Calx of Manganeſe.*
Vitriolic Acid.	Vitriolated tartar.	Glauber's ſalt.	Vitriolic ammoniac.	Ponderous ſpar.	Selenites. Gypſum.	Epſom ſalt.	Alum.	Vitriol of gold.	Vitriol of Platina.	Vitriol of ſilver.	Vit. of Merc. Turbith mineral.	Vitriol of lead.	Blue Vitriol	Greenvitriol	Vit. of tin.	Vitriol of biſmuth.	Vitriol of Nickle.	Vitriol of arſenic.	Vitriol of cobalt.	White vitriol.	Vitriol of antimony.	Vitriol of Manganeſe.
Nitrous Acid.	Nitre.	Cubic nitre.	Nitrous ammoniac.	Nitrated barytes.	Nitrated lime.	Nitrated magneſia.	Nitrated clay.	Nitrated gold.	Nitrated platina.	Lunar cauſtic.	Red precipitate.	Nitrated lead.	Nitrated copper.	Saffron of Mars.	Nitrated tin.	Spaniſh white, ſympathetic ink.	Nitrated Nickle.	Nitrated arſenic.	Nitrated cobalt.	Nitrated zinc.	Nitrated antimony.	Nitrated manganeſe.
Marine Acid.	Salt of Silvius.	Com. ſalt.	Sal-ammoniac.	Ponderous ſalt.	Marine ſelenite.	Muriated magneſia.	Muriated clay.	Salt of gold.	Salt of platina.	Luna cornea	Whiteprecipitate, corr. ſublimate.	Plumbum corneum.	Salt of copper.	Marine ſaffron of Mars.	Muriated tin	Muriated biſmuth.	Muriated Nickle.	Butter of arſenic.	Muriated cobalt.	Muriated zinc.	Butter of antimony.	Muriated manganeſe.
Fluor Acid.	Gelatinous ſubſtance.	Gelatinous ſubſtance.	Gelatinous ſubſtance.	Effloreſcent compound.	Fluor.	Gelatinous ſubſtance.	Gelatinous ſubſtance.	Fluorated gold.					Fluorated copper.	Fluorated iron.	Fluorated tin.					Fluorated zinc.		
Acid of Arſenic.	Vegetable ſalt of arſenic.	Salt of arſenic.	Arſenical ſal-ammoniac.	Arſenical barytes.	Arſenical lime.	Arſenical coagulum of magneſia.	Arſenical coagulum of clay.	Arſenical gold.				Arſenical lead.	Arſenical copper.	Arſenical iron.	Arſenical tin.	Arſenical biſmuth.	Arſenical Nickle.	Arſenic.	Arſenical cobalt.	Arſenical zinc.	Arſenical antimony.	Arſenical manganeſe.
Acid of Borax.	Vegetable borax.	Borax.	Ammoniacal borax.	Boraxated barytes.	Boraxated lime.	Boraxated magneſia.					Boraxated mercury.	Boraxated lead.	Boraxated copper.	Boraxated iron.	Boraxated tin.		Boraxated Nickle.		Boraxated cobalt.	Boraxated zinc.		
Acid of Sugar.	Vegetable ſalt of ſugar.	Mineral ſalt of ſugar.	Saccharated volatile alkali.	Saccharated barytes.	Saccharated lime.	Saccharated magneſia.	Saccharated clay.		Saccharated platina.	Saccharated ſilver.	Saccharated mercury.	Saccharated lead.	Saccharated copper.	Saccharated iron.	Saccharated tin.	Saccharated biſmuth.	Saccharated Nickle.	Saccharated arſenic,	Saccharated cobalt.	Saccharated zinc,	Saccharated antimony,	Saccharated manganeſe.
Acid of Tartar.	Tartar. Soluble tartar.	Rochelle ſalt	Tartarous ammoniac.	Tartarized barytes.	Tartarized lime.	Tartarized magneſia.	Tartarized clay.	Tartarized gold.	Tartarized platina.	Tartarized ſilver.	Tartarized mercury.	Tartarized lead.	Tartarized copper.	Tartarized iron.	Tartarized tin.	Tartarized biſmuth.	Tartarized nickle.	Tartarized arſenic.	Tartarized cobalt.	Tartarized zinc.	Emetic tartar.	Tartarized manganeſe.
Acid of Sorrel.	Oxalited vol. alkali. Salt of ſorrel.	Oxalited marine alkali.	Oxaline ammoniac.	Oxalited barytes.	Oxalited lime.	Oxalited magneſia.	Oxalited clay.		Oxalited platina.	Oxalited ſilver.	Oxalited mercury.	Oxalited lead.										
Acid of Lemon.	Limonated volatile alkali.	Limonated marine alkali.	Vegetable ammoniac.	Limonated barytes.	Limonated lime.	Limonated magneſia.	Limonated clay.		Limonated platina.	Limonated ſilver.	Limonated mercury.	Limonated lead.	Limonated copper.	Limonated iron.	Limonated tin.	Limonated biſmuth.	Limonated nickle.	Limonated arſenic.	Limonated cobalt.	Limonated zinc.	Limonated antimony.	Limonated manganeſe
Acid of Benzoin.	Deliqueſcent ſalt.	Benzoined marine alkali.		Benzoined barytes.	Benzoined lime.	Benzoined magneſia.	Benzoined clay.															
Acid of Amber.	Succinated veg. alkali deliqueſcent	Succinated mineral alkali.	Succinous ammoniac.	Succinated barytes.	Succinated lime.	Succinated magneſia.	Succinated clay.	Succinated gold.	Succinated platina.	Succinated ſilver.	Succinated mercury.	Succinated lead.	Succinated copper.	Succinated iron.	Succinated tin.	Succinated biſmuth.	Succinated nickle.	Succinated arſenic.	Succinated cobalt.	Succinated zinc.	Succinated antimony.	Succinated manganeſe.
A. of Sugar of Milk.	Saccharated vegetable alkali.	Saccharated mineral alkali.	Ammoniacal ſugar of milk.	Saccharated barytes.	Saccharated lime.	Saccharated magneſia.	Saccharated clay.			Saccharated ſilver.	Saccharated mercury.	Saccharated lead.										
Acetous Acid.	Terra foliat. Tartar regm.	Acetous ſalt.	Spiritus mindereri.	Acetous barytes.	Acetous lime.	Acetous magneſia.	Acetous clay.		Acetous ſalt of platina.	Acetous ſalt of ſilver.	Acetous ſalt of mercury.											
Acid of Milk.	Vegetable ſalt of milk.	Salt of milk	Ammoniacal ſalt of milk.	Barytic ſalt of milk.	Calcareous ſalt of milk.	Small cryſtals.	Argillacious ſalt of milk.					Solution.	Solution.	Solution.						Cryſtals.		
Acid of Ants.	Formicated vegetable alkali.	Salt of Ants	Ammoniacal ſalt of Ants.	Barytic ſalt of Ants.	Calcareous ſalt of Ants.	Hemiſpherical cryſtals.	Argillacious ſalt of Ants.		Formicated platina.	Formicated ſilver.	Formicated mercury.	Formicated lead.										
Acid of Fat.	Soluble tartar.	Salt of fat.	Sebaceous ammoniac.	Barytic ſalt of fat.	Calcareous ſalt of fat.	Sebaceous magneſia.	Argillacious ſalt of fat.	Sebaceous ſalt of gold.														
Acid of Phoſphorus.	Vegetable phoſphoric ſalt.	Salt of phoſphorus.	Microcoſmic ſalt.	Barytic ſalt of phoſphorus.	Calcareous ſalt of phoſphorus.	Phoſphorated magneſia.	Phoſphorated ſalt of clay.	Phoſphoric gold.														
Acid of Pruſſian blue.	Vegetable ſalt of Pruſſian blue.	Salt of Pruſſian blue.	Ammoniacal ſalt of Pr. blue.	Barytic ſalt of Pruſſian blue.	Calcareous ſalt of Pruſſian blue	Magneſiated ſalt of Pruſſian blue	Argillacious ſalt of Pruſſian blue	Pruſſian ſalt of gold.														
Sulphur.	Saline hepar.	Saline hepar.	Ammoniacal hepar.	Barytic hepar.	Calcareous hepar.	Magneſiated hepar.				Ore of ſilver.	Cinnabar.	Galena.	Ore of cop.	Ore of iron.	Ore of tin.	Ore of biſm.	Ore of nickle	Orpiment.	Ore of cobalt	Black Jack.	Crude antimony. liver of antimony.	Ore of manganeſe.

CHAP. XIV.

THEORY OF CHEMICAL OPERATIONS.

THE primary objects of chemical operations are analysis and composition. Bodies are analysed, or decomposed, when their constituent parts are separated from each other. By composition, not only the constituent parts of natural bodies are reunited, but artificial compounds are formed.

Of FIRE, *and its Use in Chemical Operations and Experiments.*

FIRE hath already been considered as a physical element. As an instrument of chemistry, we must recollect, that it is the cause of all fluidity and volatility; that solidity, fluidity, and volatility, depend entirely on the distance, or proximity, of the component parts of bodies, and that their expansion depends on the quantity of fire introduced and interposed. It is also necessary to remember, that the fluidity of water and of metals, in fusion, is the effect of the same cause, and that their different

ent appearance in the common temperature of the atmoſphere, is owing to their requiring a greater or leſs quantity of fire to render them fluid.

The moſt ſimple means of decompoſing inflammable bodies by fire, is by combuſtion.

SECT. II.

COMBUSTION.

COMBUSTION may be produced by the application of another body already burning; by converging the rays of the ſun; by ſtriking two hard bodies againſt each other; by mutual friction of two combuſtible bodies. By what means the fire is produced by percuſſion and by friction, is not eaſily demonſtrated. If we ſuppoſe it to be the effect of motion excited, it will prove that fire is not a diſtinct ſubſtance; that heat is not a quality of fire, but a property of every ſpecies of matter, when agitated to a certain degree. This hypotheſis is inadmiſſible. It ſeems more rational to believe, that the friction increaſes the power of focal attraction of the parts in contact, and that the fluctuating and ſpecific fire is thus concentrated, and converged to a point ſufficient to produce ignition.

Be the caufe what it may, the effect is certain. The principle of inflammability called *phlogiftion*, flies off together with every other volatile part, and thofe which are fixed remain in the afhes: it is, therefore, to obtain the fixed part of combuftible bodies, that they are burnt.

The afhes of vegetable fubftances contain fixed alkali, which being foluble in water, is procured by repeated lixiviation and evaporation.

Tar, which is burnt refin or turpentine, is alfo the produce of combuftion. It exudes from the wood of firs or pines fet on fire for that purpofe, and is afterwards converted into pitch by boiling.

Charcoal is produced by partial combuftion. When the fire has penetrated the combuftible body fo as intirely to deftroy its texture, it is extinguifhed by excluding the air. The phlogifton being thus prevented from flying off, combines with the earthy principle, and becomes fixed. Tinder is a fpecies of charcoal.

Soot is another product of combuftion. It rifes in the form of fmoke, and being condenfed by the firft cool body it touches, fixes on the internal furface of chimneys. Smoke confifts of parts capable of being volatilized by phlogifton and fome fixed matter, carried up, as it were, againft its inclination; all which have efcaped inflammation for want of a fufficient degree of heat immediately applied: therefore flame, fmoke, and

foot,

ſoot, conſiſt of the ſame matter in different ſtates. Soot being analyſed, is found to be a compoſition of water, volatile alkali, a black oil, and a large proportion of coal, which being burnt in the air, yields ſome fixed alkali. From ſome kinds of ſoot, ſalammoniac may be ſublimed.

The theory of combuſtion is not well underſtood. It is indeed a very common, but, to a philoſopher, a very amazing phenomenon. We know, by experience, that the moſt combuſtible bodies will not burn unleſs in contact with the air. We alſo know that the atmoſphere is an heterogenious mixture of volatile matter, diſſolved or ſuſpended in a variety of elaſtic fluids, poſſeſſing different properties; the chief of theſe are pure air, corrupted or phlogiſticated air, and aerial acid or calcareous gas. Now the firſt of theſe, which generally exiſts in the proportion of one third of the whole, is the only ſpecies of air capable of promoting or ſuſtaining combuſtion, and without which inflammable ſubſtances ceaſe to burn.

Flame is generally conſidered as ſmoke in a ſtate of ignition. The ſect of antiphlogiſtic philoſophers ſay, that pure air contains a large proportion of the matter of heat or of light, which light is ſet at liberty in conſequence of the oxyginous or acid principle of the pure air, uniting with the combuſtible body: flame, therefore, is light

light ſeparated from the acid principle of pure air.

We learn, from a variety of experiments, that flame exiſts only for a ſhort ſpace of time in confined air. Philoſophers formerly accounted for this phenomenon, by ſaying that the elaſticity of the air within the veſſel, was deſtroyed. Later experiments have refuted this concluſion. We are now of opinion, that the candle goes out becauſe the air is ſaturated with phlogiſton, and conſequently can take no more from the taper, which therefore ceaſes to burn. This doctrine is powerfully ſupported by the experiment of a candle burning with a much more vivid flame when confined in pure air.

From theſe data we conclude, that pure air facilitates, promotes, or produces combuſtion in conſequence of its attraction to phlogiſton, which preferring this pure air to the matter with which it was combined in the inflammable body, neceſſarily flies off, and unites with the air.

Such is our preſent apparently rational theory of combuſtion. It is not, however, without its difficulties. If, as we have ſuppoſed, combuſtion be the effect of a ſudden combination of pure air with phlogiſton, in conſequence of a powerful attraction between them, why does not the pure air in the atmoſphere ſnatch phlogiſton from the phlogiſticated air that is conſtantly preſent and in con-

contact with it. But let us suppose phlogiston to be a compound body, consisting of pure fire and an acid; and that the attraction which is the cause of combustion, is not between pure air and phlogiston, but between pure air and pure fire. Phlogiston, which is fire fixed by an acid, becomes fluid by ignition, and is thus in a proper state for decomposition, by the attraction of an adventitious substance to one of its principles. This adventitious substance is vital or pure air, and the new compound formed by this union is water. No wonder, therefore, that phlogiston cannot be retained or recovered after inflammation: it is totally destroyed, and its constituent parts, in combination with other substances, acquire other properties. The fire we have thus disposed of; but what becomes of the acid? If it be the aerial acid, it mixes in the atmosphere where it is generally found in a small proportion, or uniting with, and supersaturating a part of the undecomposed phlogiston which escapes from the burning body, it forms the phlogisticated air that constitutes so considerable a part of the atmosphere. Or let us rather suppose, that the acid principle of the now decomposed phlogiston, uniting with a certain proportion of pure air, constitutes aerial acid, which, combined with phlogiston, forms phlogisticated air. This acid of phlogiston, may possibly be the only primeval acid, and the acid principle of all the rest.

SECT.

SECT. III.

FERMENTATION.

I NOW proceed to the consideration of this subject, because, like combustion, as a chemical process, it is simple; but particularly because it is intimately connected with the theory sketched in the foregoing article. If we fail in our attempt to explain the mystery of fermentation, it will excite no wonder, as the ablest chemists have acknowledged it to be incomprehensible.

Fermentation is generally divided into three distinct species, viz *vinous*, *acetous*, and *putrifactive*. They are, in fact, gradations of the same process. The first product of fermentation is the inflammable fluid called *ardent spirit*, or *spirit of wine*; and the spirit, when separated from the water with which it is mixed, is the same, whether obtained from beer, cyder, wine, brandy, rum, &c.

That we may investigate this intricate process with as much precision as our present chemical knowledge will admit, let us first consider, what are the subjects of fermentation, and by what means it is excited. It were best to confine ourselves, at present, to vinous fermentation only.

To vinous fermentation, fluidity is essential; and the only fluid capable of this process is water. The operations requisite, are expression of the juice from ripe fruits, a very large proportion of which juice is water; or infusion of grain, dried in a state of incipient vegetation; or solution of molasses, honey, or sugar, in water. These various operations excite the same vinous fermentation, and the result is, as I have before observed, a spiritous liquor, from which the same alkohol, or spirit of wine, may be obtained by distillation.

Now, since ripe fruits, malt, and sugar, produce the same inflammable spirit, there is probably in them some soluble matter common to them all; for similar effects can only be produced by similar causes. The expressed juice of grapes, the infusion of malt, and a solution or decoction of molasses, or of sugar, are mucilaginous and sweet; but vegetable mucilage, without sweetness, will not produce vinous fermentation: therefore sugar, or the saccharine principle, must necessarily be the cause.

Sugar is an essential salt which, in distillation, yields water, an acid, an oil, and earth. The acid may be separated by boiling sugar with nitrous acid, which destroys the oil, by seizing its phlogiston. Sugar, therefore, contains phlogiston and a peculiar acid. The same acid may also be obtained from spirit of wine, which consists, when highly rectified, of the saccherine acid, phlogiston and a little water. The principles, therefore, or constituent parts, of sugar dissolved in water, and of vinous spirit, are essentially the same: consequently the extreme difference in their qualities and effects, must be ascribed either to the different proportions of acid and phlogiston, or to their being differently involved and combined. As to difference of modification, applied to principles, I do not understand it.

I deflagrated half an ounce of loaf sugar, reduced to a fine powder, in a red-hot crucible, projecting it by a single pinch at a time. It burnt with a vivid flame, and the coal, remaining at the bottom, weighed seven grains. This charcoal, mixed with 14 grains of Glauber's salt, and the same quantity of fixed alkali, I exposed, in a crucible, to a red heat for a short time, and thereby produced a liver of sulphur, which I dissolved in water and filtred. There remained on the filtre, five grains of dephlogisticated insoluble matter.

Hence it is evident, that sugar and spirit of wine differ but little in point of inflammability, and consequently in their proportion of phlogiston.

Nevertheless, sugar dissolved in water, *must*, and wort, differ essentially from spirit of wine, or brandy, or rum, or ale, in the want of that intoxicating quality called *strength*, which it is the buſineſs of fermentation to communicate. But we have ſeen that this intoxicating ſpirit is a combination of phlogiſton with an acid, probably highly rectified, attenuated, and evolved from the water, mucilage, and earth, with which it was loaded in the aqueous ſolution. Fermentation, therefore, performs this partial rectification, which is afterwards compleated by diſtillation.

From Bergman's table we learn, that the degree of ſpecific heat of brown ſugar diſſolved in water, and that of ſpirit of wine, is preciſely the ſame, viz. 1,086 ; a degree exceeding that of any other fluid. We alſo ſee that, next to theſe, water poſſeſſes the greateſt ſpecific heat, and (vinegar excepted) oils the leaſt. Hence it is evident, that phlogiſton is not the cauſe of ſpecific heat. But if heat be a quality of fire, and not a diſtinct ſubſtance, we muſt neceſſarily conclude, that ſpecific heat depends entirely on the quantity of fixed fire which exiſts in bodies as a conſtituent part ; and that ſenſible heat, which may be meaſured by the thermometer, is cauſed by fire in the volatile ſtate in which it pervades all bodies, perpetually fluctuating, and tending to an equilibrium.

Let us now return to the object of our immediate conſideration. To excite fermentation, ſugar and water are the only requiſites. The principles of ſugar are, an acid and phlogiſton; thoſe of water are, pure air and pure fire, *not* phlogiſton.

giston. The most singular phenomenon in fermentation, is the extrication, or (according to the hypothesis I am about to form) the generation of a great quantity of aerial acid, commonly called fixed air, which I believe to consist of pure acid and pure air. My reasons for this belief are; because it possesses all the properties of an acid, and because, being a weak acid, it is probably diluted by some other fluid, which, for very obvious reasons, can neither be water nor phlogiston.

But, before we proceed in our attempt to develope the mystery of fermentation, it is necessary to observe, that the contact of the atmosphere is not requisite, consequently the decomposition and combinations, whatsoever they may be, are intrinsic.

It will be granted, I presume, that the produce of fermentation, viz. fixed air and vinous spirit, are the effect of chemical attraction.

The active principles in sugar, are vegetable acid and phlogiston; phlogiston is pure acid and pure fire. Water is *pure air* and *pure fire*.

The three principles, therefore, which are in a capacity of mutual attraction, are acid, air, and fire. The pure fire uniting with the acid forms phlogiston, which, with the phlogiston already present in sugar, combined with a large proportion of undecomposed water and an acid, constitutes wine or beer; whilst another portion of acid in in combination with the pure air from the decomposed part of the water, forms aerial acid, which, having no water in its composition, rises from the surface, and gradually mixes with the atmosphere.

That water is decomposed in the process of fermentation, I conclude, because no other hypothesis will account for the production of so large a quantity of fixed air, and the progressive generation of barm, which consists principally of that aerial acid.

That phlogiston is a combination of pure fire with an acid, seems evident from the conversion of spirit of wine into vegetable acid; which can only be effected, by decomposing the phlogiston of which it principally consists; for to deprive spirit of wine of its entire phlogiston, would be not to *transmute*, but to annihilate it; and not an acid, but water would be the result.

As to the possibility of decomposing water, and that fermentation possesses this power, they seem evident from the effect.

Many more arguments might be adduced in support of this new theory of fermentation; but I have probably said enough to excite an enquiry that may possibly terminate in demonstration.

SECT.

SECT. IV.

SOLUTION, MIXTURE, DIFFUSION, SUSPENSION, PRECIPITATION.

I. SOLUTION

IS, by the French chemiſts, not diſtinguiſhed from *mixture*. The Chemical Dictionary, under the word *ſolution*, defines, and treats of, *mixture* only. By ſolution we underſtand that diaphanous union of a ſolid body with a fluid, from which it may be recovered, in its original ſtate, by ſimple evaporation; and which ſolution poſſeſſes the properties of the body diſſolved. In ſolution, no third ſubſtance is produced by the union, nor any change of properties in the ſolid body. Salts diſſolved in water are proper examples of ſolution. The moſt rational theory of this proceſs, is that which ſuppoſes the particles of the ſalt to lodge in the interſtices between the minute globules of water; for, upon any other hypotheſis, it would be very difficult to account for the bulk of the water not being increaſed.

The ſolvent, or menſtruum, is, in the language of chemiſtry, ſaid to be ſaturated, when, upon adding more of the matter to be diſſolved, it falls to the bottom of the veſſel after repeated agitation. But water, ſaturated with one ſalt, will yet diſſolve a ſecond and a third. For example: when ſaturated with common ſalt, it will take up a conſiderable quantity of nitre, and, after that, ſome ſalammoniac. On the hypotheſis above mentioned, this fact may be illuſtrated by a caſk filled with bullets; into which a quantity of ſmall ſhot may be poured; then ſand; and, finally, water; without increaſing the bulk of the whole.

Water will diſſolve a greater quantity of ſalt when warm than when it is cold. This fact may alſo be explained by our preſent hypotheſis. We know that fluids are expanded by heat; conſequently their conſtituent particles are removed to a greater diſtance from each other; and conſequently there is more room for the inſinuation of the particles of ſalt.

But, in ſolution, every drop of the fluid contains an equal quantity of the diſſolved matter. A mere mechanical interpoſition of particles will not account for this. If it were mechanical, the diſſolving particles would gravitate, and the menſtruum at the bottom of the veſſel would be more impregnated than at the top. There muſt, therefore, be another agent capable of counteracting gravitation. This agent is that ſpecies of attraction called *elective*, or *affinity*, by which certain bodies invariably endeavour to unite. Every particle of water is, in ſome degree, ſatisfied with the

the vicinity of the ſmalleſt particle of ſalt; conſequently its avidity, or attractive power, is leſs than that of thoſe which have yet no particles of ſalt near them; the neceſſary conſequence of which muſt be an equal diſtribution of ſalt.

In ſolution, a certain quantity of volatile fire becomes fixed, and conſequently cold is produced.

II. MIXTURE

Differs eſſentially from ſolution, in producing a *tertium quid*, that is, a third ſubſtance, with properties totally different from thoſe of the principles of which it is compoſed. The celebrated chemiſts Baumè and Macquer tell us, on the contrary, that chemical compounds retain the properties of their principles; or, that the property of a mixt is a compound of the properties of its principles. The contrary of this is ſo ſelf-evident, that it is difficult to imagine how they could adopt ſo abſurd an opinion. A neutral ſalt compoſed of acid and alkali, is neither acid nor alkaline in any degree, if it be not ſuperſaturated. Sulphur, which conſiſts entirely of vitriolic acid, combined with phlogiſton, is as eſſentially different from that acid as from any other ſubſtance in nature.

The combination of acids with alkalis, with earths, with metals, and of one metal with another,

ther, or of three or more metals by fusion, are examples of chemical mixture. As to the theory of these combinations, they are evidently the effect of an inherent power of attraction, and natural propensity to unite. This chemical attraction differs from that power by which all particles of matter are drawn towards each other indiscriminately according to their masses, and by which aggregate bodies were formed.

III. DIFFUSION

Implies a want of transparency. Chalk or clay mixt with water, will fall to the bottom of the vessel, or may be separated by filtration, and the water which passes the filtre acquires no new properties from the diffused matter, because chalk and clay are not soluble in water. They fall to the bottom, because their particles are sufficiently large to overcome the friction which endeavours to impede their gravitation.

IV. SUSPENSION.

Chemical suspension differs from diffusion in not injuring the transparency of the fluid, and in the suspended matter not subsiding, nor being separable by filtration. It differs from solution, in the matter suspended being naturally insoluble in the fluid, and consequently communicating no taste or other property. Minute particles of various

rious earths may be mechanically ſuſpended in water. They are too minute to injure the tranſparency of the water; and, from their minuteneſs, their ſurface is ſo large, in proportion to their weight, that the effect of their ſuperior ſpecific gravity is counteracted by friction: conſequently they remain ſuſpended.

V. PRECIPITATION

Is that chemical proceſs by which bodies diſſolved, mixed, or ſuſpended in a fluid, are ſeparated from that fluid, and made to gravitate to the bottom of the veſſel. In ſimple ſolution, as of ſalt in water, this may be effected either by evaporating part of the water by heat, or by adding ſpirit of wine. In the firſt caſe, the ſalt precipitates for want of a ſufficient quantity of the menſtruum; in the ſecond, becauſe the water prefers the ſpirit to the ſalt, which therefore, for the ſame reaſon, falls to the bottom.

Precipitates are either ſimple or compound. If to the ſolution of any earth or metal in an acid menſtruum, an alkali be added, the earth or metal will fall down; becauſe the attraction between the acid and the alkali is ſuperior to that between acids and earths, or metals. This is a ſimple precipitate: or, if to a ſolution of Epſom ſalt in water, we pour a ſolution of ſalt of tartar, magneſia alba, the baſis of Epſom ſalt will be precipitated; becauſe the vitriolic acid with which

which it was united, prefers the alkali to the earth. This is likewise a simple precipitate. If, to a solution of Glauber's salt in water, a solution of silver in the nitrous acid be added, a vitriol of silver will be precipitated; because the attraction between silver and the vitriolic acid, added to that between the nitrous acid and fossil alkali, is sufficient to effect a mutual decomposition. The cubic nitre formed by the union of nitrous acid with the fossil alkali, remains dissolved. This is a compound precipitate.

Metals, dissolved in acids, may be precipitated by other metals. For example, copper dissolved in the vitriolic acid is precipitated by iron, in consequence of a double attraction: the acid unites with the calx of iron, the phlogiston of which revives the copper.

Mercury, dissolved in the nitrous, is precipitated by the marine acid, in the form of a white powder; because that metal prefers the latter of these acids to the former.

Gold, dissolved in *aqua regia*, is precipitated by any other metal; not because the acid prefers these metals to gold, but because phlogiston prefers the calx of gold to that of any other metal.

These examples sufficiently explain the theory of precipitation.

SECT.

SECT. V.

EVAPORATION, DISTILLATION, SUBLIMATION, CONCENTRATION, RECTIFICATION.

THE theory of theſe ſeveral operations is preciſely the ſame. They are in fact the ſame chemical proceſs, differently applied for different purpoſes. Fire renders all bodies, that are capable of evaporation, volatile: the particles on their ſurfaces receding from each other, ſeparated beyond the ſphere of mutual attraction, and combined with fire, become lighter than the atmoſphere, in which they conſequently riſe.

I. EVAPORATION.

Water, whilſt fluid, and in contact with the atmoſphere, is in a conſtant ſtate of evaporation. That which takes place without the aſſiſtance of fire, and which is inviſible, is rather a ſolution of water in air. Chemical evaporation is the effect of fire; which, by its power of univerſal expanſion, converts water and other fluids into vapour. The quantity of this vapour increaſes gradually from the time when the water becomes ſenſibly warm to the moment of boiling, and then riſes in a much larger proportion, and with conſiderable ex-

expanſive force. If the boiling be continued, the water will, in a ſhort time, entirely evaporate.

Fluids, like ſolids, become hot in conſequence of the abſorption of fire in its volatile ſtate. Cold water, in a veſſel placed upon the fire, imbibes the volatile fire by ſlow degrees. Part of this fire riſes to the ſurface, and thence into the atmoſphere, carrying with it a little of the water volatilized. But when the water has abſorbed or diſſolved, all the fire it is capable of retaining; that is, when it is completely ſaturated with fire, the igneous, elaſtic fluid, which ſtill continues to paſs through the bottom of the veſſel, being no longer expanded in the water, neceſſarily riſes precipitately to the ſurface in large bubbles, producing the agitation called *boiling*; and thence riſing into the atmoſphere, carries along with it a conſiderable quantity of water volatilized, in conſequence of its ſaturation with fire.

Water evaporates in proportion to the ſurface. Eight ounces of water boiled ten minutes in a tin cylinder, three inches in diameter, will loſe about two ounces of its weight: ſixteen ounces boiled the ſame time, in the ſame veſſel, will loſe the ſame weight and no more.

The uſe of evaporation, in chemiſtry, is to ſeparate thoſe parts of a ſolution which are capable of being volatilized by heat, from thoſe that are more fixed. The theory of this proceſs is eaſily under-

underſtood from what hath been already ſaid. It is particularly the means of cryſtallization. If, to a ſolution of fixed alkali in water, we add vitriolic, nitrous, or marine acid, a neutral ſalt will be formed, which will remain diſſolved in the water; but if the water be gradually evaporated, the ſalt, for want of a ſufficient quantity to keep it in ſolution, will ſhoot into regular cryſtals.

II. DISTILLATION

Differs from evaporation in being performed in cloſe veſſels, for the purpoſe of retaining the volatile parts of the ſubject ſubmitted to this operation. They are both the effect of the ſame cauſe, and phyſically the ſame proceſs; but they differ in reſult. By evaporation, the fixed parts only are procured. By diſtillation, the fixed parts are equally ſeparated from the volatile, and both preſerved.

Wine, or any other fluid that has generated vinous ſpirit by fermentation, is diſtilled for the purpoſe of ſeparating that ſpirit from the water and other matters with which it is involved. The entire fluid being expanded by the heat applied, its heterogenious particles are conſequently removed to a greater diſtance from each other. Thus their powers of mutual attraction are diminiſhed, and thus the eſcape of the moſt volatile parts facilitated. Theſe volatile particles riſe in

vapour,

vapour, and, being condenſed by cold, unite and form brandy, rum, &c.

Aromatic vegetables, &c. are ſubmitted to diſtillation with water, for the purpoſe of making what are called *ſimple waters*, and for that of obtaining their eſſential oils, which conſtitute their odour, and other medical virtues. Theſe eſſential oils being extricated by maceration and heat, and being ſoluble in water, riſe with the aqueous vapour; which, when condenſed by cold, conſtitutes the ſimple waters of the ſhops. But a greater quantity of eſſential oil being carried over than was ſufficient to ſaturate the water when cold, part of the oil neceſſarily ſwims on the ſurface, or ſinks to the bottom, according to its ſpecific gravity.

Every ſpecies and mode of diſtillation, whether of groſs oils, acids, or of mercury, is produced by the action of fire on certain parts of compound bodies. The theory of the proceſs is the ſame in whatſoever manner performed, or with whatſoever intention.

III. SUBLIMATION

Differs from diſtillation in raiſing, by means of fire, a ſolid body inſtead of a fluid, ſuch as ſulphur, benzoin, &c. Theſe ſublimates, called *flowers*, volatilized by fire, and condenſed by cold, attach themſelves to the neck or upper part of the

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apparatus employed. The ſoot in our common chimneys is a ſublimate. Corroſive ſublimate is a cryſtallized concrete, formed in the upper part of the veſſel, by the union of the vapour of marine acid with that of mercury.

IV. CONCENTRATION,

In chemiſtry, as in common language, ſignifies the act of bringing the conſtituent or integrant parts of bodies nearer to a common centre, and conſequently increaſing the ſpecific gravity of ſuch bodies, by cauſing them to occupy leſs ſpace. This can only be done by taking away the particles of ſuch other bodies as by interpoſition prevent their approach. Vitriolic acid containing water, is eaſily concentrated by evaporation; becauſe water becomes volatile by a far leſs degree of heat than that which is requiſite to raiſe this acid. But this concentration cannot be carried to its greateſt poſſible extent by ſimple evaporation; becauſe the thirſt of vitriolic acid for water increaſes with its concentration: hence it imbibes water from the air, as faſt as it evaporates: diſtillation therefore is neceſſary to complete the concentration.

V. RECTIFICATION

Is a ſecond diſtillation for the purpoſe of obtaing more pure thoſe fluids which have been already volatilized by heat. In the firſt diſtillation they carry with them a conſiderable quantity of water, from which, by a repetition of the ſame proceſs, they are diſengaged. In the rectification of ardent ſpirits, no greater degree of heat is applied than is ſufficient to raiſe the ſpirit, which being more volatile than water, requires leſs heat. Every other ſpecies of rectification is conducted on the ſame principle.

SECT. VI.

CALCINATION, REDUCTION, VITRIFICATION.

I. CALCINATION,

IN its general meaning, is the application of fire to earths, to ſaline, and to metallic ſubſtances, by which they are reduced to powder: it is properly the proceſs of burning calcareous ſtones and earths to lime. The theory of this proceſs I will firſt explain.

Cal-

Calcareous ſtones, before they are burnt, contain aerial acid and water; quicklime contains neither of theſe: therefore they were expelled by calcination. The conſequence of this difference of principles, is a very remarkable diſſimilarity in their properties. Calcareous earth is perfectly mild, inſoluble in water, and will efferveſce with acids: lime is cauſtic, ſoluble in water, and produces no efferveſcence with acids. That this difference cannot be aſcribed to the water, is very certain; the preſence and abſence of aerial acid (fixed air) therefore muſt be the ſole cauſe. Lime, expoſed to the air, imbibes, from the atmoſphere, the water and aerial acid which it had loſt by calcination, and becomes mild calcareous earth.

In proof of this hypotheſis, which ſome French and German chemiſts are yet fooliſh enough to controvert, let us try whether lime ſtone may not be calcined without fire. Suppoſe we pound a piece of chalk, or of marble, and drop it into a bottle containing marine acid diluted with water. To the mouth of this bottle we immediately tie a bladder, firſt preſſing out the air. Giving the bottle a gentle ſhake, a violent efferveſcence begins, and the bladder is gradually inflated by an elaſtic fluid which iſſues from the mouth of the bottle. As ſoon as the efferveſcence has ceaſed, we detach the bladder, having previouſly ſecured the air in it by a ſtring tied round its neck. The liquor in the bottle is a ſolution of a neutral ſalt compoſed of marine acid and lime, and not of mild calcareous earth, if we are right in our conjecture; for we ſuppoſe the fixed air, that conſtitutes the difference between theſe two ſubſtances, to be contained in the bladder.

Now, in order to examine the earth, we muſt ſeparate it from the acid, which will be immediately effected, by adding a little cauſtic alkali; for acids preferring alkalis to earths, the latter will fall to the bottom of the bottle. We now ſhake the bottle and paſs the liquor through filtring paper, and that we may determine whether this earth, thus ſeparated from the liquor, be mild calcareous earth or lime, we put it into a veſſel of water, and we find that it diſſolves in the ſame proportion as common lime, and communicates the ſame taſte to the water.

But if lime differ only from mild calcareous earth, in being deprived of its aerial acid, the reſtoration of that gas to lime, ought to regenerate mild calcareous earth. In order to try the experiment, let us fix a tube in the mouth of our bladder, and immerſing it in the lime-water, we preſs the bladder and force its contents into the water. The water becomes turbid. The fixed air re-unites with the lime, and regenerates mild calcareous earth, which, not being ſoluble in water, falls to the bottom of the veſſel. Thus our propoſition is both analytically and ſynthetically de-

demonſtrated. The quantity of fixed air expelled from lime-ſtone by calcination, is about one third of the weight.

Metallic ſubſtances are alſo calcined by fire and by acids. But here the theory differs, and the *calx* is not *lime*. All metallic ſubſtances are imagined to conſiſt of an earth peculiar to each metal, and phlogiſton. By calcination they are deprived of that phlogiſton, and conſequently nothing but the earth remains. The calcination of metals, therefore, differs from the calcination of marble, lime-ſtone, chalk, or ſhells, both in the matter expelled, and in the remaining calx; but the operation in both is the ſame. In both caſes the ſubſtance is decompoſed, and the volatile principle conſequently eſcapes.

A very extraordinary phenomenon obſerved in metallic calces is, that they are heavier than the metals before calcination. Various cauſes have been aſſigned for this ſurpriſing fact. Some philoſophers aſcribe it to the privation of phlogiſton, which, they ſay, poſſeſſes the ſingular property of counter-acting gravitation; others are of opinion, that fixed air is the cauſe, becauſe theſe calces are found to yield a conſiderable proportion of that gas; but later experiments have proved, that other elaſtic fluids may be obtained from metallic calces: ſo that the truth remains yet veiled in obſcurity.

II. REDUCTION,

In chemiſtry, implies the reſtoration of metallic calces to their original ſtate of metals. This is effected by melting them in a crucible with charcoal, fat, or any other matter containing phlogiſton. The theory of this proceſs is eaſily underſtood, when we recollect that they became calces in conſequence of being deprived of their phlogiſton. But this is to be underſtood of thoſe metallic ſubſtances only that are calcinable by fire. The perfect metals, upon which fire has no effect, and which can only be deprived of their phlogiſton by ſolution in acids, may be reduced by heat alone, without the addition of any phlogiſtic matter. To account for this ſingularity, we muſt ſuppoſe, either that the calces of perfect metals retain a portion of phlogiſton ſufficient for their reduction, or that they attract phlogiſton from the fire.

III. VITRIFICATION

Is the converſion of earths, or metallic calces, into glaſs, either by means of heat alone, or with the addition of other matters which poſſeſs the property of producing this effect.

The perfect metals are incapable of calcination by fire, and conſequently cannot be vitrified. The imperfect metals are vitrifiable by a degree of of heat ſufficient to expel a certain proportion of their phlogiſton. Of theſe, lead is moſt eaſily converted into glaſs. The ſemi-metals are alſo readily vitrifiable by heat alone.

The unmetallic earths are incapable of fuſion or vitrification, when ſeparately and without addition, expoſed to the greateſt heat; mixed, they act as fluxes to each other. That kind of earth commonly called *vitrifiable*, and which I have called *flint*, is generally uſed as the baſis in making glaſs for various uſeful purpoſes, This earth may be vitrified by fuſion with calx of lead, or of tin, or of antimony, or biſmuth, or arſenic: but the flux commonly employed is barilla or kelp, which are the aſhes of certain marine plants, that have been fuſed in burning. Borax is alſo uſed for the ſame purpoſe. The matter, which principally acts as a flux to the flint, is the foſſil alkali contained in theſe ſubſtances. Vegetable fixed alkali has the ſame effect.

As to the theory of vitrification, that which is produced on metallic calces by heat alone, is very difficult to account for; that which is produced by fuſion of powdered flint, or ſand, with alkaline ſalts, may be more eaſily conceived. Tranſparent quartz, or mountain cryſtal, may be conſidered as a perfect natural glaſs, of which the glaſs formed by art is an imitation. Mountain cryſtal conſiſts almoſt entirely of pure flint. The minute particles of the fineſt white ſand are tranſparent cryſtals. Theſe minute cryſtals diſſolved, in fuſion, by alkaline ſalts, unite into one compact maſs, which, analagous to other ſolutions, retains its tranſparency, but differing a little in its properties from mountain cryſtal in conſequence of its combination with fixed alkali. When an over proportion of alkali is uſed, the whole maſs aſſumes, ſo entirely, the nature of an alkaline ſalt, as to be ſoluble in water.

SECT. VII.

SMELTING, REFINING, PARTING, PURIFICATION.

I. SMELTING,

OR melting, or fuſing of ores, is done for the purpoſe of ſeparating the metals they contain from the ſulphur and arſenic with which they are mineralized, and alſo from other heterogeneous matters. If the ore be known to be heavier than the extraneous matters with which it is combined, they may be ſeparated by firſt pounding, and then waſhing with water, in which the ore will neceſſarily ſubſide. The greateſt part of the ſulphur and arſenic being both volatile, may be diſ-

diſſipated by burning or *roaſting*, as it is termed, before ſmelting.

In order to facilitate the fuſion of ores, it is frequently neceſſary to add ſome other ſubſtance by way of flux, the choice of which depends on the nature of the ore. Calcareous earths, alkaline ſalts, or fuſible ſpars called *fluors*, are generally uſed with this intention. They act upon the ore by fuſing the earth it contains: if it be clay, calcareous earth will fuſe it; alkaline ſalts diſſolve all earths; fuſible ſpars, called *fluors*, promote the fuſion of calcareous and argillaceous earths. The entire maſs being thus rendered fluid, the metallic parts unite, and, becauſe they are heavier than the reſt, fall to the bottom: from this regulus, as it is called, the lighter matter that forms a diſtinct ſcoria, or droſs, on the ſurface, is eaſily ſeparated.

Some ores contain only metallic earth not combined with phlogiſton; they conſequently, without the addition of ſome matter containing that principle, would, in ſmelting, produce glaſs inſtead of metal. In fluxing theſe ores, charcoal is commonly added, to ſupply the neceſſary phlogiſton.

Some ores contain two, three, or more metallic ſubſtances. But the ſimple operation of ſmelting, as above deſcribed, does nothing more than divide metal from lighter matter. This would anſwer very little purpoſe, if the metals could not be ſeparated from each other.

If, in ſmelting, to an ore containing gold and ſilver, we add a quantity of lead, part of it will combine with the perfect metals, which, in conſequence of a ſuperior attraction, relinquiſh the earths and other metallic ſubſtances. The remainder of the lead is converted into litharge, which poſſeſſes the power of vitrifying all imperfect metals and earths, with which it forms a ſcoria that ſwims on the ſurface.

II. REFINING

Is the proceſs of ſeparating the perfect metals from other metalic ſubſtances, by what is called cupellation: that is, by fuſing the alloyed metal, mixt with a quantity of lead, in an earthen veſſel, called a *cupel*, in a reverberatory furnace. The perfect metals ſuſtain the heat without alteration, whilſt the lead, deprived of its phlogiſton, is vitrified, and is abſorbed by the cupel, or floats, in the form of litharge.

III. PARTING

Is the operation of ſeparating gold from ſilver. By the laſt proceſs, the two perfect metals were ſeparated from the lead. We are now to conſider by what means they may be divided from each other. The common method is, firſt to granulate the

the mafs by melting, and then pouring it from the crucible into cold water in agitation. Thefe grains are put into a glafs veffel, and fomewhat more than their own weight of pure nitrous acid poured on them. The *parting-glafs* is then placed in a fand or water-bath, and gradually heated. The gold quits the filver and falls to the bottom; becaufe nitrous acid diffolves filver and not gold. By diftilling the nitrous acid in clofe veffels, both that and the filver are recovered: or if it be put into a copper veffel, the acid will feize the copper, and let the filver fall.

This *parting* by nitrous acid is ufed only when the proportion of filver is to that of gold, at leaft, as three to one; becaufe a greater proportion of gold prevents the folution. When that is the cafe, other methods of parting are employed, one of which is that called parting by *cementation*. The metal, beaten into thin plates, is put into a crucible and interlaid with a powder compofed of brick-duft, calcined green vitriol, and nitre or common falt. The crucible is then put into a furnace, and kept in a moderate heat for twelve hours, or longer. The acid of the vitriol, from its fuperior attraction to the alkali, fets free the nitrous or marine acid, which, in this ftate of vapour, diffolves the filver. But this method of parting is incomplete, as the acid vapour acts only on the furface of the plates.

A more

A more effectual method of ſeparating ſilver from a maſs of gold, is to melt it with antimony, the ſulphur of which readily quits its regulus to unite with the ſilver, forming a ſcoria on the ſurface, whilſt the gold, combined with the regulus of antimony, ſubſides. This regulus, being volatile in a ſufficient heat, is eaſily diſſipated in fume.

Gold, thus obtained, is generally ſuppoſed to be perfectly pure; nevertheleſs, a very accurate inveſtigation will diſcover a ſmall proportion of ſilver. It may be entirely extracted by ſolution in *aqua regia*, and precipitation with green vitriol.

IV. PURIFICATION.

This term is particularly applied to the ſeparation of gold and ſilver from the baſer metals: of gold, by means of antimony, as deſcribed in the laſt article; and of ſilver, by detonation with nitre, the theory of which proceſs is eaſily underſtood. The ſilver, in ſmall grains, mixed with about one fourth of its weight of nitre, a little potaſh and powdered glaſs, is put into a crucible and melted in a furnace. Nitre, we know, poſſeſſes the power of calcining the baſer metals, in a proper degree of heat; its acid inflames or detonates (as it is improperly called) with their phlogiſton, and both eſcape: therefore there remains

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in the crucible, the alkali of the nitre, and the calces of the imperfect metals, with which the silver was alloyed: these, with the potash and glass, form a scoria on the surface of the purified silver. All metals, in their metallic state, are incapable of combination with metallic calces; these, therefore, necessarily quit the silver the moment they are deprived of their phlogiston.

CHAP. XV.

The THEORY of ASSAYING.

ASSAYING, by chemists called the *docimastic art*, is, in plain English, the trial of a small portion of an ore, for the purpose of ascertaining what metal or metals it contains, and in what quantity; thereby to determine the profit that may be expected from working the mine in which it is found. The same art is also employed to determine the quantity of pure gold or silver in the ingots of these metals. A perfect recollection of the contents of the preceding chapter, and of the peculiar attractions of metallic substances, will considerably facilitate the theory of assaying.

In order to determine the quantity of a metal contained in a large maſs of matter, by examining a ſmall part, it is neceſſary that ſmall weights ſhould repreſent great ones: for example, a grain, or a dram, or an ounce, may ſtand for a pound, accordingly as the ore, from the ſuppoſed quantity of its contents, may require a larger or leſs ſpecimen to be aſſayed. If, in aſſaying an ore of ſilver, a grain is, by ſuppoſition, a pound, it is evident that the quantity of pure ſilver extracted from a hundred grains will indicate the quantity that a hundred pounds of the ſame ore will yield, by the common rule of proportion.

I. GOLD.

All ores of gold contain the precious metal either native, that is, in a metallic form, or mineralized by ſulphur by means of iron. For the uſual method of aſſaying theſe ores, conſult the articles *ſmelting*, *refining*, &c. in the laſt ſection of the preceding chapter. Native gold may alſo be aſſayed by ſolution in *aqua regia*, and precipitation with green vitriol. The phlogiſton of the iron which is the baſis of this ſalt, uniting with the calx of gold, reduces it, and it falls to the bottom in a metallic ſtate. If the native gold contain ſilver, that metal will combine with the marine acid, and alſo precipitate in the form of a metallic ſalt called *luna cornea*. If there be any

copper

copper mixed with the gold, it will remain diſſolved in the menſtruum, and may be collected by emerſing a plate of iron.

Ores of gold, in which the pure metal is intimately mixed with ſtony matter, may be aſſayed by pounding, waſhing, and boiling in *aqua regia*, and then precipitating the clear ſolution with martial vitriol.

Ores of gold, in which it is mineralized by ſulphur by means of iron, may be aſſayed by digeſtion in a large proportion of diluted hot nitrous acid gradually applied. The acid diſſolving the iron only, breaks the union: the ſulphur floats in the menſtruum, and the gold falls to the bottom in very minute particles, which may be eaſily waſhed from the inſoluble matter that ſubſided along with it.

The purity or value of an ingot of gold may be accurately determined by cupelling a few grains of it (ſix for example) with eighteen grains of pure ſilver, and ſixty of lead. The pure gold and ſilver unite in a button, the lead, which is entirely abſorbed by the cupel, having vitrified and carried along with it all the alloy of baſe metal, the quantity of which is determined by weighing the button. The weight of the pure gold, ſeparated from the ſilver by ſolution in nitrous acid (ſee *parting*, in the laſt ſection of the laſt chapter) confirms the eſtimate.

II. SILVER.

II. SILVER.

The general principles of aſſay for ores of ſilver and gold, depending chiefly on their indeſtructibility by fire, are preciſely the ſame. They both combine with lead in fuſion, from which they are afterwards ſeparated by cupellation.

Ingots of ſilver, and native ſilver, may alſo be aſſayed by ſolution in nitrous acid. If they contain gold, or regulus of antimony, theſe will remain undiſſolved. If copper be the alloy, it may be precipitated from the ſolution by a clean plate of iron.

The ores of ſilver, in which it is mineralized by ſulphur alone, or with arſenic, and combined with other metallic ſubſtances, may alſo be aſſayed, in the moiſt way, by ſolution in nitrous acid, and precipitation with the marine, in combination with which the ſilver will form a *luna cornea* and precipitate.

III. PLATINA,

Which, becauſe it is found to be indeſtructible by fire, is ranked among the perfect metals, is ſoluble in *aqua regia*, and may be thence precipitated by ſal-ammoniac; a property by which it is ſufficiently diſtinguiſhed from every other metallic ſubſtance. From a knowledge of theſe proper-

ties,

ties, any mineral ſuppoſed to contain platina may be eaſily aſſayed.

IV. MERCURY

Is found in mines, either in its natural fluid form, diffuſed in clay or ſtones; or, mineralized by ſulphur, in the form of a red or reddiſh powder called *native cinnabar*. The firſt of theſe ores is eaſily aſſayed by diſtillation, without the addition of any other matter; for we know that the mercury will riſe with a degree of heat that will have no effect on its matrix. The cinnabar may be analyſed alſo by diſtillation, but with the addition of ſome other ſubſtance which ſulphur prefers to mercury. Now we learn from our table of attractions, that any other metal, or fixed alkali will anſwer the purpoſe: iron filings are generally uſed.

Cinnabar may be decompoſed by boiling in *aqua regia*, and precipitation by zinc. The *aqua regia* ſuſpends the ſulphur and diſſolves the mercury, which is precipitated by zinc, becauſe all acids prefer zinc to every other metal. The *Maître Apothicaire* of Paris, M. Baumè, aſſures us that he has decompoſed cinnabar in the moiſt way, by means of fixed alkali. This is certainly one of the many experiments in which the *Maître Apothicaire* deceived himſelf.

Mercury is said to have been lately found mineralized by acids; but such ores are so rare as to merit little attention.

V. LEAD.

The most common ore of this metal is called *Galena*. It consists of lead mineralized by sulphur, with a small proportion of silver and a little iron. The usual method of assaying this ore is, after roasting, to melt it with black flux, borax, iron filings, and decrepitated common salt. By previous roasting, most of the sulphur is evaporated, and the remainder combines with the iron in fusion. The black flux and borax act merely as fluxes to the ore, and the salt is supposed not only to prevent the too violent ebullition of the fluid, but to facilitate the separation of the scoria from the metal. The proportion of silver, combined with the lead, may be ascertained by cupellation.

A considerable part of the above operation is unnecessary. The sole intention being to separate the sulphur from the metallic part, it is evident that melting the ore with iron filings alone would answer the purpose.

This ore may be assayed, in the moist way, by boiling in diluted nitrous acid, which will dissolve the lead and silver only. These may be precipitated by the mineral fixed alkali, for which the acid

acid will relinquiſh the metals. If this precipitate be digeſted in cauſtic volatile alkali, the calx of ſilver only will be diſſolved, and the calx of lead will ſubſide. The theory of this proceſs requires no explanation.

VI. COPPER

Is generally found mineralized by ſulphur and arſenic, and frequently mixed with iron. The uſual method of aſſaying the ore, is, to diſſipate the ſulphur and arſenic by long calcination, and then to fuſe the calx with black flux, pitch, and ſea-ſalt. Theſe matters reduce the metal by ſupplying it with phlogiſton, and form a ſcoria that floats on its ſurface.

The ores of copper may be aſſayed in the moiſt way by ſolution in nitrous acid, and precipitation with a clean bar of iron. The acid takes the copper from the ſulphur; the calx of iron quits its phlogiſton to combine with the acid, which prefers the calx of iron to that of copper; and the phlogiſton of the iron, uniting with the calx of copper, reſtores it to its original metallic form. If the ore contain any iron, it will evidently remain diſſolved in the acid.

VII. IRON.

The ores of iron are various both in their appearance and combination. They generally contain the metal in what is called a calciform ftate; that is, the earth of iron without its phlogifton. Sometimes it is found mineralized by fulphur and arfenic.

To affay thefe ores in the dry way, fuch additions are required as will promote their fufion, and, at the fame time, fupply the calx with phlogifton fufficient to reduce it to a metallic ftate. After repeated calcination, in order to diffipate the fulphur and arfenic, the ore is mixed with black flax, charcoal, and fea-falt, and melted in a very hot furnace. Later experiments have difcovered that pounded glafs, calcined borax, and charcoal, anfwer the purpofe better. The metal thus revived, and feparated from all extraneous matter, is found collected at the bottom of the crucible.

Iron ores may be affayed in the moift way, by folution in marine acid and precipitation with Pruffian alkali. In this procefs, the precipitation is effected by a double attraction. The alkali of the lixivium unites with the acid, and the phlogifton with the metallic calx. To have a clear conception of this operation, we muft recollect, that the Pruffian alkali is a lixivium or folution of fixed alkali combined with phlogifton; and, that the metallic folution into which it is poured, is iron, and probably other metals, diffolved in marine acid. Now we know that acids prefer alkalis to metals; confequently that the alkali

alone

alone were ſufficient to precipitate the iron, &c. but the ſingle attraction between the acid and alkali, is not ſufficient to ſeparate the latter from the phlogiſton, without the attraction between the phlogiſton and the calx of iron, which, acting at the ſame time, produces a double decompoſition and two new compounds, viz. digeſtive ſalt, and Pruſſian blue.

But this hypotheſis, though very ingenious, is not quite ſatisfactory. If the calx of iron were, in precipitation, combined with phlogiſton only, why is the precipitate Pruſſian blue, and not common iron? From the experiments of the incomparable *Scheele*, it is highly probable that this colouring matter conſiſts of aerial acid, volatile alkali, and phlogiſton; which, therefore, combined with iron, form Pruſſian blue. Now, as Pruſſian blue is known to contain about one-ſixth of its weight of iron, the quantity of this metal that the ore, thus aſſayed, will produce, is eaſily determined.

If the iron be ſuppoſed to contain manganeſe, which, if the ſolution of the ore in the marine acid was red, is certainly the caſe; by digeſting the Pruſſian blue in pure water, the Pruſſian manganeſe will diſſolve.

If the iron be ſuppoſed to contain much zinc, the Pruſſian blue muſt be calcined, and then thrown into dephlogiſticated nitrous acid, which will diſſolve the calx of zinc only; becauſe acids prefer that metal to iron, which remains undissolved, because zinc precipitates iron, consequently prevents its solution.

VIII. TIN

Hath been supposed to be generally mineralized by arsenic. This is doubtless a mistake. The arsenic in tin ores proceeds from the matrix and not from the tin *. In most of the ores of tin, the metal is in a calciform state, involved in particles of flint.

The common method of assaying these ores is, after twice roasting, to fuse them with black flux, or calcined borax and pitch. These fluxes reduce the metal by giving phlogiston to the calx, as in other operations of the same nature.

Ores of tin are with difficulty assayed in the humid way, because the calx being so entirely dephlogisticated, is but partially soluble in any of the acids. Bergman, however, has generally succeeded by means of the united power of vitriolic and marine acid, and precipitation with mineral alkali. 131 grains of this precipitate is equal to 100 grains of tin.

IX. BISMUTH

Is more frequently found native than any other metallic substance. If it be alloyed with silver or any other metal, they may be easily separated from

* Kerwan's Min. p. 294.

from it by ſolution in nitrous acid. By adding water to this ſolution, the biſmuth alone will fall to the bottom of the veſſel.

The ores of biſmuth generally contain it in a calcined ſtate, mixed with the ores of other metals, or mineralized by ſulphur. As this ſemi-metal requires no great degree of heat to melt it, it may ſometimes be reduced by fuſion without addition; but the common method is, to fuſe the ore with black flux and pitch, or with borax and charcoal.

The ores of biſmuth, as well as the native metal, may be aſſayed by ſolution in nitrous acid, and precipitation with water, or by means of iron or copper, to which the nitrous acid has a ſuperior attraction. The calx of biſmuth is precipitated by water, becauſe it is not ſoluble in a weak acid. 113 grains of the calx precipitated from nitrous acid, will yield, when fluxed, 100 grains of metal.

X. NICKEL.

The ore of this ſemi-metal, called *kupfer-nickel*, is very difficultly analized. In this ore the nickel is intimately combined with ſulphur, arſenic, cobalt, and iron, from which it hath hitherto been found impoſſible to ſeparate it entirely. By the common proceſs of roaſting and fuſion by means of black flux and ſea-ſalt, a regulus is obtained; but this metallic ſubſtance is ſtill a mixture of nickel, sulphur, arsenic, and cobalt. To separate these by chemical means is very laborious, and, after all, it seems impossible to get entirely rid of the iron. The humid way is equally unsuccessful.

XI. ARSENIC.

The proper ores of arsenic contain this semimetal either in a reguline, or calciform state, or mineralized by sulphur. Being very volatile, it is easily obtained in a metallic form by sublimation in close vessels. In the moist way, when mineralized by sulphur, marine acid, with the gradual addition of a little nitrous acid, will dissolve the arsenic and not the sulphur. Zinc will afterwards precipitate the arsenic from the filtered solution. The acid, preferring the calx of zinc, disengages its phlogiston, which, uniting with the calx of arsenic, reduces and precipitates the semimetal.

XII. COBALT

Is generally mineralized by sulphur and arsenic, and being itself fixed in the fire, is easily separated from these by calcination. It may then be reduced by fusion with any alkaline flux. In the moist way, the ores of cobalt may be dissolved in nitrous acid, and precipitated by fixed alkali, because its attraction to acids is superior to that of the

the metal. If the ore be supposed to contain iron, the solution may be evaporated to dryness, and the residuum dissolved in vinegar, which will take up the cobalt only. Fixed alkali added to this solution, will throw down a pure calx of cobalt, 160 grains of which will produce upon reduction 100 grains of cobalt.

XIII. ZINC

Is generally found, either calciform or mineralized by sulphur, by means of iron. This semimetal being easily volatilized by heat, the ores which contain it can only be assayed, in the dry way, by distillation in close vessels; but, as it readily unites with copper, if the powdered ore be melted in a covered crucible with thin plates of that metal and charcoal, the zinc, uniting with the copper, will form brass, the weight of which, deducting that of the copper employed, will give the quantity of zinc contained in the ore.

In the moist way, the ores of zinc may be assayed by solution in vitriolic acid, and distillation to dryness. The residuum will probably consist of white vitriol (that is, vitriol of zinc) vitriol of iron, flint, and clay; all which, except the flint, are soluble in hot water. Now, if to this solution in hot water, we add caustic volatile alkali, all but the zinc will precipitate, because the zinc alone is soluble by vitriolic ammoniac, from which

which it may be precipitated by the Pruſſian alkali.

XIV. ANTIMONY

Is generally found mineralized by ſulphur. It may be ſeparated from the ſtony matter, by melting in a crucible with a hole in the bottom, put into another crucible ſunk in aſhes, that it may remain cool whilſt the upper one is ſurrounded with charcoal, and heated ſo as to melt the antimony which runs through the hole into the lower crucible. It is then roaſted to diſpel the ſulphur, and afterwards fluxed with black flux The theory of theſe operations requires no explanation.

XV. MANGANESE.

The ores of this ſemi-metal generally accompany the ores of iron. They are of various colours, but may always be diſcovered by their property of giving a garnet colour to glaſs of borax when melted by means of a blow-pipe. The metal in theſe ores is always in a calciform ſtate. They are inſoluble in acids, unleſs ſome phlogiſtic matter be added to the menſtruum. Into the nitrous acid uſed for this purpoſe, therefore, we drop a bit of ſugar, and, after digeſtion in a proper degree of heat, precipitate with fixed alkali.

END OF THE FIRST PART.

PART II.

FIRST LINES OF THE PRACTICE OF CHEMISTRY.

CHAP. I.

LABORATORY.

A Laboratory, for the purpose of philosophical chemistry, is an object of less expence and magnitude than one would suppose, from the multifarious descriptions of authors. It is true, a complete laboratory, on a large scale, for the double purpose of experiment and trade, is a kind of *encyclopædia*, containing, beside the peculiar utensils and instruments of chemistry, a variety of implements special to other arts, and many that are common to all. But super-circumstantial descriptions tire and disgust the reader; because he immediately perceives that many of the objects are either too obvious or too insignificant to require description. There can be no ne-

necessity for telling a young chemist that, in constructing his laboratory, he must not forget a nail to hang his hat on.

SECT. II.

PNEUMATICAL APPARATUS.

THE pneumatic engine, called an *air-pump*, is of indispensible utility in a variety of experiments inseparably connected with chemistry. The original invention of this instrument is ascribed to Otto de Guerick, consul of Magdeburg. It was first made, in this kingdom, by the direction of our countryman Mr. Boyle, who is generally considered as the inventor, and not without reason, as he appears to have learnt nothing more from the German than a report of the effect of the new invention. Mr. Boyle's air-pump was a more perfect instrument than that of de Guerick, and it has been lately considerably improved by Mr. Smeaton, and others.

Pneumatic chemistry, which, for some time past, hath engaged the attention of many of the most distinguished philosophers of the present age, apparently originated in the *Chemico statical Experiments* of Dr. Hales. But this indefatigable philosopher's experiments went no farther than to deter-

determine the quantity of air that might be extricated from animal and vegetable matter by chemical means, without any ſuſpicion that the air, thus obtained, differed from that of the atmoſphere. But, though his reſearches were thus limited, the idea of confining air by means of water, a circumſtance of ſo much importance to future chemiſts, ſeems to have been in a great meaſure his own invention; alſo that of meaſuring the quantity of air extricated from various matters in diſtillation, fermentation, &c. Dr. Hales' apparatus was extremely ſimple, conſiſting principally of a ſmall retort, a bolthead and a glaſs cylinder ſtanding in a veſſel of water. The air generated in the proceſs diſplaced the water, and the ſpace occupied by this air determined its quantity. If he wanted to aſcertain the quantity of air conſumed by a burning candle or living animal, he placed them on a pedeſtal, under a glaſs cylinder ſtanding in water, which water he raiſed to a certain height, by drawing out the air by means of a ſyphon. As the air diminiſhed during the experiment, the water neceſſarily roſe.

Dr. Hales determined the quantity of air produced or loſt in his experiments, by marking, with a waxed thread, the point to which the water in the cylinder roſe or fell; and, when the experiment was over, by filling the ſpace which the air had occupied, with water poured from a veſ-

ſel,

fel, which, with its contents, he had previoufly weighed. Having now filled the fpace in the cylinder, he weighed the veffel of water a fecond time, and the deficiency gave the weight of water required to fill the fpace occupied by the air. Thus he fixed a ftandard, by which the quantity of air generated or diminifhed by different means, might be accurately compared and determined.

When his fubject promifed no great quantity of air, the Doctor's apparatus confifted of a common jelly-glafs, into which he put the fermenting matter; and a fmall-beer tumbler, which, covering the jelly-glafs, he placed in a bafon of water. He then fucked out part of the air thro' a cyphon, and left the matter to ferment. The air thus produced by fermentation, he found to be permanently elaftic. This fpecies of air was afterwards diftinguifhed from other elaftic fluids by the name of *fixed air*, by Dr. Black, of Edinburgh, who difcovered it to be a conftituent principle of calcareous earths and alkaline falts, and that they become cauftic in confequence of being deprived of this principle by burning, or by folution in acids. But in juftice to the memory of Dr. Hales, we muft remember, that the procefs for confining and meafuring fixed air expelled from calcareous earth by acid folutions, was originally his; nor muft we forget that this inquifitive philofopher alfo difcovered that lime, with

with acids, produced no fixed air. This fact naturally ſuggeſted a ſuppoſition that *cauſtic* lime differed from *mild* calcareous earth only in the want of fixed air.

We learn alſo from the experiments of Dr. Hales, that he produced nitrous, inflammable, and phlogiſticated airs, though he did not diſcover their nature and properties. He likewiſe proved the diminution of air by a burning candle, and by living animals; and, I believe, he was the inventor of the very ingenious contrivance of ſetting fire to inflammable bodies confined by water under a glaſs veſſel, by means of a burning-lens. He likewiſe diſcovered the abſorption, as he called it, of atmoſpheric air by nitrous gas; that is the diminution of bulk when theſe fluids are mixed: an experiment by which it hath been ſince imagined the comparative ſalubrity of the air might be determined.

When Dr. Hales wanted to draw out the air from his inverted cylinder, in order to make the water riſe in it, he commonly, as I have ſaid before, ſucked it through a ſyphon; but when the air was of a noxious kind, he fixed to the cyphon, the noſe of a large bellows, whoſe wide ſucking orifice was cloſed up. By now enlarging the bellows, he drew out of the glaſs cylinder as much air as he thought proper.

Doctor

Doctor Macbride, of Dublin, above twenty years ago, publiſhed *Experimental Eſſays*, to prove the power of fixed air to counteract putrifaction. In this volume he exhibits a ſimple apparatus (the original contrivance of Dr. Black) by which the fixed air, from any effervefcing mixture, may be eaſily communicated to a cauſtic fluid, which will receive it with avidity. This apparatus conſiſts of two glaſs bottles or phials, with the oppoſite ends of a bent glaſs tube fixed in the mouth of each, in ſuch a manner as to be perfectly air-tight. In the ſhoulder of the bottle deſigned for the effervefcing mixture, is drilled a ſmall hole, through which, by means of a glaſs funnel, the vitriolic, or other acid, is poured upon the alkali or calcareous earth previouſly put into the bottle.

In Dr. Macbride's firſt contrivance, the ends of the curved tube were clumſily ſecured by luting. He afterwards fixed a metal tube in the centre of a cover that ſcrewed on to the top of one phial, and he ſecured the oppoſite end of the tube in the mouth of the other bottle, by means of leather wrapped round it. To this apparatus Mr. Dean, a friend of the Doctor's, as a final improvement, added an air valve, which, being fixed in the neck of the recipient, prevented the return of the fixed air. If he had fitted the two ends of his glaſs tube into the necks of the phials by grind-

ing,

ing, both his luting and his metal tube and cover would have been unneceſſary. This ſimple apparatus is very uſeful. See Plate VII. fig. 1.

The celebrated Dr. Prieſtley, with a genius for philoſophical experiments peculiar to himſelf, hath demonſtrated the exiſtence of ſeveral ſpecies of elaſtic fluids: he hath diſcovered the means by which they may be procured; aſcertained their properties, and taught us the art of retaining, transfuſing, transferring, and mixing them, with the ſame facility as if they were viſible and palpable liquids. The apparatus for theſe purpoſes is,

1. A wooden trough, or pail, about two feet in length, one foot and half wide, and eleven inches deep. In this tub, about two inches below the top, is fixed a ſhelf, an inch and a half thick, and half the width of the veſſel, with holes three inches aſunder near the edge, a quarter of an inch in diameter in the upper ſurface, and in the under ſurface hollowed out in the ſhape of funnels. This veſſel is filled with water, ſo that the ſhelf may be about half an inch below the ſurface.

2. Cylindrical glaſs jars of various dimenſions, from four to ten inches in height, and from two to three inches wide.

3. Phials of flint glaſs, of various ſizes, with round and thin bottoms; their mouths exactly fitted, by grinding, to glaſs tubes bent in the form of an S.

4. A ſmall glaſs funnel.

With this apparatus (Plate VII. fig. 2.) the uſe of it being well underſtood, many very curious experiments may be performed. The explanation of a few general principles will open an extenſive field of enquiry to an inventive genius, who will gradually be led by analogy to multiply his experiments, and enlarge his apparatus.

We know that different kinds of air, or gas, may be procured from earths and metallic calces by means of acids, or by heat alone. If, in order to determine the ſpecies of gas, or for any other purpoſe, I wiſh to collect a quantity of this gas, and confine it by water in the upper part of a glaſs cylinder, I plunge the cylinder ſideways into the tub of water. When thus entirely immerſed, I give it a perpendicular direction with the open end downwards, and, in that poſition, place it on the ſhelf, projecting ſo far over the edge as to admit the end of a glaſs tube. The cylinder thus placed is completely filled with water. The ingredients that are to produce the gas being put into one of my round-bottomed phials, I fix the ground-end of a bent tube into its mouth, and introducing the oppoſite end under the edge of the cylinder, leave the phial ſuſpended over the ſide of the tub.

If, for example, I want *fixed air*, the contents of the phial being chalk and vitriolic acid, or any other calcareous earth with any other acid, with-

out

out the aſſiſtance of heat, I ſhall immediately perceive the aerial fluid riſe in bubbles through the water, and, collecting in the upper part of the jar, diſplace a quantity of water equal to its own bulk: for air being lighter than water muſt neceſſarily occupy the upper part of the veſſel.

If the contents of the phial be ſuch as will produce pure air, inflammable, or any other kind of air, by the application of heat, I apply the flame of a lamp, or candle, or burning charcoal, gradually to the bottom of the phial, and immediately I ſhall ſee the air bubbling through the water, which it will, by degrees, force down into the tub, and fill the whole jar or cylinder. The jar thus filled, I ſlide to the back part of the ſhelf, where it will remain without any alteration in the quantity or quality of its contents, unleſs the air be in any degree ſoluble in water. The cylinder being thus removed, I have room for others on the edge of the ſhelf. Two or more of theſe operations may proceed at the ſame time with tubes of different lengths.

If I know, or ſuſpect, that different kinds of air will ariſe at different periods of the proceſs, it is neceſſary to change the jars frequently, and reſerve them for future examination. They may be eaſily removed from the tub, and placed in any other part of the room, by ſliding the cylinder with one hand into a breakfaſt ſaucer, held under the ſurface of the water, with the other. In a multiplicity of theſe glaſs veſſels nearly of the ſame ſize and ſhape, it is difficult to avoid miſtaking one for another: to prevent this, it is uſual to diſtinguiſh them by paper labels; but ſucceſſive numbers, 1, 2, 3, &c. engraved on the jars, is a much better method. By uſing the loweſt number firſt, and invariably appropriating the ſame number to the ſame kind of air, where the ſpecies is certain, miſtakes may be eaſily prevented; and, where the ſpecies is doubtful, the loweſt number will always indicate that which was firſt produced; and the higheſt, that which cloſed the proceſs. The different kinds of air may be thus numbered—No. 1. Pure air; 2. aerial acid; 3. inflammable air; 4. phlogiſticated air; 5. nitrous air; 6. vitriolic acid air; 7. marine-acid air; 8. nitrous-acid air; 9. fluor-acid air; 10. alkaline air; 11. hepatic air.

If I have filled ſeveral jars with one ſpecies of air, which I want to collect in one larger veſſel, I plunge this veſſel ſideways into the tub, and when thus filled with water, ſet it on the ſhelf with the open end downwards. If the jars, containing the air, ſtand upon the ſhelf, I take them in ſucceſſion; and ſliding the jar off the ſhelf, I bring its edge below that of the larger cylinder, which projects beyond the verge of the ſhelf. I then gradually turn horizontally the jar, which I hold in my hand under water, and the air which it contains being forced

forced out by the gravitation of the denſer water, riſes into the upper part of the receiver, forcing down an equal bulk of water into the tub. I then take the other jars and empty them in the ſame manner.

If any ſpecies of air which I want to transfer be contained in a jar ſtanding in a ſaucer, I ſink the ſaucer in the tub, and, bringing the edge of the jar beneath that of the receiver, proceed to tranſfer the air in the manner above deſcribed.

If I want to transfer a particular ſpecies of air from a jar on the ſhelf into a phial, in which it may be confined by a cork for the purpoſe of tranſportation; I firſt fill the phial with water by plunging it into the ciſtern. I then place it on the ſhelf, with its mouth over one of the holes, through which I introduce the glaſs funnel, and ſliding the jar, which contains the gas, off the ſhelf, I bring its edge under that of the funnel, into which I pour the elaſtic fluid, by gradually lowering the cloſed end of the jar. If the holes in the ſhelf be properly excavated, the glaſs funnel is generally unneceſſary. The phial being thus filled with air, I ſlide it off the ſhelf, and cork it whilſt under water, and in a perpendicular poſition.

Dr. Prieſtley diſcovered, that in mixing atmoſpheric air with nitrous gas, a diminution of bulk took place in proportion to the purity of the former. For the purpoſe of trying this experiment,

ment, and alſo for that of meaſuring various kinds of air, it is neceſſary to have your jars graduated with a diamond, each diviſion containing one ounce weight of water, and theſe ounces, which are conſidered as ounce meaſures of air, ſubdivided into ten equal parts.

Theſe jars, thus graduated, are ſufficient for experiments that do not require any great degree of accuracy. But if you wiſh to determine the diminution of atmoſpheric and nitrous air, with greater preciſion, you muſt be provided with a glaſs tube about three feet in length, and one third of an inch wide, graduated into meaſures, tenths, and hundred parts of a meaſure, beginning from the cloſe end of the tube. In this tube, previouſly filled with water, and properly ſupported in the tub, the two airs may be eaſily mixed by means of the glaſs funnel: or they may be mixed in a jar, and afterwards transferred to the tube for more accurate admeaſurement. But this accuracy is of leſs importance than was firſt imagined. The diminution of air in this experiment, is an imperfect criterion of the ſalubrity of the atmoſphere. Inſtruments of various conſtruction, called *eudiometers*, have been lately invented for the purpoſe of thus determining the purity of the air, by its diminution when mixed with nitrous air in equal proportions. They are ingenious contrivances, but of very little uſe, as a nara narrow graduated glaſs jar, or tube, will anſwer every purpoſe, and is preferable on account of its ſimplicity. We muſt remember, that the purer the air the greater the diminution; and that, in trying the purity, or (according to Dr. Prieſtley) the degree of dephlogiſtication, the two airs are mixed in equal proportions, viz. one ounce meaſure of each.

Modern chemiſts indicate the degrees of diminution of air by decimal numbers thus 1, 6; 1, 46; 0, 65; 0, 9. &c. To perſons unacquainted with decimal fractions, theſe numbers are unintelligible. But they are eaſily comprehended, if we apply them to the meaſuring tube, each ounce meaſure of which is divided into ten equal parts, and each of theſe ſubdivided alſo into ten equal parts; ſo that the whole meaſure contains 100 parts. Now the two meaſures of air, if no diminution were to happen, would occupy 20 tenths, or 200 hundredths. But if, after they are mixed, they fill only one meaſure and ſix tenths of the ſecond meaſure, I write it thus, 1, 6.—If they occupy one meaſure, four tenths and ſix of the ſubdiviſions of the fifth tenth, I write it thus, 1, 46: that is, one meaſure and 46 hundred parts. If the water riſes quite above the ſecond meaſure, and up to 65 in the firſt meaſure, I write it in this manner, 0, 65. Thus air is ſaid to be of the ſtandard 1, 2; 1, 6, &c.

P 4 Some

Some kinds of air are diſſolved or abſorbed by water; they muſt therefore be confined by quickſilver inſtead of water. A ſmall wooden ciſtern, with the bottom made cylindrical, may be conveniently uſed for this purpoſe, with jars, &c. on a leſs ſcale.

If I wiſh to extract a gas from, or convert any ſolid ſubſtance into gas, by means of heat, with a poſitive excluſion of atmoſpheric air, I put the ſubſtance into one of the phials with a thin round bottom. I then fill it with quickſilver, and invert it in a veſſel containing a quantity of the ſame fluid. The ſubſtance on which I am to operate being lighter than the mercury, will remain preſſed againſt the inverted bottom of the phial. To this ſubſtance I apply the focus of a burning-glaſs. The air thus produced by heat, will, by its elaſticity, preſs out the quickſilver and occupy the upper part of the inverted phial.

If I mean to operate on a quantity of matter too large to be contained in the bottom of a phial, and which may require a conſiderable degree of heat, I make uſe of a common gun-barrel, in this manner. Having dropped the ſubſtance, which is to produce the inflammable or other air, into the barrel, the touch-hole being previouſly ſpiked up, I fill the barrel with ſand that has been well burnt. I then lute one end of the ſtem of a tobacco pipe into the mouth of the gun-barrel, and, to the other, I tie a bladder,

from

from which I have preſſed out the air. I now thruſt the butt end between the bars of a common grate, and ſupport the apparatus by a ſtring or iron tripod. This ſimple contrivance, which is originally Dr. Prieſtley's, is ſufficient for many purpoſes. By tying the neck of the bladder when filled, the air may be eaſily tranſported, preſerved, or conveyed into a jar ſtanding on the ſhelf in the water, by bringing the mouth of the bladder under its edge with one hand, and cutting the ſtring with the other.

This apparatus, however, though eligible for its ſimplicity, and the eaſe with which it may be procured, is improper in experiments where either the ſubject or the produce is known to act upon iron. In ſuch caſes, a ſmall glaſs retort, with a long neck, muſt be uſed. (Plate VII. fig. 4.) It may be placed in a portable furnace, or on a chafingdiſh of charcoal. To the mouth of the retort, a glaſs tube may be luted, with a mixture of pipe-clay and ſand, and bent ſo as to turn up under the receiver ſtanding in water or quickſilver; or the neck of the retort being long, and curved a little, may anſwer the purpoſe of a tube.

In certain chemical mixtures for the production of gas, the efferveſcence is ſo ſudden and violent as to drive the liquor over the top of a common phial into the tube. To obviate this inconveniency, Dr. Prieſtley uſed long phials, with thin

and

and round bottoms, like thofe above defcribed. Glafs tubes of different fhapes muft be fitted, by grinding, to the mouths of thefe phials. If, with any particular view, I want to pafs the air produced in the long phial, through fucceffive veffels of water, or any other fluid, I adapt the ground end of a fyphon (fo bent that the legs are parallel) to the mouth of the long phial, and pafs the other leg through the mouth, to the bottom of the firft bottle containing the water. In the fhoulder of this bottle there is a ground perforation above the furface of the water. Into this orifice I fix the fhort leg of a fecond fyphon, the longer leg of which goes to the bottom of a fecond bottle of water; and fo, if neceffary, I proceed to a third and fourth. With an apparatus of this kind, though of a conftruction fomewhat different, Dr. Prieftley impregnated water with nitrous vapour, which water affumed different colours at different periods of the procefs. See Plate VII. fig. 3.

For impregnating water with the aerial acid, commonly obtained by mixing oil of vitriol with chalk, for the purpofe of making artificial pyrmont, and other acidulous mineral waters, Dr. Prieftley firft invented an apparatus that fufficiently anfwered the purpofe of experiment. Dr. Nooth improved upon this invention in the conftruction of a glafs urn, which is now in general ufe. Dr. Withering, of Birmingham, in the

year

year 1781, in a letter which was publiſhed in the fifth volume of Dr. Prieſtley's writings on air, deſcribed another apparatus, of his own invention, for impregnating water with calcareous gas. It is a very ingenious contrivance; but the bladders, the copper, braſs, and leather tubes of which it is compoſed, are objections which, though perhaps of no ſolid importance, will not be eaſily removed. Dr. Nooth's apparatus, being made entirely of glaſs, and conſequently much neater, at leaſt in idea, certainly deſerves the preference. This apparatus, and the method of uſing it I ſhall therefore deſcribe. But before I proceed, it is neceſſary to obſerve, that Dr. Nooth's invention has been improved by Mr. Parker and Mr. Blades.

This apparatus conſiſts of three diſtinct glaſs veſſels, a glaſs funnel, and a mahogany ſtand. The lowermoſt of theſe veſſels, which when they are joined is the foot of the urn, is, in ſhape, like a bell. In the ſide of it is a hole fitted with a ground ſtopper, for the purpoſe of occaſionally letting out the air when the effervescence is too violent, or of adding more acid. If the ſtopper be not preſſed in too tight, it will bounce out of its own accord, when there is more fixable air in the veſſel than can paſs eaſily into the water, and will thus prevent a dangerous exploſion.

The middle veſſel, which is the largeſt, and contains the water to be impregnated, has, at the bottom,

bottom, a neck which fits, by grinding, into the mouth of the hollow pedeſtal above deſcribed. This neck contains a glaſs valve, which ſuffers the fixable air to riſe through it into the water, but prevents the water from deſcending.

The upper veſſel which, from its ſhape, I call the funnel, is alſo fitted, by grinding, into the mouth of the middle glaſs which contains the water. The uſe of this upper veſſel is to receive, through its bent tube, the water which, during the proceſs, would otherwiſe overflow. In the mouth of this funnel there is a ſmooth glaſs ſtopper, that prevents the eſcape of the air merely by its weight; which air, therefore, when ſufficiently accumulated and condenſed to lift the ſtopper, makes its way out, and the ſtopper being lifted but a little, falls again into its place: ſo that this apparatus may be left to operate by itſelf without any danger. See Plate VII. fig. 5.

The method of impregnating water with aerial acid by means of this glaſs machine, I ſhall now deſcribe. Having filled the middle veſſel with water, I join it to the upper one, and place them on the mahogany foot. I now pour into the lower veſſel, or pedeſtal, as much water as will cover the riſing in the center of it, which will be near a pint. Through the ſide orifice I pour one ounce *meaſure* of oil of vitriol, by little at a time; for, if it were ſuddenly mixed with the water, the heat produced might endanger the glaſs. I then take

take an ounce of chalk, or rather of marble grofsly pounded, and pour it through the wide glafs funnel into this mixture of vitriolic acid and water. The ufe of the funnel is indifpenfibly neceffary; for, without this precaution, fome of the chalk might ftick to the internal furface of the neck of the pedeftal, which would cement it fo effectually to the middle veffel, that it would be impoffible to feparate them without breaking. I fuffer the effervefcence to proceed a little while, that the common air may be expelled. I then join the apparatus, and, taking care that the ftopper, in the fide of the pedeftal, is not too tight, I concern myfelf, for the prefent, no farther about it.

The fixable air, from the effervefcing mixture in the pedeftal, gradually paffing through the valve, and thence through the water, will occupy the upper part of the middle veffel, forcing a quantity of water, equal to its own bulk, thro' the bent tube into the upper glafs. By taking off the two upper veffels from the pedeftal, and fhaking them for a few minutes, part of the gas will be abforbed, and the water in the upper veffel, which I call the funnel, will fall down. After two or three fuch agitations, I lift the funnel a little, and all the water will fall into the middle veffel.

But water may be impregnated with fixable air, by an apparatus much more fimple than any of of thofe above defcribed. Let a glafs tube be ground fo that one end fhall fit into the mouth of a quart bottle, and the other into a fhort neck in the fhoulder of a two-quart decanter. Let the mouth of this decanter be fitted with a conical ftopper ground fmooth, fo as to be air-tight without adhefion. Put the effervefcent mixture into the quart bottle, and as foon as the common air is expelled, join it by the tube to the two-quart decanter containing three pints of water. See Plate VII. fig. 6.

The fpace in the decanter, or receiver, above the water, will foon be filled with aerial acid, which, being heavier than atmofpheric air, will immediately occupy the fpace next the water, and gradually accumulating, will force the lighter air, which fwims on its furface, to lift the ftopper and let itfelf out. The aerial acid will now fill the entire fpace between the furface of the water and the ftopper, which, when too much compreffed, it will lift up and part of it will efcape. Thus condenfed and preffed upon the water by the weight of the ftopper, this acid air will be fpeedily abforbed. If, however, the operator be very impatient, he may accelerate the procefs by detatching the decanter (putting a ftopper into the fhoulder-orifice) and fhaking it as long and as often as he pleafes. In this manner, and with this fimple apparatus, I conceive he will faturate any given quantity of water with fixable air, in lefs

lefs time than by any other method with which I am hitherto acquainted.

Every inventor of an apparatus for impregnating water with the aerial acid, has been particularly attentive to its paffage through the water; a circumftance that I believe to be of no importance. I queſton whether any of this gas be abforbed in its rapid progrefs from the bottom of the water to the furface.

After writing this laft paragraph, I determined to put my conjecture immediately to the proof of experiment. I took a two ounce phial, and filled one third of it with chalk, broken with a hammer in pieces juft fmall enough to enter the bottle, which I then half filled with vitriolic acid diluted with water. To the mouth of this phial, I adapted the fhorter end of a glafs fyphon, and paffed the long leg to the bottom of a three-pint glafs decanter, containing a quart of water. The mouth of the decanter was left open. The effervefcence proceeded moderately and regularly, fo as to emit about 30 large bubbles in a minute.

At the expiration of an hour, I found that the water had received no impregnation difcoverable by the tafte. I then dropped into a wine glafs of it, many drops of lime-water, without the leaft cloud or fign of decompofition, which, I know, muft have appeared if there had been any aerial acid in the water. Now, fince not lefs than 1800 bubbles of this air paffed through the water, in the

the ſpace of an hour, without mixing with it in the ſmalleſt degree, it is very evident that this part of the proceſs is entirely uſeleſs, and that the abſorption of fixable air is at the ſurface of the water only.

SECT. III.

ARTIFICIAL MINERAL WATERS.

WITH the apparatus for impregnating water with aerial acid above deſcribed (Plate VII. fig. 6.) all the celebrated mineral waters may be artificially prepared, by adding the ingredients to the water in the receiver before you join it to the bottle containing the effervеſcent mixture.

PYRMONT WATER

Contains a conſiderable proportion of magneſia, part diſſolved by the aerial acid, and part by the acid of vitriol, conſtituting Epſom ſalt; lime diſſolved in both theſe acids; a little common ſalt, and a ſmall proportion of iron diſſolved by the aerial acid. But the medical virtues of this water are rationally ſuppoſed to be principally owing to the quantity of aerial acid which it contains in an uncombined ſtate. The gypſum, that is, lime combined with vitriolic acid, can certainly anſwer no ſalutary purpoſe; nor can we ſuppoſe that lime combined with aerial acid, which is marble or common chalk, is more medicinal: lime, therefore, may be properly omitted. Magneſia diſſolved by the aerial acid, is the common magneſia alba; magneſia, or rather the earth of magneſia, diſſolved by vitriolic acid, is Epſom ſalt. The firſt of theſe may act, in a ſmall degree, as an antacid, and the latter as a very mild laxative. Probably, however, the aerial acid and the iron are the only ingredients of any importance.

To the decanter containing three pints of ſpring water, add 15 grains of Epſom ſalt, 5 grains of common ſalt, 10 grains of magneſia, and 5 grains of clean iron filings. Then ſaturate the water with aerial acid, and you will produce a medicated water preferable to that of Pyrmont.

SPA WATER

Contains a large proportion of Magneſia combined with aerial acid; ſome mineral alkali, calcareous earth, a little iron, and a very ſmall proportion of common ſalt. The aerial acid, uncombined, is about half the quantity of that which exiſts in Pyrmont water. To imitate this water, add to the water in the receiver 7 grains of mineral alkali, a ſcruple of magneſia, iron filings

3 grains, and one grain of common ſalt. Join the apparatus, and continue the proceſs until you ſuppoſe the water to be about half ſaturated.

SELTZER WATER

Contains a large proportion of common ſalt; magneſia and calcareous earth diſſolved by aerial acid, and ſome mineral alkali. Into the receiver containing three pints of ſpring water, put 60 grains of common ſalt, one ſcruple of magneſia, 15 grains of mineral alkali, and 7 grains of chalk. Join the apparatus, and continue the proceſs until the water is almoſt ſaturated with aerial acid.

SULPHURIOUS WATERS

Are immediately known by their peculiar ſmell, reſembling that of putrid eggs, or the waſhings of a foul gun. Theſe waters are impregnated with what is called hepatic gas; that is, air diſengaged from liver of ſulphur by an acid. They may be artificially prepared, by adding liver of ſulphur inſtead of chalk, to the quart bottle containing oil of vitriol and water. The quantity of this *hepar* muſt be in proportion to the impregnation of the natural water you wiſh to imitate. Harrowgate water is ſtrongly ſulphurious, and contains beſides, a large proportion of of common ſalt; if therefore a water, ſimilar to that, is to be made, half an ounce, or five drams, of ſalt muſt be put into the receiver containing three pints of water to be impregnated.

But the apparatus in which theſe artificial waters are made, may be converted to many other uſes, particularly in paſſing air, from effervеſcent mixtures, through water, or any other liquid. For this purpoſe, I adapt the ground end of a ſyphon to the mouth of my quart bottle, and paſs the longer leg through a cork in the neck of the two-quart decanter, to the bottom of the liquid which it contains. If then I want to collect the gaſs under a jar reverſed in water or quickſilver, I adapt a ſecond glaſs tube to the ſhort neck of the decanter, and place the other extremity of the tube under the edge of the jar, into which the gaſs, after paſſing through the liquid in the decanter, will neceſſarily riſe. If it be requiſite that the gas ſhould paſs through more than one veſſel, any number of them, and of any ſize, may be joined in the ſame manner, by means of glaſs tubes. (See Plate VII. fig. 3.) In this way any kind of air may be paſſed through lime water, in order to ſeparate it from the fixed air with which it may be combined.

Since philoſophers have been of opinion, that the conſtituent principles of water are inflammable and pure air, various attempts have been made to decompoſe this compound, by forcing it in in the form of ſteam, through a red-hot tube. Now, though they have not ſucceeded in the principal object, they have diſcovered, in forcing ſteam through red-hot tubes filled with charcoal, or iron ſhavings, particularly the laſt, that inflammable air in great abundance, with different proportions of fixable air, were produced. From Dr. Prieſtley's experiments it appears, pretty evidently, that the inflammable air was expelled from the charcoal or iron, and that the water contributed nothing to its formation. As to the fixable air, on the modern ſuppoſition that it conſiſts of the ſame principles as water, and of which it is conſequently a modification, there is no great difficulty in accounting for its production in this proceſs. But time, I believe, will diſcover this to be an erroneous hypotheſis. With all due deference to men of far ſuperior knowledge and abilities, I am ſtill of opinion, that fixable air is a compound of pure air and an acid; that phlogiſton is a compound of fire and an acid, and that in this, as in all other phlogiſtic proceſſes, where fixable air is produced, the acid principle of the fixable air is ſupplied by the phlogiſton which is conſequently decompoſed. The other principle, namely, the pure air, may be ſupplied by the water, ſome part of which is decompoſed in paſſing through the red-hot tube.

Dr.

Dr. Prieftley conftructed a particular kind of furnace, for the purpofe of heating the copper or earthen tube through which the fteam was impelled: it appears, from the plate annexed to his fixth volume, to be a kind of long trough of brick-work, open at each end, with a grate in the middle to fupport the fuel. In one end of the tube, which lies horizontally in the furnace, he inferts the beak of a glafs retort, in which he boils the water by means of another furnace, or a lamp. The other extremity of the tube communicates with the pipe of a worm-tub, fuch as are commonly ufed in diftillation. This tub being filled with cold water, the condenfed fteam falls in drops, into a veffel ftanding on the ground, through a pipe fitted to a fmall orifice in the fhoulder of this receptacle; to the mouth of which is fitted another tube, bent fo as to pafs under the edge of a jar, ftanding reverfed and full of water, on the fhelf of the water-tub ufed for other pneumatical experiments. By this very ingenious contrivance, the air produced in the procefs, is feparated from the fteam, and may be examined at leifure.

But, to thofe who are poffeffed of a portable furnace, this of Dr. Prieftley's conftruction is unneceffary. If two holes are drilled, oppofite to each other, in the upper part of the body of fuch furnace, the tube, paffed through them, may be con-

conveniently heated to any degree that may be required. See Plate VII. fig. 7.

The experiment of ſetting fire, by the electrical ſpark, to a mixture of pure and inflammable air, and thereby producing water, is performed in a ſtrong glaſs cylinder, open at one end only. To this open end a wooden or braſs cap is firmly cemented, and the opening cloſed by a ſcrew-top. Near the oppoſite extremity of the cylinder are drilled two ſmall holes diametrically oppoſite, through which two braſs wires, exactly fitting the holes, are paſſed and fixed ſo that their points approach within three quarters of an inch of each other. By means of theſe wires, which have knobs at their external ends, the electric ſpark inflames the incloſed air, and the water produced is ſeen trickling down the internal ſurface of the glaſs. Whether this water be the effect of compoſition, or of decompoſition, is yet matter of diſpute. See Plate VII. fig. 8, a.

With a ſtrong cylinder, thus furniſhed, the experiment never fails: but it is very difficult to drill the holes, in which the wires are inſerted, without breaking the glaſs. To obviate this difficulty my worthy friend *Walker*, univerſally diſtinguiſhed as an experimental philoſopher, paſſes the two wires through two ſmall glaſs tubes which perforate the ſcrew-top of the cylinder. (See Plate VII. fig. 8, b.) The only inconveniency

ency attending this apparatus is, that the ſpark will ſometimes paſs from one wire to the other externally; but, in general, the experiment ſucceeds.

Thoſe who are acquainted with experiments of this nature, will require no farther deſcription of this apparatus; but, for the ſake of thoſe who are not, it is neceſſary to be more minute, and alſo to deſcribe the manner of preparing for the experiment.

The cylinder muſt be of flint-glaſs, thick, with a round bottom, and a wide neck. On to this neck muſt be cemented (ſee *Cement*) an open braſs cylinder, with a ſcrew on the outſide. A braſs cap, or cover, with two holes in the top, and a cork cemented to its internal ſurface, ſcrews on to this cylinder. This cork is perforated by two ſmall glaſs tubes, through which two braſs wires are paſſed, the internal points bending towards each other, and the external knobs receding. Theſe wires are ſecured in the tubes by cement, ſo as to render the cover perfectly air-tight.

The cylinder, previous to the reception of vital and inflammable air, muſt be filled with quickſilver, and inverted in a trough of the ſame fluid, a very large quantity of which is requiſite for this experiment. The two airs are procured by diſtillation, and introduced in the ſame manner as gas in general is thrown into veſſels inverted in water. When the cylinder is thus properly filled with

with the two airs, and the quickſilver conſequently expelled, it may be lifted a little out of the trough, and the cover ſcrewed on, without any apprehenſion that the factitious airs, which are lighter than that of the atmoſphere, will eſcape through the mouth of the veſſel. This mixed air, thus confined, may, by the electric ſpark, be fired whenever you pleaſe.

There is another apparatus (Plate VII. fig. 9.) by means of which, inflammable and pure air may be mixed and inflamed, for the purpoſe of producing water, with leſs trouble and without any doubt of ſucceſs. If a ſmall quantity of iron filings, together with diluted oil of vitriol, be put into the phial, inflammable air will ſoon iſſue through the extremity of the tube. Apply a lighted candle to this extremity, and the air will immediately take fire. You then introduce the tube through the neck of the balloon, and the flame will continue as long as any inflammable air is produced. It will not be long before you will perceive water condenſed on the internal ſurface of the glaſs, and, trickling down in ſmall currents, collected in the bottom of the balloon. In this experiment, the pure air, neceſſary to the production of water, is ſupplied by the current of atmoſpheric air, which ruſhes into the globe through the neck, to ſupply the place of that, which, being rarified by the heat of the flame, and being conſequently lighter than the external

air,

air, eſcapes through the upper pipe. By this circulation of air, the inflammable air continues to burn, and, in conſequence of its attraction to the pure air in the atmoſphere, or perhaps rather in conſequence of the attraction of its phlogiſton to pure aïr, a combination takes place by which water is produced.

That water ſhould be thus produced, is indeed a wonderful phenomenon; nevertheleſs it is by no means deciſive as to the conſtituent principles of water. Water may poſſibly be a real ſimple element, notwithſtanding all the experiments that ſeem to prove the contrary. Poſſibly it may be a conſtituent principle of all the elaſtic fluids with which we are hitherto acquainted. If this be true, the water produced by the inflammation of pure and inflammable air, is merely the effect of decompoſition.

Retorts (Plate VII. fig. 4.) are a neceſſary part of the pneumatical apparatus. They are made of common bottle-glaſs, of flint-glaſs, of earth, or of iron. They are uſed for expelling different kinds of gas from various matters by means of fire. In producing pure air from nitre, Dr. Prieſtley found the ſmall earthen retorts, made by Mr. Wedgewood, far preferable to any other. M. Lavoiſier, the celebrated French chemiſt, diſappointed in the uſe of glaſs and earthen retorts in the reduction of lead from minium, for the purpoſe of meaſuring the quantity of elaſtic fluid

ſe-

ſeparated in the proceſs, contrived a retort made of plates of iron ſoldered together with copper. But iron ſo eaſily parts with its phlogiſton, that Mr. Wedgewood's retorts are infinitely preferable in every pneumatic experiment in which fire is employed, and which requires accuracy.

SECT. IV.

FURNACES.

WE are taught, by experience, that combuſtible bodies refuſe to burn without the admiſſion of air. We have alſo learnt from experience, that their conſumption is accelerated, and the heat increaſed, in proportion to the quantity of air made to paſs through the fire in a given time. We know that air is rarified by heat; that rarified air, being lighter than denſe air, muſt neceſſarily riſe in the atmoſphere, and that, to ſupply the place of this aſcending air, the cold and denſe air will ruſh in below with an impetus proportionable to the rarefaction above.

On theſe eſtabliſhed properties of air and fire, are founded the principles on which all furnaces are conſtructed. The furnaces commonly uſed by brewers, and for boiling water for other purpoſes,

poſes, are ſimple fabricks of brick, conſiſting of a cavity for containing the fuel, an iron grate for its ſupport, a door for its introduction, and an opening below for admitting the air and receiving the aſhes. Above the cavity which contains the fire, a copper is ſet in brick-work, and a flue from the upper part of the fire-place, communicates with a common chimney. If, inſtead of a copper, a pot of caſt iron be ſet in brick-work above the fire-place, you have a ſand-pot for the reception of a retort for various operations in chemiſtry.

For the purpoſe of melting metals, a wind furnace may be conſtructed in the following manner, ſo powerful, as entirely to ſupercede the uſe of bellows, and ſo durable as to bear conſtant working for a conſiderable length of time.—Sink a cavity in the floor about two feet deep, four feet long, and two feet wide. Line this cavity with one tier of bricks, ſo as to leave a ſpace of about 16 inches between the ſides. One end of this oblong cavity muſt be left open, and to this open end muſt be adapted a ſquare wooden trunk, which paſſing horizontally under the floor, and through the wall of the laboratory, admits the external air through an iron grate fixed in the wall. On the oppoſite extremity of this excavation, place a cylinder of caſt iron, about an inch and a quarter in ſubſtance, 20 inches internal diameter, and 24 inches deep. But before the cylinder is placed upon the foundation, two iron bars, two inches asunder, must be fixed across the cavity at the distance of eleven inches from the closed end, for the support of the fire-bricks with which the cylinder must be lined to the height of six inches from the bottom. On these fire-bricks you rest a grate for the support of your crucible, and of the fuel. From the grate upwards, you line the cylinder, to the thickness of about five inches, with glass-grinder's sand; which, from the particles of glass it contains, becomes, in a short time, a solid vitrious mass, capable of sustaining any degree of heat. The founders who use this kind of furnace, generally cover that part of the underground cavity which projects in the front of the furnace, with an iron grate, on which the operator stands, and which is occasionally raised, for the purpose of taking out the ashes. But it were much better to have this trap-door made of iron not grated; because the grate necessarily diverts the stream of external air. About two inches from the top of the cylinder, a lateral flue communicates with a chimney in the laboratory, which ought to have no other communication. The coak, or charcoal, is put in at the top of the furnace, which is then covered by a very thick, flat, round tile.

M. Macquer, in the Transactions of the French Academy for the year 1758, describes a wind furnace as an improvement of that of the celebrated M. Pott, of Berlin, in which he produced

a very

a very extraordinary degree of heat. It is constructed entirely of baked clay; is of a quadrangular form, and consists of three parts, viz. the body, the dome, and the chimney. In the first of these, an iron grate rests upon a ledge near the bottom which is open. In the front, four inches and a half above the grate, there is a semicircular opening, like that of a common oven, and closed in the same manner by a loose plug of baked clay. The dome rests upon the body, of which it is merely a continuation. In the front of it, which slopes backward, there is also a semicircular door, for the purpose of putting in fuel. On this dome stands a chimney of baked clay, six inches in diameter, and about ten feet long, on which is placed another cylinder of plate-iron twelve feet in length. This furnace stands upon an iron tripod about six inches high. The mineral subject of the operation is put into a muffle, which rests upon two bricks standing on the grate. Mr. Baumé, from whom I take this description, gives no dimensions except that of the chimney: but, from that, I suppose the area of the furnace to be about ten inches by fourteen.

This last mentioned chemist afterwards constructed a wind-furnace entirely of bricks, which, he says, produced a degree of heat not only far superior to that above described, but even greater than the furnace of a glass-house. This fabric was nothing more than a perpendicular, quadrangular

drangular tower or chimney, fifteen feet high: the area ten inches by thirteen from top to bottom. There is a grate at the lower extremity; ſix inches above that, an oven-door for introducing the muffle; and eight inches higher, another for the coals. This tower is raiſed about eighteen inches above the platform of the laboratory. I have no doubt of the power of this ſimple and rational contrivance, becauſe the chimney is not contracted. The idea of increaſing the draught of air by contracting the chimney, is unphiloſophical. You may, by that means, increaſe the roar; but, inſtead of accelerating, you impede the ſtream of air. I ſhall be aſked—"How comes it then, that the chimneys of our houſes are prevented from ſmoking by contracting them at the top with a red pot?"—This very circumſtance is a powerful argument in favour of my opinion. Theſe red pots are, it is true, externally ſomewhat leſs than the chimney on which they ſtand; but from their thinneſs and circular form, their internal capacity is almoſt twice as much. Let us ſuppoſe the inſide of a chimney to be twelve inches ſquare: a pot to cover this chimney muſt be ſeventeen inches diameter. Now, the area of a ſquare, whoſe ſides are 12 inches, is 144 inches; but the area of a circle of 17 inches diameter is 221. So that the good effect of theſe pots is entirely owing, not to their diminiſhing, but to their increaſing the area of the chimney at the top.

The

The furnace used by the coach-founders, and other artists, in London, for the purpose of refining silver, is more simple, more expeditious, and more powerful than any of those described by chemical authors. It consists of a simple quadrangular wind-furnace, built of brick, and covered by a thick flat quadrangular tile. One side of this furnace being about an inch and a half lower than the other three sides, there is consequently an aperture on that side when the cover is placed on the mouth of the furnace. This open side communicates with an horizontal trough of brick-work, about two feet in length, fourteen inches wide, and five or six inches deep. The opposite extremity of this trough communicates with the chimney. In this trough the operator places his *test* containing the silver mixed with lead, and then covers the trough with two thick tiles; these being contiguous to each other, and to that which covers the furnace, confine the flame, which passes with violent impetuosity over the surface of the metal. The middle tile is occasionally lifted, to examine the progress of the operation. This furnace has every advantage over the reverberatory furnaces described by authors. The tests used by the artists in this branch, are made entirely of calcined bones.

In the year 1731, Dr. Shaw and Mr. Francis Hauksbee, published a small pamphlet containing the description of a portable furnace, with several

ſeveral copper-plates well engraved. A copy of moſt of theſe plates may be ſeen in the fourth plate of chemiſtry, in the laſt edition of Chambers's Dictionary. The idea of a portable furnace ſeems to have originated in the German chemiſt *Becher*. This of Dr. Shaw conſiſted of a *cover*, two *rings*, a *body*, and a *foot*. The uſes of theſe ſeveral parts are eaſily underſtood. The *body* contains the fuel; it has three grates, to be fixed at different heights, according to the different operations. The ring placed upon the body contains retorts for diſtillation. If, inſtead of the ring, an iron pan be placed upon the body, it becomes a calcining furnace. The cover placed either upon the body or the ring, renders it a reverberatory furnace for cupellation, &c. To the body, with the lower grate, an alembic may be adapted for diſtillation of ſimple waters, &c. By uſing the body of the furnace only with the middle grate, with a pan of water or of ſand, it becomes a water or ſand-bath, whichſoever may be required. The body without a grate, ſtanding on the cloſe foot, may be uſed as a blaſt furnace for ſmelting the ores of lead, iron, or tin. In ſhort, there are few chemical operations in which fire is concerned, that may not be conveniently performed in this portable furnace. The authors of the pamphlet in which it was deſcribed, are ſilent as to the ſubſtance of which it was made, nor do they mention any lining. Theſe they probably

bably thought matters of unneceſſary information, as the furnaces, ready fitted for buſineſs, were advertiſed to be ſold by Mr. Haukſbee, in Crane-court, Fleet-ſtreet.

Dr. Lewis, in his *Commercium Philoſophico tecnicum*, deſcribes a portable furnace compoſed of two black lead crucibles, one inverted on the mouth of the other. The crucibles which he found moſt convenient for this purpoſe, were thoſe marked 60 on the bottom. Their perpendicular height internally is about twelve inches, and their width, at the top, almoſt eight. A round hole is ſawed in the bottom of each crucible; that in the lower crucible admits the air, which eſcapes, through the hole in the upper pot, into the chimney, when the crucibles form a wind-furnace. In each of theſe crucibles a round hole is ſawed, a little above the bottom, for the purpoſe of occaſionally admitting more air, or of introducing the pipe of a bellows. Oppoſite to this round hole, there is a ſmall ſquare aſh hole; and, over this, another, of the ſame form, for the purpoſe of introducing fuel, or of placing a crucible or teſt on the lower grate. There are three grates of different ſizes for different purpoſes, as in the other portable furnace above deſcribed. To theſe lateral apertures, plugs, ſawed out of pieces of broken crucibles, are adapted, to be inſerted or omitted occaſionally.

To render this furnace durable, each crucible is bound with three or four thick copper wires, let into grooves, and faſtened by twiſting their ends with a pair of pincers; and the mouth is encircled by a thin copper hoop, to prevent it from wearing by frequent uſe. In order to increaſe the dimenſions of the furnace for the purpoſe of receiving a ſmall copper ſtill, a ring of forged iron, ſix inches in height, with a ſemicircular aperture, is placed on the mouth of the crucible. The chimney, either upright or lateral, is of plate-iron, and differs in no reſpect from that of other portable furnaces.

The principal objection to this furnace of Dr. Lewis, is the thinneſs of the black-lead crucibles; whence not only a quantity of heat is loſt, but the operator is much incommoded when it becomes red-hot. To prevent theſe inconveniences, iron furnaces are always lined with lute, which is generally compoſed of clay mixed with ſand. But this lute is apt to crack in drying. To obviate this evil, Mr. More, ſecretary to the Society of Arts, &c. in a paper printed in the fourth volume of their Tranſactions, recommends a lining of Windſor or Nonſuch bricks, ſet in the loam of which they are made The body of his furnace is a cylinder of ſtrong plate-iron, eleven inches diameter, and twelve or fourteen in length, riveted or brazed together. To form the aſh-hole, a piece, four inches ſquare, muſt be cut out at one

one end, and an iron door fixed to it. Immediately above this aperture, three iron pins at equal diſtances, and projecting half an inch or more from the internal ſurface of the cylinder, are to be firmly rivited. Four or five inches above theſe pins, you are to cut another ſquare hole for the purpoſe of feeding the fire. This hole likewiſe has an iron door. Having now reſted your grate on the three iron pins, you line the cylinder, from the grate upwards, with the fire-bricks above mentioned, which muſt be ground to the thickneſs of one inch and a half. If you chuſe, for the purpoſe of uſing grates at different heights, that your furnace ſhould be internally conical, the lower bricks muſt be left thicker, and muſt diminiſh gradually to the top. When it is to be uſed as a wind furnace, the upper aperture muſt be ſtopped with a plug of fire-brick, and the door ſhut.

There is another kind of furnace that anſwers the purpoſe of diſtillation, by means of a lamp, perfectly well It is made of plate iron, with a dome, ſand-pot, and feet; of the ſame metal. It is worked by one of Argand's lamps. By taking off the dome, a glaſs alembic may be uſed inſtead of a retort; or, where no great degree of heat is required, it may be worked with the naked retort, without the iron cap. See Plate VII. fig. 10. This apparatus I firſt ſaw at Mr. Parker's in Fleet-ſtreet.

Any of the furnaces above defcribed will anfwer the purpofes of experimental chemiftry; but an experimental chemift may be fo fituated as to be unable to procure an iron furnace, or black-lead crucibles. Perfons fo fituated may conftruct a portable furnace equal to any of the former, and of materials that may eafily be obtained in any part of the kingdom: thefe materials are common garden-pots, of baked earth: they may be had of any fize, and by means of a faw and a file, may be eafily adapted to any chemical purpofe.

LAMP FURNACE.

This apparatus for the purpofe of diftilling, by a retort either naked or in fand, I conftruct in the following manner. I take a garden-pot of eight inches external perpendicular height, and the fame in diameter. Having ground the top-edge flat, by rubbing it on a ftone with fand and water, I enlarge the hole in the bottom (by means of a round file) until it will admit the glafs chimney of one of Argand's lamps. In this pot I place another, meafuring five inches, the bottom apperture of which is filed to the fame fize as that of the other, with which it exactly correfponds. I now cut off about three inches from the bottom of a pot which is eleven inches in diameter at the top. This bottom inverted forms the dome of my furnace, and fits the body exactly. Out of each

each of theſe I ſaw a ſemicircular *ſinus* for the neck of the retort. The mouth of the inner pot ſupports either the naked retort, or an iron ladle with the handle cut ſhort, by way of a ſand-pot. See Plate VII. fig. 7, a.

A WIND FURNACE,

For ſmelting ores, or for other chemical operations that require a great degree of heat, I conſtruct in the following manner.

I take one of the eight-inch pots above-mentioned, and ſaw off the bottom. I then take one of thoſe of eleven inches diameter at the top, and, with a chiſel, form three ledges in the inſide, at equal diſtances, for ſupporting the grate, and at ſuch a diſtance from the bottom, that when the ſmaller pot reſts upon the grate, the upper edges of the two pots may be nearly equal. Having enlarged the center-hole in the bottom of the larger pot (the pots of this ſize have alſo three lateral apertures) to two inches diameter, I fix the grate, and having placed the ſmaller pot upon it, I fill the ſpace between the two pots with the matter which I ſcrape from the ſtone on which the mouths of the pots were ground, mixed with a little pounded glaſs, and a ſmall quantity of coal duſt. The lateral holes at the bottom of the large pot I ſtop with plugs of baked clay; ſo that they may be cloſed or open for the purpoſe of admitting more or lefs air. When thefe three holes are clofed, the opening beneath the grate is much fmaller than is generally given to wind furnaces, through which the velocity of the current of air is imagined to be increafed by contracting the chimney, regardlefs of the bottom aperture, which, authors tell us, may equal the diameter of the furnace. Doubtlefs this is an error. The aperture beneath the grate, in every kind of wind furnace, fhould be confiderably lefs than that of the chimney, contrary to the directions of all the writers upon this fubject.

One of the three lateral holes at the bottom of the external pot, I firft enlarge by means of a round file, and then with a triangular or flat file, I give it a quadrangular fhape, floping the fides and top outwards, fo that the external dimenfion of this afh-hole is greater than the internal: the bottom is horizontal; therefore the plug, cut out of a piece of broken pot, can neither fall outward nor be pufhed into the furnace. This afh-hole needs not be more than two inches wide, and one in height.

This furnace ftands upon an inverted pot of the fame fize, with a large hole in its bottom, and with three large pyramedal openings fawed in its fides, fo as to form a kind of tripod. I make thefe openings pyramedal rather than arches, becaufe I can faw right lines with an old fcythe.

The

The dome is an inverted pot of the ſame ſize as the inner pot of the body. Out of the mouth of this dome, which, by grinding, fits that of the inner pot, I ſaw a triangular aperture, whoſe ſides are four inches, for the purpoſe of introducing fuel, and examining the ſtate of the crucible. This aperture is formed and pluged in the ſame manner as the aſh-hole above deſcribed: that for the chimney is three inches diameter; ſo that it is a third wider than the aperture below the grate. By thus fixing the dome on the inner pot, it ſtands much firmer than if it were adapted to the larger pot, and it is better proportioned than that of Dr. Lewis, which is too large for a reverberatory furnace.

The chimney is of forged iron, and compoſed of ſeveral pieces that fit into each other. On the outſide of the bottom piece, about an inch from the lower extremity, there is a thick iron ring, flat on the under ſide, which reſt upon the dome. The part of the chimney below this ring, fixes into the aperture in the top of the dome.

The body and dome of this wind-furnace, I ſecure by iron hoops, which, being put on whilſt red hot, require no other faſtening. *Vide* Plate VII. fig. 11.

Nothing can be more eaſy than, with theſe garden-pots, to conſtruct every kind of furnace that can be required for experimental chemiſtry. An ingenious operator will model them to his own peculiar intentions with great facility.

SECT. V.

BLOW-PIPE.

THIS inſtrument is a neceſſary part of a chemical apparatus. It is uſed by goldſmiths, enamellers, and other artiſts, for various purpoſes. It is ſaid to have been firſt applied to the analyſis of minerals by Swab, a Swediſh chemiſt, about fifty years ago. Since that time, ſeveral improvements have been ſuggeſted, both in its conſtruction and application. This inſtrument, in its moſt ſimple and original form, was nothing more than a conical braſs tube, ending in a point, and curved near the extremity, ſo as to be applied horizontally to the flame of a lamp or candle. But thoſe who frequently uſed the blow-pipe, finding an inconveniency from the accumulation of water which iſſues with the air from the lungs, annexed a ſmall hollow ſphere for its reception. Bergman, in his diſſertation on the conſtruction and uſe of this inſtrument, gives a particular deſcription of that which he himſelf uſed, and which he he found to anſwer beſt the purpoſes of chemical inveſtigation. It conſiſts of three parts, and is made of pure ſilver, with a ſmall addition of platina, in order to give it the neceſſary degree of hardneſs. Theſe three parts fit into each other without ſcrews. To the middle one is annexed a flat box, inſtead of a ball, for collecting the moiſture.

M. le Blond, *Medecin Naturaliſt du Roi*, in a letter to the editor of the *Journal de Phyſique*, for February 1787, propoſes, inſtead of blowing through the tube, to adapt to the wide end of it a leathern bag, the ſize of an oxe's bladder, filled with air from a bellows; or, which is much better, with pure air. This pure, vital, or dephlogiſticated air, is known to accelerate combuſtion, and conſequently produces a much greater degree of heat than common atmoſpheric air. For this reaſon it may be advantageouſly applied in experiments on very refractory matters. But the production and application of this air is attended with a great deal of trouble. Common air is generally ſufficient, and M. le Blond's leathern bag is doubtleſs preferable to the old method of blowing with the mouth, which, if continued for any length of time, is very fatiguing: beſides, it ſupercedes the neceſſity of a complicated blow-pipe, a ſimple tube of ſilver, or of glaſs, without either joint or bulb, being ſufficient.

The

The only objection to this wind-bag is, that it will work eaſily only whilſt it is tolerably full of air, and that experiments are interrupted during its repletion. If therefore we can contrive any means of ſupplying the bag with air, ſo that it may be kept conſtantly full, we ſhall doubtleſs render the blow-pipe a perfect inſtrument. An Iriſh bag-pipe is the very thing. Inſtead of the muſical pipes, the operator will fix his blow-pipe to the bag, which he will conſtantly replenish with air, by means of the bellows under his arm.

The uſe of the blow-pipe is, by heat alone, or, with the addition of certain fluxes, to analyſe, by fuſion, minute particles of mineral bodies; particularly gems, the ſmalleſt pieces of which may be thus examined.

The matter under examination muſt be ſupported either by a hollow piece of charcoal, or in a ſilver or gold tea-ſpoon with a wooden handle. The charcoal ſhould be of beech or fir. Charcoal is uſed as a ſupport in experiments with the blow-pipe, becauſe it acts as a flux to the matter intended to be fuſed; but, if the ſubject may be abſorbed by charcoal, or in caſes where phlogiſton is not required, the ſpoon muſt be uſed. In theſe caſes the fluxes generally employed are microcoſmic ſalt, mineral alkali, or borax.

A common tallow candle, not too thick, is generally preferable to wax or to a lamp. The wick muſt not be ſnuffed too ſhort, becauſe it ſhould bend a little towards the object. When the flame is forced, by the blaſt of air, to take a lateral direction, it exhibits, diſtinctly, an internal blue figure, and an external one which is of a browniſh white, and not ſo well defined. The greateſt heat is at the apex of the blue flame, which apex muſt be directed to the object after the exterior flame has been applied for a few minutes.

The matter to be fuſed ſhould not exceed the ſize of a pepper-corn. It may be broken into pieces of a proper magnitude, by means of a ſmall hammer, the matter being placed on a ſteel plate, within a looſe iron ring, which prevents the particles from being ſcattered. One piece of the matter to be examined, of the ſize above mentioned, ſhould be ſeparately tried with the ſeveral fluxes, and the phenomena carefully obſerved.

Foſſils, that is, unorganized bodies, are either *ſaline*, *earthy*, *inflammable*, or *metallic*.

SALTS.

Many of theſe, when expoſed to the flame of the blow-pipe, eaſily liquefy, then ſplit, and are finally fuſed; others are diſperſed by ſudden heat.

EARTHS,

EARTHS,

We recollect, are five in number, viz *lime*, *ponderous earth*, *clay*, *flint*, and *magnesia*. None of these, when pure and alone, are fusible by heat.

Crude calcareous earth dissolves in borax or microcosmic salt; and if a very small particle of it be thus fused, and immediately plunged into hot water, it will retain its transparency.

Ponderous earth, calcined by the blow-pipe, without any addition, is deprived of its fixed air, and consequently, like calcareous earth, becomes caustic and soluble in water. It is fusible with borax or microcosmic salt.

Clay, as dug from the earth, is always mixed with a variety of heterogeneous matter, particularly flint, which generally constitutes half its bulk. The pure clay of chemists is the earth of alum, which is obtained by digesting that salt in an alkaline lixivium, and washing it in water. This pure clay fuses, with effervescence, in borax or microcosmic salt.

Flint, submitted to the flame of the blow-pipe, in the spoon, with an alkaline salt, dissolves with violent effervescence. If the quantity of flint exceed that of the flux, a pellucid glass will be produced. It is equally fusible in borax and microcosmic salt.

Mag-

Magnesia alone exposed to the flame impelled by the blow-pipe, loses its fixed air, together with its property of effervescing with acids. With the fluxes, it dissolves with effervescence.

INFLAMMABLES.

Inflammable substances, when once inflamed by the blow-pipe, should be suffered to burn out, and the residuum, if there be any, may be afterwards examined by the flame.

METALS.

The perfect metals may be fused by the blow-pipe; but they are neither altered nor diminished: when calcined by acids, their calces may be reduced by heat alone.

Imperfect metals may be calcined by the flame of the blow-pipe; but their calces cannot be reduced without the contact of some phlogistic substance. Imperfect metals are fusible in the following order: tin, bismuth, lead, zinc, antimony, silver, gold, arsenic, cobalt, nickel, iron, manganese, platina. All these, except the two last, are fusible by the blow-pipe, without addition of a flux.

Perfect metals, in fusion, have a polished surface: they cannot be calcined by fire alone. Imperfect metals have also a polished surface when they

they are first fused; but they are soon obscured by a calcined film, in consequence of the power of air, with the assistance of heat, to attract phlogiston from the earth of imperfect metals. Some of these, by continued heat, evaporate entirely; others are partially resolved into smoke.

Gold, though generally supposed incapable of calcination by fire, will, nevertheless, by means of the blow-pipe, when fused with a globule of microcosmic salt, with the subsequent addition of turpeth mineral, form a ruby coloured glass. This experiment does not always succeed. It requires a great deal of management, and seems to depend in a great measure upon accident.

Silver easily fuses by the blow-pipe, but is not calcined. The calx of this metal, precipitated from nitrous acid, is readily reduced by the blow-pipe. Microcosmic salt dissolves it immediately. If there be any copper present, the solution will be green. Silver mineralized by acids is soluble in microcosmic salt: it may be reduced by borax. If mineralized by sulphur, a polished globule may be produced by fusing the ore upon charcoal. If arsenic or lead be also present, the sulphur must be first dissipated by roasting. The lead may be driven off by repeated fusions with the blow-pipe.

Mercury, being volatile in a moderate degree of heat, when exposed to the flame impelled by the blow-pipe, flies off, and is entirely lost.

Lead

Lead readily fuſes, and is eaſily calcined. Galena, that is, lead mineralized by ſulphur, yields a diſtinct regulus.

Copper, with a ſmall portion of tin, gives a ruby colour to fluxes; when calcined, the pellucid globule becomes green, but, on cooling, it acquires an opake red, if, during fuſion, the calx or metal be added in ſufficient quantity. If the quantity be farther increaſed, the globule will be opake, even during fuſion, and, when cold, it will aſſume a metallic ſplendor. A portion of copper ſo ſmall as ſcarce to tinge the flux, may be rendered viſible by adding a bit of poliſhed iron, on which it will be precipitated, and the globule will take the colour of iron.

If copper be diſſolved in the ſpoon by a flux, it may be precipitated, in a metallic form, by a bit of cobalt, and the vitrious globule will be blue.

The ores of copper may be eaſily and expeditiouſly aſſayed by the blow pipe. If mineralized by aerial acid, it turns black the moment it is touched by the flame, and fuſes in the ſpoon; if, by a ſuperabundance of marine acid, an opake redneſs is produced in a globule of borax; if by ſulphur alone, the regulus may be obtained by fuſion with borax; if iron be preſent, roaſting and fuſion will be ſufficient without any addition. Roaſting is effected by the exterior flame of the candle.

Iron

Iron. Forged iron may, by the blow-pipe, be calcined, but not fused, except with microcosmic salt, and it is then rendered brittle. Calcined iron becomes magnetic by heating on the charcoal. It fuses in the spoon. To fluxes it gives a green colour.

Tin is easily fused and calcined by the blow-pipe. The smallest proportion of it may be precipitated from any flux on a piece of iron. Crystallized ore of tin, upon charcoal, yields its metal reduced.

Bismuth fuses in the spoon, and with borax or microcosmic salt, forms a yellow glass. Upon charcoal, the calx of bismuth is reduced. Copper and iron precipitate this semi-metal. Bismuth, mineralized by sulphur, fuses with a blue flame: if fused with borax, the metal may be precipitated by manganese or iron.

Nickel calcines in fusion, but slower than other metals. The calx gives to fluxes a yellow colour. Nickel in solution may be precipitated on iron or copper. Iron and arsenic are always present in nickel mineralized by sulphur. The regulus may be obtained by roasting and fusing with borax.

Arsenic, reguline, kindles by a sudden heat, and diffuses a quantity of white smoke. The calx does not burn, but emits a garlic smell. To fluxes it communicates a yellow colour, and may be be precipitated, in a metallic form, by iron or copper. Yellow arſenic liquifies, ſmokes, and is totally diſſipated. When a little heated by the exterior flame of the candle, it becomes red, and, upon cooling, yellow.

Cobalt, calcined, tinges the flux deep blue; which colour it retains obſtinately in the fire. The regulus, in fuſion, will precipitate, from the globule, upon iron. The common ore of cobalt yields a regulus by roaſting and fuſion.

Zinc, under the operation of the blow-pipe, produces a beautiful blue-green flame; but it is ſoon extinguiſhed by a downy white calx. If the *nucleus* be farther urged, it inflames by ſtarts, and explodes a little. This alſo happens in fuſion with microcoſmic ſalt; with borax it froths, and at firſt tinges the flame. The white calx of zinc remains fixed in the fire: whilſt expoſed to the flame, it has a bright yellowiſh appearance.

Antimony crude, that is mineralized by ſulphur, expoſed to the flame impelled by the blow-pipe, liquifies upon charcoal, and is totally abſorbed. The regulus, in the ſame ſituation, if the blaſt be ſuddenly ſtopped, ſends forth a perpendicular column of white ſmoke, whilſt that which invelopes the globule is condenſed into cryſtalline ſpiculæ. The calx of antimony tinges the fluxes of a pale orange colour. The diſſolved metal is precipitated by copper and by iron.

*Mangane*ſ*e* is ſcarce melted by the blow-pipe before it calcines. The black calx gives a bluiſh red tinge to the fluxes; which colour may be alternately destroyed by the interior, and recalled by the exterior flame. The white calx, by ignition, becomes black.

The principal advantages attending the use of the blow-pipe, are, that the experiments may be performed at much less expence, in much less time, and with a far less quantity of the subject to be examined, than by any other mode of operation: add to these advantages, that of observing the entire progress of the process. It must be nevertheless acknowledged, that the blow-pipe is defective in not determining the proportions with any degree of accuracy.

For a more circumstantial description of the use of this instrument, I must refer the reader to Bergman's Dissertation on the subject, which he will find at the end of Dr. Edmund Cullen's translation, vol. 2.

The apparatus described in this chapter, comprehends the principal furniture of an experimental laboratory. Many other utensils, less important, but equally necessary, must be provided: these, necessity will indicate, and will gradually accumulate according to the particular pursuit of the operator. Glass funnels, filtring paper, Wedgewood's mortars, retorts, &c sand, charcoal, and distilled water, are indispensibly requisite. The last of these ought to be perfectly pure, and the surest method of obtaining it totally free from ex-

extraneous matter, is to boil it in an open veſſel for half an hour, and then diſtil it ſlowly in a glaſs alembic. The firſt portion that comes over ſhould be thrown away, and alſo a third part of the whole ſhould remain in the ſtill. The pure water thus obtained, muſt be preſerved in very clean bottles, carefully ſecured by ground ſtoppers. Water thus purified, if the diſtillation has been properly conducted, will neither change the colour of the tincture of tournſol, nor become, in the leaſt degree, turbid on dropping into it a ſolution of mercury or ſilver in the nitrous acid.

The *materia chemica* may be eaſily collected from the preceding pages. Farther knowledge, relative to chemical experiments, may be acquired, as it is wanted, by conſulting the following Lexicon, which ſerves alſo as an index to this volume, and to a ſelect few of other chemical books.

LEXICON

AND

INDEX.

ABSORBENTS are earths, &c. which uniting with acids form neutral ſalts. If the acid be in ſmall proportion, the earth imbibes or abſorbs it: if, on the contrary, we add a little earth to a quantity of acid, the earth diſſolves, and is thence called a ſoluble earth. Abſorbent earths have frequently been called *alkaline earths*; but with evident impropriety: alkalis are *abſorbent*, but they are ſalts and not *earths*; earths are alſo abſorbent, but they are not alkaline. The earths commonly diſtinguiſhed by the term *abſorbent*, are the calcareous and magneſia.

ABSTRACTION, is a word uſed in chemiſtry, as in common language; it is the act of drawing off one ſubſtance from another by diſtillation, evaporation, or otherwiſe: thus the menſtruum is abſtracted by evaporation from the matter which it held in ſolution.

ABSTRACTITIOUS ſpirit is that which is drawn by diſtillation from vegetables, without fermentation. It is, in fact, the eſſential oil of plants diſſolved in water or in ſpirit of wine.

ACANOR, a word uſed by ſome writers inſtead of *Athanor*.

ACCENTION, the act of kindling, igniting, or inflaming.

ACETIFICATION is the act or proceſs of converting a vinous liquid to vinegar, by continuing and accelerating the fermentation, by the heat of the ſun, or by particular ferments.

ACETOUS, *i. e.* belonging or appertaining to vinegar. *Acetous acid* is the acid of vinegar; that is, the acid produced by the fermentation which ſucceeds the vinous. *Acetous æther* is that which is produced by the diſtillation of vinegar with ſpirit of wine.

ACESCENT is properly applied either to things turning ſour, or which promote or produce ſourneſs.

ACIDS, *vide* chap. vi. p. 39.

ACID *aerial*, p. 23. See alſo Bergman's excellent Eſſay on this ſubject.

ACID of Ants, p. 52.

—— arſenical, p. 44.

—— acetous, p. 48.

—— animal, p. 49.

—— of amber, p. 45.

—— of benzoin, p. 45.

ACIDULÆ are mineral waters ſuperabundantly impregnated with the aerial acid: other acids, in a diſengaged ſtate, are only found in waters accidentally. The waters in which this acid is entirely ſaturated with any metal or earth, are improperly called *acidulæ*. But waters abounding with aerial acid, are found nevertheleſs to effervesce with acids and not with alkalis. This phenomenon has puzzled many notable chemiſts. Theſe acidulæ alſo change the colour of ſyrup of violets to green, which is conſidered as a certain proof of an uncombined alkali. There is indeed an alkali in theſe waters, but it is ſaturated with the aerial acid, which, being a very weak acid, does not entirely repreſs the alkaline properties. Nevertheleſs the acid is ſo far prevalent as to render tincture of tournſol red. They effervesce with acids, becauſe the alkali is combined with the aerial acid, the expulſion of which, by a ſtronger acid, produces the effervescence. Pure or cauſtic alkali excites no effervescence with acids. Mild alkali cannot effervesce with the aerial acid, becauſe no expulſion takes place. *Acidulæ* containing no alkali, but lime or magneſia combined with aerial acid, effervesce with the ſtronger acids, for the reaſon above mentioned.

ACIDUM PINGUE, an imaginary new principle, ſuppoſed to have been diſcovered by one Meyer, a German chemiſt, who, in 1764, publiſhed a treatiſe on quicklime, in which he endeavours to prove, that Dr. Black's theory of cauſticity is falſe; that lime becomes cauſtic and ſoluble in water, not becauſe it is deprived of its fixed air by burning, but in conſequence of its having imbibed, during calcination, a peculiar ſubſtance which he calls *cauſticum*, or *acidum pingue*, and which he imagines to be a ſubtle, indeſtructible thing, compoſed of fat, an acid, and the principle of fire. It is this fat acid, he ſays, which is imbibed by metallic calces, and increaſes their weight. United with vitriolic acid, it renders it volatile. It exiſts naturally in ſulphurious caverns.

verns. This doctrine, with all its abſurdity, and, in oppoſition to the moſt unequivocal demonſtration, was nevertheleſs adopted and ſtrenuouſly defended by ſeveral German chemiſts, particularly Crantz.

ACTIVE *principles*, in the language of obſelete chemiſtry, were ſalt, ſulphur, and mercury; paſſive principles were earth and water. Later chemiſts allow of but one active principle, which they called fire or ſulphur. Theſe diſtinctions are at preſent of no uſe: they were conceived in a total ignorance of the nature and properties of the principles thus diſtinguiſhed. Some of the ancient chemiſts called theſe active principles ſpirit, oil and ſalt.

ADAL, in the language of Paracelſus, ſignifies the active parts of vegetable ſubſtances.

ADAMUS, a word uſed by alchemiſts to ſignify the philoſopher's ſtone.

ADEPTS, in the ridiculous language of alchemiſts, were thoſe who were ſuppoſed to have diſcovered the philoſopher's ſtone.

ADIOPHORUS is a name given by Mr. Boyle to what he called a ſpirit obtained by the diſtillation of tartar, which was, in fact, nothing more than an empyreumatic, oily acid.

ADOPTER, is a ſmall glaſs baloon, with two oppoſite necks, one of which is luted to the retort, the other to the receiver, in certain diſtillations.

ADROP, a word uſed by alchemiſts to ſignify the matter from which the philoſopher's ſtone is to be extracted.

ÆS USTUM, or *æs veneris*, or *crocus veneris*, or *ſaffron of copper*, is nothing more than the calx of copper; that is, copper deprived of its phlogiſton by burning, either alone or with ſulphur. It is ſuppoſed to be drying and deterſive, and is, therefore, ſometimes uſed in plaſters; alſo for ſtaining glaſs.

ÆTHER is the lighteſt, moſt volatile, and moſt inflammable of all liquids. It is produced by diſtillation of acids with rectified ſpirit of wine. The vitriolic is the acid generally employed. The beſt method of making æther, is by the following proceſs.

To two or three pounds of rectified ſpirit of wine, add the ſame weight of oil of vitriol, and ſuffer the mixture to continue unmoleſted during twelve hours. Then pour it into a glaſs retort large enough to hold three times the quantity. Place the retort in a ſand-bath; lute it to a large receiver, and make a hole with a pin through the luting. Diſtill with a ſtrong heat, and as ſoon as the liquor boils with large bubbles, remove the fire entirely. The heat retained by the ſand will be ſufficient to complete the diſtillation. The diſtilled liquor muſt then be poured into a clean retort, with two or three ounces of ſalt of tartar, and diſtilled, by a gentle heat, till about half

half of it has paſſed over. If it then be mixed with an equal quantity of ſpring water, and ſhaken, the pure æther will ſwim on the top : but part of the æther will be loſt in the water, which diſſolves about one tenth of its own weight, and the æther will imbibe a certain proportion of water. For theſe reaſons this waſhing is generally omitted. See *Scheele*'s *Eſſays*, p. 299.

Nitrous æther may be made by ſimply mixing nitrous acid with ſpirit of wine in a bottle cloſely ſtopt. In three or four days the æther will ſwim on the ſurface, and may be ſeparated by a glaſs funnel.

Æther poſſeſſes the ſingular property of taking gold from *aqua regia*.

To make *marine æther*, the acid muſt be firſt concentrated by ſaturating it with flowers of zinc, and then diſtilling off the water.

ÆTHERIAL OIL. Eſſential oils are ſo called by ſome chemiſts.

ÆTHIOPS *antimonial*. Flux crude antimony with an equal quantity of ſea-ſalt for an hour. Separate the matter at the bottom of the crucible from the ſcoria, and grind it with an equal weight of mercury.

ÆTHIOPS *martial*, is a black powder, produced by putting ſteel filings into a bottle of water, and letting them there remain till the water becomes black when ſhook, and depoſites a black powder, which is *martial æthiops*.

ÆTHIOPS

ÆTHIOPS *mineral* is mercury combined with ſulphur either by trituration or fuſion in equal parts.

AFFINITY, or *Elective Attraction*, are terms uſed by modern chemiſts to expreſs that peculiar propenſity which different ſpecies of matter have to unite and combine with certain other bodies excluſively, or in preference to any other connection. I do not like either of theſe terms: the firſt implies *relation* that does not exiſt; the latter *choice*, of which inanimate bodies are incapable. For theſe reaſons, I have ſubſtituted *chemical attraction*: *chemical* to diſtinguiſh this ſpecies of attraction from that of Sir Iſaac Newton, which acts in proportion to the quantity of matter. See chap. xiii.

AGATE. A ſpecies of flint, mixed with a ſmall proportion of ſome other earth and iron. Its ſpecific gravity is 2,64. and its chemical properties the ſame as thoſe of flint in general.

AGGREGATE. An aggregate body, in the language of chemiſtry, is a ſolid ſubſtance, compoſed of homogeneous, or of heterogeneous parts, united, not by *chemical*, but by *coheſive* attraction, and which parts may be ſeparated, by mechanical or chemical means, without decompoſition. The component parts of an aggregate body are called *integrant* parts, and thoſe which compoſe theſe integrants, are called *conſtituent* parts, which differ in their nature and properties. When theſe con-

ſtituent

ſtituent parts are diſunited, the body which they formed is ſaid to be decompoſed: an aggregate body, on the contrary, a lump of ſugar for example, may be pounded in a mortar, or diſſolved in water, yet every particle of it, has the ſame properties as the whole lump.

AIR, *atmoſpheric*, page 9.

—— *fixed*, p. 23.

—— *hepatic*, p. 34.

—— *inflammable*, p. 26.

—— *nitrous*, p. 31.

—— *phlogiſticated*, p. 29.

—— *pure*, p. 20: alſo, *Scheele*'s *Eſſays*, page 259.

—— *vital*, p. 20.

ALABASTER is a ſpecies of that genus of ſtones whoſe baſis is calcareous earth. It differs from marble in being combined, not with the *aerial*, but with vitriolic acid; therefore, when mixed with any acid, no efferveſcence appears. It is ſoluble in about 500 times its weight of water at the temperature of 60. It is fuſible alone in a long continued porcelain heat, or by the blowpipe. Specific gravity 1,87. Texture granular, with ſhining particles. In compoſition, and conſequently in its chemical properties, it does not differ from gypſum, ſelenite, and plaſter of Paris.

ALBARESE. So the Italians call lime-ſtone.

ALCOHOL,

ALCOHOL, rectified *spirit of wine*, p. 120.

ALEMBIC is a chemical apparatus of copper or of glaſs, formerly in general uſe for the purpoſe of diſtillation. The bottom part, which contained the ſubject for diſtillation, is called, from its ſhape, the *cucurbit*; the upper part, which receives and condenſes the ſteam, is called the *head*, the beak of which is fitted into the neck of a receiver. Retorts, and the common *worm-ſtill*, are now more generally employed.

ALKAHEST, a word invented by Paracelſus to ſignify an univerſal ſolvent, that never exiſted, except in his own brain, and in that of his brother alchemiſt Helmont.

ALKALI, p. 55.

—— *marine, mineral, foſſile*, p. 58.

—— *vegetable*, p. 56.

—— *volatile*, p. 58.

—— *Pruſſian*, is a ſolution of fixed alkali ſuper-ſaturated with the tinging matter of Pruſſian blue, by boiling. Its principal uſe in chemiſtry is to precipitate iron, or ponderous earth.

The method of preparing this alkali is as follows. To half an ounce of the common white flux, diſſolved in a ſufficient quantity of diſtilled water, add, gradually, two ounces of Pruſſian blue. Let them digeſt a while in a moderate heat; then increaſe the fire, and ſtir the mixture frequently with

with a ſtick. When the lixivium is become clear by ſtanding a while, filter it through paper, and preſerve it for uſe. If it be properly prepared, it will neither efferveſce with acids, nor make paper blue that is tinged with Brazil wood.

The peculiar property of this alkali is, that it will precipitate iron and ponderous earth from their ſolution in acids; whence its uſe in aſſaying earths and ores in the moiſt way. Though called an alkali, it is, in fact, a triple ſalt, conſiſting of the tinging acid, ſaturated partly with iron, and partly with alkali.

ALLOY, or *allay*, in chemiſtry, means the combination of one metal with another: as a term of coinage, it implies the mixture of copper with gold or ſilver. Gold and ſilver cannot be chemically combined in equal quantities; but either of them will unite with copper in any proportion. Gold or ſilver may be alloyed with iron: it renders the firſt of theſe metals hard, brittle, and pale; with copper it unites reluctantly, and in ſmall proportion. Tin readily combines with all metals. Lead unites with all metals, except iron; zinc with all metals except biſmuth. Biſmuth combines with all metals and ſemi-metals, except zinc and arſenic. Regulus of cobalt unites with all metallic ſubſtances, but not in any proportion. Regulus of antimony, of arſenic, and nickel, may be alloyed with moſt metals and ſemi-metals.

ALOE,

ALOE, the inspissated juice of the Aloe plant. It is perfectly soluble in vinous spirit; in water partially.

ALUDELS are pots, shaped like pears, placed upon each other, the neck of the under pot being inserted into a hole in the bottom of that above it, to the number of five or six, for the purpose of sublimation. The bottom pot is adapted to a cucurbite which contains the matter to be sublimed.

ALUM is a crystallizable salt, composed of vitriolic acid and clay. Any given quantity of alum contains about a quarter of its weight of vitriolic acid, somewhat less than a fifth of clay, and the rest water. It requires 15 times its weight of water to dissolve it in the temperature of 60. Alum may be decomposed by alkalies fixed or volatile, because the vitriolic acid prefers these to clay. If therefore the smallest quantity of alum be dissolved in water, a few drops of any alkaline solution will precipitate the clay. A solution of chalk or of silver, in the nitrous acid, is rendered turbid by a solution of alum in water. Waters containing alum in solution are very rare, though so frequently mentioned by writers on mineral waters. Concerning the preparation of alum, see *Bergman*'s *ninth Dissertation*; also *Scheele*'s *Essays*, p. 193.

Alum is used by dyers, to fix their colours, and in various other arts.

ALUM *Plumose.* An improper name given to *fibrous asbestos.*

ALUTA *montana.* A variety of *asbestos*, whose constituent parts are flint, magnesia, lime, clay, fixed air, and iron.

AMALGAM signifies the combination of mercury with any other metal, or metallic substance. For the combination of one metal with another, it is generally sufficient that one of them be in a state of fluidity: mercury, being always fluid, is therefore capable of amalgamation with other metals without heat; nevertheless, heat considerably facilitates the operation.

To amalgamate without heat, requires nothing more than rubbing the two metals together in a mortar; but the metal to be united with the mercury should be previously divided into very thin plates or grains. When heat is used (which is always most effectual, and with some metals indispensibly necessary) the mercury should be heated till it begins to smoke, and the grains of metal made red hot before they are thrown into it. If it be gold or silver, it is sufficient to stir the fluid with an iron rod for a little while, and then throw it into a vessel filled with water. This amalgam is used for gilding or silvering on copper, which is afterwards exposed to a degree of heat sufficient to evaporate the mercury.

Amalgamation with lead or tin, is effected by pouring an equal weight of mercury into either of these metals in a state of fusion, and stirring with an iron rod. Copper amalgamates with great difficulty, and iron not at all.

AMBER becomes electric by friction, and then emits a very agreeable smell. It melts in 550 degrees of Fahrenheit's thermometer. It is soluble in vitriolic acid and in balsams; but not in water, nor in spirit of wine. In expressed oils it may be dissolved by long digestion, but not without some decomposition. 100 grains of amber contain near 90 of phlogiston, and four of a peculiar acid, which is obtained by distillation; with an oil of the nature of petrolium, and a little water.

AMBERGRIS is, after much controversy, now believed to be of animal origin: it is totally soluble in essential oils, and in spirit of wine.

AMIANTHUSE, classed by Mr. Kirwan, in the muriatic genus of earths, because it contains about a fifth part of magnesia. Its other constituents are flint, mild calcareous earth, barytes, clay, and a very small proportion of iron. It is fusible *per se* in a strong heat, and also with the common fluxes. It differs from *asbestos* in containing some ponderous earth.

AMMONIAC *sal*. All neutral salts, composed of an acid combined with volatile alkali, are called *ammoniacal*; but *sal ammoniac*, properly so called,

called, consists of volatile alkali and marine acid. It is of considerable use in various arts and manufactures, and is imported in large quantities, particularly from Egypt, where, we are told, it is produced, by sublimation, from soot procured by burning the dung of cows and camels. But *sal-ammoniac* may be made by saturating marine acid with volatile alkali. This salt cannot be decomposed by heat alone in close vessels; it will sublime entirely. It may be decomposed, in distillation, by the vitriolic or nitrous acid, because their attraction to alkalis is superior to that of the marine. If nitrous acid be employed, part of it will rise with the marine, and form *aqua regia*.

Sal ammoniac may also be decomposed by calcareous earth, or fixed alkali, because acids in general prefer these to volatile alkali. Thus, if powdered sal-ammoniac be distilled with twice its weight of chalk, a concrete volatile alkali will line the inside of the receiver, equal in weight to the sal-ammoniac employed. This last circumstance puzzled the celebrated Baumé exceedingly, not knowing that the increase of weight proceeded from the combination of fixed air with the volatile alkali, the marine acid uniting with the lime.

If, instead of chalk, or mild fixed alkali, quicklime be employed, a liquid, caustic volatile *spirit of sal-ammoniac* will be obtained. It is cauſtic becauſe there is no fixed air preſent in the proceſs.

If *Sal ammoniac* be diſtilled with vitriolic acid, the marine acid will paſs into the receiver, and the vitriolic acid, uniting with the volatile alkali, will form *vitriolic ammoniac*. Nitrous acid will have the ſame effect.

AMMONIAC *gum*, is a gum-reſin, conſequently partly ſoluble in ſpirit of wine, and partly in water; but, as part of either ingredient will diſſolve with the other, of an ounce, ſpirit will diſſolve ſix drams, or water will diſſolve nearly ſeven.

AMETHIST, a ſpecies of flint, generally of a pale, reddiſh, violet colour. It loſes its colour in a ſtrong heat; but does not melt alone. It may be imitated by adding to a frit of cryſtal glaſs, eight parts of magneſia, and one part of zaffre.

AMORPHOUS. Shapeleſs, exhibiting no regular form or geometrical figure.

ANALYSIS is the reſolution of a body into its conſtituent parts, either by fire or by ſolution.

ANNEALING, by the workmen called *nealing*, is particularly uſed in making glaſs: it conſiſts in placing the bottles, &c. whilſt hot, in a kind of oven or furnace, where they are ſuffered to cool gradually; they would otherwiſe be too brittle for uſe.—Metals are rendered hard and brittle by hammering; they are, therefore, made red hot

in

in order to recover their malleability; this is called *nealing*.

ANNOTTO is ſoluble in water in which alkaline ſalt is diſſolved, and this ſolution being boiled with ſilks, woolen ſtuffs, or linen, communicates an orange colour, deep but not durable. Diſſolved in ſpirit of wine, it is uſed in varniſhes and laquers.

ANTIMONY, p. 111, 200.

APHRONITRE of the ancients, was probably the ſaline efflorefcence gathered from the walls of vaults. It is the ſame ſalt which, in another ſhape, they called *natron*, and which we denominate *marine*, or *foſſile alkali*.

APPARATUS *pneumatical*, p. 204.

APPLE. From apples M. Hermbſtædt, of Berlin, obtained an acid which he takes to be an imperfect vinegar, containing too little phlogiſton for ſaccharine acid, and too much for pure vinegar. He ſuppoſes it to be the acid of tartar altered by an internal fermentation in the fruit. Might he not, with propriety, have called this acid *verjuice?*

APYROUS bodies are thoſe which are unalterable by fire.

AQUA FORTIS is the nitrous acid commonly uſed by artiſts and manufacturers; that which is concentrated and ſmoking, is called *ſpirit of nitre*. The aquafortis uſed by dyers, braſs-founders, &c, is is not only weaker than ſpirit of nitre, but contains a portion of vitriolic acid. It may be made by diſtilling crude nitre with calcined vitriol, equal parts. The nitrous acid, expelled by the vitriolic, will riſe in red fumes, and paſs into the receiver. The vitriolic acid, uniting with the alkaline baſis of the nitre, forms *vitriolated tartar*; but, there being more vitriolic acid than is requiſite to ſaturate the alkali, the ſurplus riſes with the nitrous acid: *aquafortis*, therefore, is a mixture of theſe two acids. It may alſo be made by diſtilling crude nitre with ſomewhat more than half its weight of oil of vitriol; or by mixing one part of oil of vitriol with nine parts pure ſpirit of nitre. See *Spirit of Nitre*.

AQUA MARINE, a precious ſtone of the firſt order. See *Beryl*.

AQUA REGIA is a compound of nitrous and marine acid, in different proportions according to the purpoſe for which it is intended. It is uſually made by diſſolving, in nitrous acid, ſal ammoniac, or common ſalt, both which are combinations of marine acid with alkali. When made with ſal ammoniac, the common proportion is one part of this ſalt to four parts of nitrous acid; but, to diſſolve platina, equal parts are requiſite. A purer *aqua regia* may be made by ſimply mixing the two acids.

Aqua regia is particularly uſed as a menſtruum for gold; it likewiſe diſſolves all other metals, except

except silver. The gold dissolved in *aqua regia* is, in fact, dissolved in the dephlogisticated marine acid only, which, being deprived of its phlogiston by the nitrous acid, recovers it from the gold, and thus renders gold soluble; for metals are not soluble in acids, until they lose a part of their phlogiston.

AQUA SECUNDA. *Aqua fortis* diluted with water.

AQUA VITÆ. Spirit of wine.

AQUILA ALBA. Calomel.

ARBOR DIANÆ. The silver tree, so called by ancient chemists, who gave to silver a name which the Heathen mythologists had given to the moon. The production of this tree is an experiment of mere amusement. It is nothing more than a precipitation of silver, by mercury, from the nitrous acid, and is thus produced. Amalgamate four drams of silver-leaf with two drams of mercury. Dissolve this in four ounces of spirit of nitre, and then dilute it with a pint and a half of distilled water. Shake the bottle, then stop it close and preserve it for use. When the experiment is to be made, put an ounce of the mixture into a phial, with a bit, the size of a pea, of a soft amalgam of silver, and in a short time particles of silver will precipitate, and, adhering to each other, will spread in form of a shrub.

ARBOR MARTIS, the iron tree, is produced by saturating a solution of iron filings in nitrous acid,

acid, with *olium tartari*. The tree will appear on the internal ſurface of the glaſs.

ARCANUM CORALLINUM. Red precipitate.

ARCANUM DUPLICATUM. Vitriolated tartar.

ARCHIL, or ORSEILLE, a white moſs uſed in dying. Ground and moiſtened with volatile alkali it yields a fine purple, but not durable.

ARGENTUM MOSAICUM, or MOSIVUM, is an amalgam of tin, biſmuth, and mercury. Mixt with white of egg, or ſpirit varniſh, it is uſed for covering plaſter figures.

ARGIL. Clay, ſo called by Mr. Kirwan.

ARSENIC, p. 102 and 200: alſo *Bergman's Diſſertation* xxi. and *Scheele's Eſſays*, p. 143.

ASA FŒTIDA, a gum-reſin, from which ſpirit extracts more than water. It contains a little eſſential oil, in which its ſmell reſides.

ASBESTOS, *fibrous*. A greeniſh ſtone of the muriatic genus. It is compoſed of flint, magneſia, calcareous earth, clay, and iron. It is generally infuſible *per ſe*; but may be fuſed with borax. There is a variety of this ſpecies, called mountain cork, of the ſame chemical properties.

ASPHALTUM. See *Bitumen*.

ASSAY. p. 189.—in the humid way, ſee *Bergman's Diſſertation*, xxiv.

ATHANOR, a fixed furnace, ſo contrived as to feed itſelf with fuel, by means of a tower filled with charcoal. It is now totally out of uſe, ſince we are no longer in ſearch of the philoſopher's ſtone.

ATTRACTION, p. 134.

AURUM FULMINANS, p. 72. See alſo *Gold fulminating.*

AURUM MOSAICUM, or MUSIVUM, conſiſts of gold-coloured flakes. It is uſed as a pigment, and, mixed with melted glaſs, to imitate the ſpangles of *lapis lazuli.* It ſeems to be a mixture of tin and ſulphur It may be made thus: ſulphur, ſal ammoniac, and mercury, each ſix ounces; tin, twelve ounces; firſt melt the tin, then add the mercury. When it is cold, reduce it to powder, and add the other ingredients. Sublime the mixture in a matraſs, and the aurum moſaicum will be found under the ſublimate.

AURUM POTABILE, or *tincture of gold.* A medicine formerly in great repute, though certainly good for nothing It was made by mixing oil of roſemary with a ſolution of gold in *aqua regia*; ſhaking the bottle; afterwards pouring off the oil; and, finally, digeſting it for a month in ſpirit of wine.

AURUM SOPHISTICUM, ſham gold. Melt together in a crucible, diſtilled verdegriſe 8 ounces, crude tutty 4 ounces, borax 12 ounces, nitre one ounce and a half.

AZURE. Pounded ſmalt.

BALANCE, *hydroſtatical,* is a peculiar apparatus for determining the ſpecific gravity of bodies, by weighing them in water. A body is ſpecifically

cally heavier than another when, under the ſame dimenſions, it contains a greater weight. A body ſpecifically heavier than a fluid, when weighed in that fluid, loſes ſo much of its weight as is equal to the weight of a quantity of the fluid of its own bulk; or, to ſo much of the fluid as would run over, if the veſſel were quite full. An ounce of gold, containing the ſame quantity of matter, in leſs ſpace than an ounce of ſilver, will conſequently diſplace a leſs quantity of water. For example, I ſuſpend a guinea in a loop of horſe-hair, faſtened by a hook to the under ſurface of a ſmall braſs ſcale, and balance it with 129 grains in the oppoſite ſcale. I then immerſe the guinea in a veſſel of water, and find that the ſcale, containing the weights, will ſo far preponderate, as to require 7 grains to be put into the ſcale over the guinea, before I can reſtore the equilibrium. Therefore the quantity of water diſplaced by the guinea, weighs 7 grains. I divide 129 by 7, and the product is 18. Hence I conclude, that the gold, of which this guinea was made, is 18 times ſpecifically heavier than water, and I call its ſpecific gravity 18.

The ſpecific gravity of fluids, comparatively, is eaſily determined by ſuſpending a ball of any metal in the place of the guinea, and ſubſtracting the number of grains required, in each fluid, to reſtore the equilibrium, from the original weight.

BALLS,

BALLS, *martial,* are a mixture of iron filings and cream of tartar, formed into balls, for the purpose of impregnating water, &c. with iron. They are out of date.

BALLS, *mercurial,* are an amalgam of tin with mercury, formerly used for purifying water. They are good for nothing.

BALLOON. A round glass receiver.

BALLOON. A globe, or rather artificial bladder, in the shape of a pear, made of varnished silk, for the purpose of sailing in the air. Chemistry is principally concerned in this species of navigation; first, in making the varnish; and secondly, in filling the balloon with inflammable air. A varnish for this purpose may be made, by first dissolving elastic gum in five times its weight of spirit of turpentine, and then boiling one ounce of this solution in eight ounces of drying linseed oil for a few minutes. It must be used warm.—A varnish for the same purpose may be made by boiling, for an hour, litharge, gum sandarach, and white vitriol, of each two ounces, in a pint of linseed oil, and diluting the strained solution with spirit of turpentine.——Another varnish is prepared by boiling a pound of birdlime in three pints of drying linseed oil, which is afterwards to be diluted with an equal quantity of spirit of turpentine.

The inflammable air with which these balloons are inflated, is produced by a mixture of iron

turn-

turnings and diluted vitriolic acid. A circumstantial description of this operation, may be seen in the *Appendix* to the last edition of *Chambers's Dictionary*.

BALNEUM MARIÆ means a water-bath; that is, a vessel of boiling water, in which another vessel, containing the matter to be distilled or digested, is placed. Why it is called *balneum mariæ*, I know not.

BALSAM, *native*, is a resinous, aromatic, thick juice, issuing from incisions in certain trees. They owe their smell to an essential oil, that may be extracted by the heat of boiling water. They are rendered miscible with water, by the yolk of eggs, by sugar, or by gum. When deprived of their essential oil by distillation, they are mere resins.

BALSAM OF SULPHUR. Sulphur dissolved in oil by boiling over a slow fire.

BARYTES, ponderous earth, p. 61: also, *Kirwan*'s *Mineralogy*, p. 5.

BASALTES, *Trap*, or *Touchstone*. A blackish smooth stone, generally found in angular columns, as in the Giants causeway in Ireland. It melts, *per se*, in a strong heat into a slag. Borax dissolves it in fusion. According to Bergman, 100 parts of basaltes contain 50 of flint, 15 of clay, 8 of calcareous earth, 2 of magnesia, and 25 of iron.

BASIS,

BASIS, applied to neutral or metallic salts, means the alkali, earth, or metal, which, combined with an acid, constitutes the salt in question.

BATH, is a substance used in certain chemical operations to transmit heat equally and in a moderate degree. Water, or sand, in which vessels for distillation or digestion are placed, are the only baths now used in chemistry.

BAUME *de vie*. ℞. Agaric, zidoary, flowers of sulphur, of each two drams. Socotorine aloes, theriaca, of each one ounce. Rhubarb six drams. Gentian half an ounce. Saffron two drams. Brandy one quart. Sugar four ounces.—Digest in a sand-bath for five or six days. Express the liquor through a flannel bag, and after standing till it is perfectly clear, pour it off.

This famous medicine was the invention of David Spina, who published the *recepe* in his *Body of Pharmacy*. The agaric and flowers of sulphur are of no use. The agaric serves only to render the farrago more nauseous.

BDELIUM. A gum-resin, more soluble in water than in spirit.

BELL-METAL is a composition of 22 pounds of tin to 100 weight of copper.

BEN-*nut*, is the fruit of the *Guilandina moringa* of Linnæus. It grows in the East Indies and in America. This nut yields, by expression, an oil which will keep many years without becoming rancid;

rancid; in consequence of this property, it is impregnated, by perfumers, with the oders of those flowers which yield very little essential oil in distillation. On a layer of fine cotton-wool, dipt in this oil, they strew a thick layer of the flowers; then another of cotton, and so alternately till the vessel is full, which being covered close, is placed in a water-bath for 24 hours, and the oil afterwards pressed out.

BENZOIN is a resin containing an acid salt which, by sublimation, concretes into crystalline spiculæ called flowers of benzoin, of which a pound of the resin will yield from 9 to 12 drams. This acid may be also separated from benzoin by pouring upon it a solution of alkaline salt in water; but more effectually by boiling it in lime-water, and precipitation with marine acid. See *Scheele*'s *Essay* vii.

BERYL is of the first order of precious stones, the constituent parts of which are flint, clay, calcareous earth, and iron. It differs from the emerald only in its colour, which is a lighter and yellowish green; and from the *augites*, or *aqua marine*, which has a bluish tinge. It melts *per se* into a slag, and is vitrifiable with borax and microcosmic salt. It may be imitated by adding to flint-glass, in fusion, a small proportion of calcined copper and zaffre.

BEZOAR *mineral.* A foolifh name given to an infoluble, inert calx of antimony, the preparation of which is not worth knowing.

BISMUTH, p. 100, 198.

BISTRE is a brown pigment, which is made by grinding the foot of beech-wood with water, then adding more water, and when the groffer parts have fubfided, pouring the liquor into another veffel, and leaving it for three or four days to fettle. The water being then ftrained off, the biftre remains.

BITTERN is the mother-ley, or liquor which remains after the cryftallization of fea-falt. It contains fome Glauber's falt, a great deal of Epfom falt, a little fea-falt with a calcareous bafis, and fome uncryftallized common falt.

BITUMEN is a generic term applied to a variety of foffil inflammable fubftances. Except coal, they are all electric *per fe,* and infoluble in water or fpirit of wine, but may be diffolved in fome oils. The fpecies are, naphtha, petrolium, Barbades tar, afphaltum, mineral tallow, jet, coal, amber, ambergrife.

BLACK. This colour, when artificial, is produced by the mixture of a folution in water of a metallic falt, of which iron is the bafis, with an infufion of fome vegetable aftringent. Green vitriol, alfo called copperas, and galls are generally ufed for this purpofe. This mixture is the foundation of ink, and of all black dyes for filk, woollen-

cloth,

cloth, hats, and leather. Black pigments are made either of black chalk, or charcoal: that of ivory is the beſt.

BLOW-PIPE, p. 248: alſo *Bergman*, vol. ii. p. 463.

Charcoal, or a gold or ſilver tea-ſpoon, have been uſed by Bergman and other chemiſts, as ſupports for the various minerals fuſed by the blow-pipe. From the *Journal Phyſique* for July and Auguſt 1787, I learn, that M. Dodun has invented a new ſupport: it conſiſts of a ſolid piece of glaſs, of a triangular form, two or three inches long; its baſe about one third of an inch, and gradually tapering upwards to a fine point. Having wetted this point a little, he takes up a minute fragment, or a very ſmall quantity of the powdered matter to be examined, which, by holding it a little while in the flame of the candle, becomes ſufficiently attached to the red-hot apex of the ſupport. He then applies his mouth to the pipe which he holds in his right-hand, and the ſupport in his left. With this apparatus M. Dodun was able to fuſe a conſiderable number of mineral ſubſtances, many of which have been deemed infuſible *per ſe*. In theſe *Memoires* (as the French chuſe to call them) M. Dodun relates no leſs than 63 experiments upon refractory matters, in which he ſucceeded beyond his expectation. He attributes his ſucceſs to his being able, by means of this ſupport, to operate upon a much ſmaller

ſmaller quantity of matter than was poſſible by any other means; but he ſeems throughout to have deceived himſelf in ſuppoſing that theſe were fuſions *per ſe*. Could he poſſibly forget that the glaſs of the ſupport acted as a flux?

BLUE. This colour, extracted from vegetable matter, is of great uſe in diſcovering the preſence of acid or alkali in any fluid. Syrup of violets hath been generally uſed, and, if genuine, it anſwers the purpoſe very well. Tincture of *turnſol* poſſeſſes greater ſenſibility, as it will diſcover the preſence of aerial acid, which, I believe, other vegetable blues will not. Theſe blue ſyrups or tinctures from blue flowers, are changed to green by alkali, and red by acids. I have found that a ſyrup, or tincture with the addition of a little ſpirit of wine, made of the purple petula of the *viola tricolor*, known in our gardens by the name of heart's-eaſe, will anſwer the ſame purpoſe. I have alſo tried the purple rocket larkſpur with equal ſucceſs. In dying, indigo, woad, and logwood, are generally uſed for giving a blue colour to various ſtuffs. The latter is not permanent.

BLUE, *Pruſſian*, is ſuppoſed, by M. Macquer, to be a precipitate of iron ſuper-ſaturated with phlogiſton. We learn from the celebrated Scheele, that it contains a peculiar acid. Be that as it may, the beſt proceſs for making Pruſſian blue, is as follows: take 3 lb. of dried ox's blood, 6 lb. of quicklime, 2 lb. of red tartar, $1\frac{1}{2}$ lb. of nitre. Calcine theſe in a crucible, in a hot fire, for four hours. Throw this into a large pail of boiling water, and, after filtration, mix it with a ſolution of 1 lb. of green vitriol. About 26 oz. of Pruſſian blue will precipitate. A large quantity of alum is generally added, but it is of no uſe. See *Scheele*'s *Eſſays*, p. 319.

BLUE, *Saxon*. Take any quantity of indigo, and digeſt it in ſpirit of wine, and, when quite dry, throw it into four times its weight of oil of vitriol in a glaſs veſſel, and digeſt in the heat of boiling water during one hour. Then mix it with twelve times the weight of water, and filtre it when cold.

BOLE. Clay, coloured, naturally or artificially, by calx of iron.

BOLT-HEAD, or *matraſs*, is a round bottle with a long neck, uſed chiefly for digeſtions.

BONES are ſoluble in all acids, ſufficiently concentrated. Bones may be coloured by boiling in water with drugs uſed for dying; or, without heat, by metallic ſolutions. Gold in *aqua regia*, purple: ſilver in nitrous acid, brown or black: copper in vinegar, green: copper in volatile alkali, blue green.

BORAX is a neutral ſalt, conſiſting of a peculiar acid, ſuper ſaturated with mineral alkali. It may be decompoſed, in ſolution, by the vitriolic,

the

the nitrous, or the marine acid, for any of which the mineral alkali will quit the acid of borax, called by Homberg who diſcovered it, *ſedative ſalt.* Borax, in fuſion, diſſolves and vitrifies all earths, and promotes the fuſion of metals; hence its uſe in aſſaying of ores, and in ſoldering. It is uſed in dying, and in other arts. It is ſoluble in ſpirit of wine and in water; but ſuffers no decompoſition by fire: expoſed to a ſtrong heat, it melts into a glaſs, which, diſſolved in water and evaporated, forms cryſtals of borax as before.

BRANDY is diſtilled from wine, and differs from ſpirit of wine only in containing more water.

BRASS is a compoſition of copper with about a fourth part of zinc. It is generally made by a cementation of copper with *lapis calaminaris*, an ore of zinc, in the following manner. The *lapis calaminaris* being calcined and ground to a fine powder, is mixt with a fourth part of powdered charcoal, and, with water, made into a maſs. Seven pounds of this maſs is put into a melting-pot, and over it five pounds of granulated copper. It is then covered with powdered charcoal, and expoſed to the heat of a wind-furnace for eleven or twelve hours; after which it is caſt into plates or lumps of braſs, which will weigh ſomewhat more than eight pounds.

BRONZE. A compoſition of tin and copper, to which zinc and other metals are ſometimes added,

ded, according to the purpofe for which it is defigned, whether bells, cannon, or ftatues.

BUTTER *of Antimony* is a folution of half calcined regulus of antimony in concentrated marine acid. This cauftic is procured by diftilling, in a retort, placed in a fand-bath, one part of the regulus with three parts of corrofive fublimate, both reduced to a fine powder. If crude antimony be ufed inftead of the regulus, the proportion is three parts of antimony to four of the fublimate. M. Macquer, and other French chemifts, tell us that, in this procefs, the marine acid quits the mercury and unites with the regulus of antimony, in confequence of a fuperior affinity to the latter. They are certainly miftaken. The mercury, in corrofive fublimate, being a calx, attracts the phlogifton, neceffary for its reduction, from the regulus of antimony, and the marine acid, thus fet free, unites with the half-calcined regulus. Vide *Scheele*'s *Effay* xi.

BUTTER *of Wax.* Wax deprived of part of its acid by diftillation.

BUTTER *of Tin*, is a combination of tin with concentrated marine acid, obtained by diftilling this metal with corrofive fublimate. What firft comes over is called *fmoking fpirit of Libavius*; the latter part, which is thick, is called *butter of tin.*

CADMIA, a vague word applied by Pliny and others to very different fubftances: viz. calamine, flowers of zinc, cobalt, copper ores, &c.

CA-

CALAMINE, or *Lapis Calaminaris*; is a calciform ore of zinc, containing alſo iron and clay in different proportions. Its colour and texture are various. When calcined with charcoal, flowers of zinc are ſublimed. It is ſoluble in acids. Moſt of the Engliſh calamine contains lead. Its ſpecific gravity is from 4,000 to 5,000. For the application of calamine to copper for making braſs, ſee *Braſs*.

CALCAREOUS *earth*, p. 61. Calcareous earths or ſtones from a diſtinct genus of foſſils, comprehending eleven ſimple and five compound ſpecies. *Kirwan*'s *Mineralogy*, p. 22.—It is commonly found combined with aerial, or with ſome other acid; with other earths or metals.

CALCES *of metals*, are the peculiar earths of metals deprived of their phlogiſton, either by burning or by ſolution in acids. Theſe are capable of being reduced, that is revived, or reſtored to their former metallic ſplendor, by the addition of phlogiſton contained in fat, oil, or charcoal. Theſe calces are found to be heavier than the metals themſelves. Some philoſophers ſuppoſe this increaſe of weight to be owing to fixed air; ſome to water, ſome to pure air imbibed in the calcination, and others to the matter of heat.

CALCINATION, p. 178.

CALOMEL, or *mercurius dulcis*; is marine acid ſaturated with quickſilver, by rubbing the metal in a mortar with about an equal quantity of corrofive fublimate, and then fubliming the mixture, in a matrafs, repeating the operation feveral times. This *fweet mercury*, as it is called, is a metallic neutral falt, which, like all neutral falts where the faturation is complete, is mild. The marine acid, which was highly corrofive in the fublimate, is now mild in the calomel, becaufe it is faturated with mercury.—This procefs for making calomel, is both dangerous, troublefome, and expenfive: the incomparable Scheele, therefore, propofes a much more fimple method of faturating corrofive fublimate with mercury, thus:—Digeft half a pound of quickfilver with the fame weight of pure *aqua fortis*, in a long-necked cucurbit, for three or four hours, in warm fand. Increafe the heat fo as almoft to make it boil. Shake the veffel now and then, and in three or four hours more, make it boil during a quarter of an hour. Mean while diffolve four ounces and a half of common falt in feven pints of water, and, whilft boiling, pour the liquor into a glafs veffel. To this folution add that of the mercury, alfo boiling, by little at a time, with conftant agitation. Let it ftand to precipitate; then pour off the clear liquor, and wafh the precipitate with hot water till it comes off quite taftelefs. Now filtre the precipitate, and dry it flowly. This is calomel.

CAMPHOR is a very fingular inflammable fubftance, faid to be obtained, by diftillation, prin-

principally from the roots of a ſpecies of Laurus growing in the Eaſt Indies. Like reſins, it is ſoluble in ſpirit of wine; but it ſublimes without decompoſition. Like oils it is inflammable; but it rejects all union with alkalis. It is ſoluble in the vitriolic or nitrous acid, but ſeparates unaltered from either on the addition of water.

CANTHARIDES. Spaniſh flies. From four ounces of theſe inſects, Neuman extracted, by ſpirit of wine, ſix drams and two ſcruples of an acrid reſinous ſubſtance, which is probably the cauſe of their ſtimulating effect.

CAP, is the upper piece of a wind-furnace; or, in a portable furnace for diſtillation, that piece which covers the retort.

CAPITAL. The head of an alembic.

CAPUT MORTUUM. That which remains in the retort after diſtillation to dryneſs.

CARMINE. A beautiful and coſtly pigment of a crimſon colour. It is a precipitate of cochineal, by means of alum, from its ſolution in an alkaline lixivium.

CARNELIAN. A red precious ſtone of the ſiliceous genus, mixed with other earth and iron. It is affected by borax and microcoſmic ſalt like other flints. Its ſpecific gravity is 2, 6.

CASE-HARDENING is a ſuperficial converſion of iron tools or inſtruments, into ſteel by *cementation*.

CASSIA. That which is now generally in uſe is brought from the Antilles. It is ſoluble both in vinous ſpirit and in water.

CAUSTIC *common*, is fixed vegetable alkali deprived of its fixed air by quicklime. It is made by evaporating ſoap-ley to dryneſs, and melting it afterwards in a crucible: or by boiling the ley down to a fourth of its quantity, and then mixing it with quicklime to the conſiſtence of a paſte.

CAUSTIC *lunar*, or *lapis infernalis*, is a metallic ſalt compoſed of ſilver and nitrous acid. It is made by diſſolving the pure metal in twice its weight of the acid, and exhaling the moiſture in a crucible until the maſs flows like oil. It is then poured into ſmall moulds.

CAUSTICITY, is that quality in certain ſubſtances, which burns, corrodes, or, more properly, diſſolves any part of an animal body to which they are applied. The ſubſtances which poſſeſs this property, are, pure alkalis, pure lime, ſtrong acids, and their combinations with certain metals. What is the cauſe of this deſtructive power? Baumé ſays, it is actual fire; that this *almoſt pure fire*, as he calls it, is not only the cauſe of all cauſticity, but alſo of taſte. If this be true; if *almoſt pure fire* be the cauſe of cauſticity, both in acids and alkalis, it is very extraordinary that, when theſe two ſubſtances are mixed, their cauſticity is deſtroyed; and that, during the mixture,

cold

cold ſhould be produced inſtead of heat, the reverſe of which would certainly be the caſe, if, in the conflict, the fire were expelled; and if it be not expelled, what becomes of it.—Meyer, a famous German chemiſt, aſcribes cauſticity to an imaginary ſomething which he calls *cauſticum*, or *acidum pingue* (oil and vinegar) compoſed of an acid and the principle of fire. Abſolute nonſenſe!—Cauſticity is the effect of peculiar attractions; of a propenſity in certain bodies to combine with each other; of that *paſſion* (I had almoſt ſaid) and power of gratification or ſaturation in certain bodies, which they never fail to exert when brought within their proper ſphere of attraction. Pure acid and pure alkali are equally cauſtic; but they diſcover no conſtituent principle which is common to both: therefore the immediate cauſe of their cauſticity cannot be attributed to any principle in their compoſition. They have each a propenſity to unite with certain other ſubſtances: they are both cauſtic, becauſe they are unſaturated; but their objects are different. Acids corrode an animal body in conſequence of their violent attraction to ſome of its principles, with which, when they are once ſaturated, they ceaſe to be corroſive. Alkalis and quicklime deſtroy animal ſubſtances, in conſequence of their exertion to ſaturate themſelves with fixed air and water. Lunar cauſtic, &c. is more violently corroſive than the ſimple acid, becauſe the acid, in this ſtate of combina-

tion,

tion, is more concentrated: this appears from the ſtrong vinegar obtained, by diſtillation, from verdigriſe, and from the proceſs of making butter of antimony, with corroſive ſublimate.

In the *Appendix* to Macquer's *Chemical Dictionary*, the reader will find a very long diſſertation on cauſticity, in which the author ſtrangely confounds chemical attraction with gravitation.

CAWK, or *ponderous ſpar*, is a greyiſh hard ſtone, conſiſting of ponderous earth combined with vitriolic acid. It is inſoluble in water or in acids: infuſible *per ſe*, but fuſible with the uſual fluxes. It may be decompoſed by calcination with fixed alkali.

CEMENT, is the paſte or powder uſed in the proceſs of cementation: that with which gold is ſtratified, for the purpoſe of purification, in the operation called *parting*, is compoſed of four parts brickduſt, with ſea-ſalt and calcined green vitriol, each one part, made into a paſte with water:—that which is employed in converting iron into ſteel, is made of two parts charcoal, one part charred bones, and half a part of wood aſhes:—that for making braſs, conſiſts of equal parts charcoal and *lapis calaminaris*:—that which is uſed for converting glaſs into porcelain, is compoſed of equal parts of ſand and gypſum.

CEMENT is alſo a glutinous matter, uſed in preparing glaſs veſſels for chemical purpoſes, by faſtening braſs or wood to particular parts of them;

them: it is made by melting resin and bees wax p. æ. and thickening it to a proper consistency with fine brick-dust.

CEMENT *Copper*, is copper precipitated by iron, from natural springs in which copper is found dissolved in the vitriolic acid, which quits the copper to unite with the iron; but the copper appears in its metallic form, because phlogiston prefers copper to the iron with which it was combined.

CEMENTATION is the process by which metals are purified or altered by heat, without fusion, by means of a cement with which they are stratified or covered.

CERUSS, or *white lead*, is an imperfect calx, rust, or solution of lead, which is produced by exposing thin sheets of this metal to the vapour of vinegar. Cerufs is found native in France, Germany, and in England; but generally mixed with a little iron and earth.

CERUSS *of antimony* is the white powder that precipitates from the water with which *diaphoretic antimony* has been washed.

CHALCEDONIAN, a siliceous stone of a bluish white colour, consisting principally of flint, with a small proportion of other earths and iron.

CHALK, *white*, is lime (*i. e.* pure calcareous earth) combined with aerial acid in the proportion of about four parts of the latter to six of lime.

M. Baumé

M. Baumé ſays, that the pureſt chalk contains ſome iron; but M. Baumé is frequently miſtaken.

CHALK *black* conſiſts of magneſia, flint, clay, mineral oil, and aerial acid. It calcines to a reddiſh earth, and is inſoluble in acids.

CHALK *red* is clay mixed with the red calx of iron. In a ſtrong heat it melts into a black glaſs,

CHALK *ſpaniſh*, or *ſoap-rock*. Its compoſition is the ſame as black chalk, except the mineral oil. Its colour is yellow or whitiſh.

CHARCOAL prepared by burning wood covered from the external air, ſeems to conſiſt entirely of phlogiſton and an earth, which principles cannot be ſeparated, without addition, by the moſt intenſe heat in cloſe veſſels. That charcoal, which conſiſts almoſt entirely of phlogiſton, ſhould, if excluded from the air, bear the ſtrongeſt fire, for any length of time, without the leaſt diminution or change, ſeems aſtoniſhing. It is, however, a ſtrong proof, that all decompoſition is the effect of chemical attraction. The phlogiſton, in charcoal confined in a red-hot crucible, adheres to its earth, becauſe it is in contact with nothing that can attract it. But, when charcoal is burnt in the open atmoſphere, the phlogiſton is attracted by the pure air, which it prefers to earth, and therefore quits it. For the ſame reaſon, charcoal acts as a flux to metallic calces, by reſtoring their phlogiſton, which prefers metallic

earths

earths to its own.—The celebrated Abbé Fontana lately diſcovered, that a piece of charcoal made red hot, and ſuddenly extinguiſhed in quickſilver, will abſorb four or five times its bulk of air.—Charcoal, particularly that of ivory, is uſed by painters as a black pigment.

By the modern ſect of philoſophers (I believe we have not one in this kingdom) who deny the exiſtence of phlogiſton, charcoal is made an element, and not only a conſtituent principle of all animal and vegetable ſubſtances, but of metals alſo: they tell us moreover, that charcoal with vital air, forms aerial acid. Nonſenſe.

CHEMISTRY, p. 1.

CHERT is a ſpecies of flint, but more opake than common flint, and generally of a dark blue or yellowiſh grey colour. It contains about a fourth of its weight of clay with a ſmall proportion of calcareous earth. It is generally fuſible *per ſe*, and totally ſoluble with borax.

CHRYSOCOLLA. Borax, in the impure ſtate in which it is imported, is ſo called. Mountain blue, an ore of copper, is alſo, by ſome writers, called *chryſocolla*.

CHRYSOPRASIUM, a ſtone of the ſiliceous genus, of an apple-green colour, and ſemi-tranſparent. It loſes its tranſparency in the fire, but does not melt *per ſe*. It contains a very ſmall proportion of calcareous earth, magneſia, and iron. *Kirw. Min.* chap. 8. ſp. 8.

CHRYSOLITE. See *Emerald.* We are told that this ſtone may be imitated by fuſing ſix ounces of minium and twenty grains of crocus martis, with two ounces of cryſtal glaſs.

CINNABAR, *native* or *factitious*, is a compoſition of mercury and ſulphur, in the proportion of about eight parts of the former to two of ſulphur. The mercury is eaſily ſeparated by diſtillation with iron filings, which will unite with the ſulphur, and the mercury will paſs over into the receiver.

CINNABAR *of Antimony*, differs not at all from other cinnabar. It is equally uſeful for painting and equally uſeleſs as a medicine. It is obtained by ſubliming the æthiops that remains in the retort after the diſtillation of butter of antimony. The two ſubſtances employed in the proceſs are equal parts of corroſive ſublimate and crude antimony. The firſt of theſe, we know, conſiſts of mercury and marine acid; the latter, of the regulus of antimony and ſulphur. The acid quits the mercury to unite with the metal, and they riſe together in the form of butter of antimony. The mercury and ſulphur, being both diſengaged, combine in the retort, and (the fire being conſiderably increaſed, and the receiver changed) ſublime in the form of cinnaber.

CIVET is ſoluble in oils only.

CLAY, p. 65.—alſo *Scheele*'s *Eſſay* viii:

CLOVES. Eight ounces yield one ounce of essential oil.

CLYSSUS is the condensed vapour arising from the detonation of nitre with charcoal, with sulphur, or with antimony. The clyssus of nitre is mere water: that of sulphur, and of antimony, is vitriolic acid. It is produced by a troublesome and dangerous operation to answer no rational purpose. *Parturiunt montes*, &c.

COAGULATION is the reduction of fluids to a state of solidity.

COAK is fossil charcoal.

COAL, in the English language, means fossil or pit-coal. The dissertation under this word, in Macquer's dictionary, belongs properly to *charcoal*. In the Cyclopedia we are told, that pit-coal contains a large quantity of sal-ammoniac. This is certainly not true. Pit-coal consists principally of that bitumenous substance called *petrol* or *asphaltum*, combined with clay, and frequently with pyrites.

COATING, called also *Lorication*, is the covering of glass retorts to prevent their breaking when exposed to a naked fire. This coating is generally made of clay and sand, p. æ. with a little powdered glass and cow's hair, made into a thin paste with fresh bullock's blood diluted with water. You apply it to the retort with a brush, and when the first coat is dry, repeat the operation.

tion, and in like manner three or four times, till the covering be a quarter of an inch thick.

COBALT, p. 105. 200.—alſo *Kirwan*'s *min. cap.* 13.

COCHINEAL diſſolved in water, gives to woollens and to ſilk a durable crimſon colour; by the addition of a ſolution of tin in the nitrous acid, or in *aqua regia*, the dye becomes ſcarlet, which is alſo permanent.

COHOBATION. Repeated diſtillation of the ſame matter with the ſame fluid poured back into the alembec: formerly much practiſed, to very little purpoſe, and now entirely laid aſide.

COLCOTHAR. Mere calx of iron which remains in the retort after the diſtillation of vitriolic acid from calcined vitriol. If any acid ſtill adhere to this calx, it is eaſily waſhed off by water. Under this word in the *Cyclopædia*, there is a paragraph tranſcribed from the *Philoſophical Tranſactions*, which, if the laſt editor had been a chemiſt, he would have expunged.

COLOUR. The change of colour is, in chemiſtry, particularly uſeful in diſcovering acid or alkali in any liquid. Tincture of turnſol, ſyrup of violets, and tinctures and ſyrups of other blue flowers, turn red with acids, and green with alkalis. Water containing a ſmall proportion of iron, on the addition of a few drops of tincture of galls, becomes purple; if there be much iron, the colour will be black. Water containing the

ſmalleſt

ſmalleſt quantity of iron, is tinged blue by Pruſſian alkali.

COLOPHONY. Common roſin. It is the ſubſtance which remains after the diſtillation of oil from turpentine. The chief uſe of this drug, ſays the author of the *Cyclopædia,* is in the cure of venerial ailings. He would have been nearer the truth if he had ſaid, the chief uſe of this drug is to rub a fiddle-ſtick.

COMBUSTION, p. 156.

CONCENTRATION, p. 177.

CONDENSATION, is the act of bringing the parts of volatile fluids nearer together by preſſure or by cold. Thus, air is condenſed by preſſure, and the ſteam condenſed by cold into water.

COPAL, is neither ſoluble in water nor in ſpirit of wine; but it may be diſſolved by digeſtion in linſeed oil, with heat. This ſolution diluted with ſpirit of turpentine, forms an excellent varniſh.

COPPER, p. 88, and 195.—alſo *Kirwan*'s *Min. cap.* iv.

COPPERAS. Vitriol of iron.

CORK. This dry bark of a tree hath not eſcaped the modern chemical purſuit after new acids. In *Crell*'s *Annals of Chemiſtry*, Ann. 1787, p. 145, I find a ſeries of experiments on this ſubſtance, by D. L. Brugnatilli; whence it appears, that cork, burnt in a crucible, is almoſt entirely conſumed, the remaining aſhes being ſcarce vi-

 ſible;

ſible; that, by fire, in cloſe veſſels, it is almoſt entirely volatilized into inflammable air; that vitriolic or marine acid ſcarce affect it at all, even with the aſſiſtance of heat; but, that the vapour of ſmoking ſpirit of nitre attacks and reduces it, in part, to a yellowiſh ſaline powder. Diſtilled with nitrous acid, there remained in the retort a viſcous acid maſs, almoſt entirely ſoluble in boiling water. This acid is alſo ſoluble in hot ſpirit of wine: it combines with metals, with alkalis, and with earths, particularly with lime. Hence it is concluded, that cork conſiſts of a peculiar vegetable acid combined with phlogiſton, and a very ſmall proportion of earth.

CORAL differs not at all in its chemical properties from oyſter ſhells, crabs claws, &c. It is principally mild calcareous earth.

CREAM *of Lime* is formed on the ſurface of lime-water. It is nothing more than lime which has recovered the fixed air which it loſt in calcination; conſequently it is mild calcareous earth.

CREAM *of Milk* is the oily part of milk mixt yet with ſome whey and curd, from which it is entirely ſeparated by churning into butter.

CREAM *of Tartar* is a ſalt compoſed of vegetable fixed alkali ſuper-ſaturated with the acid of tartar. Cryſtals of tartar are the ſame thing. They are obtained by boiling crude tartar in water, and differ from it only in being more pure. If cream of tartar be ſaturated with any alkali, a tartarous ſelenites will precipitate; *i. e.* the acid of tartar combined with calcareous earth; therefore cream of tartar contains calcareous earth.

CROCUS. Saffron. The yellowiſh red calces of metals are alſo ſo called. *Crocus antimonii*, or *metallorum*, is made by deflagrating antimony with nitre in a red-hot crucible. *Crocus martis*, in whatſoever manner prepared, is calx or ruſt of iron, and nothing more.

CRUCIBLES are veſſels of indiſpenſible uſe in chemiſtry in the various operations of fuſion by heat. Their form is that of an inverted cone. They are made of clay mixed with powdered baked clay, or with ſand, or flint, or glaſs, or black lead, according to the purpoſe for which they are intended. Heſſian crucibles are beſt calculated to ſuſtain a violent degree of heat. Thoſe of black-lead are generally uſed for melting of gold. Thoſe intended for vitrification ſhould be made of clay mixed with powdered baked clay only.

CRYSTAL, or *quartz*, is the moſt pure of the ſiliceous genus of ſtones. It generally contains a ſmall proportion of clay and calcareous earth, and is frequently coloured by metallic particles. Its chemical properties are thoſe of flint in general.

CRYSTALLIZATION is an operation of nature, in which various earths, ſalts, and metallic ſubſtances, paſs from a fluid to a ſolid ſtate, aſſuming certain determined geometrical figures. All fluids are prevented from cryſtallizing by heat: that is, the fluid fire which they contain keeps their parts aſunder, which, without its interpoſition, would, in conſequence of their mutual attraction, run into a ſolid regular maſs. Ice is water cryſtallized. Precious ſtones, flints, ſpars, pyrites, &c. are cryſtals of earths and metals. But, if it be true, that all fluids are prevented from becoming ſolids by the interpoſition of fire, it will neceſſarily follow, that in order to cryſtallize all cryſtallizable bodies, which are in a ſtate of fluidity, nothing more is required than to take away this fluid fire, which, by interpoſition, keeps their conſtituent parts out of their ſphere of attraction. Water cryſtallizes in a certain degree of cold. Saturated ſolutions of ſalts in warm water, produce cryſtals as the fire flies off; and in all caſes whatſoever an adequate deprivation of heat will effect cryſtallization.

But, in the common temperature of the atmoſphere, cryſtallizable bodies, diſſolved in water, may be prevented from cryſtallizing by the quantity of the menſtruum; for, as, in ſolution, the diſſolved body is equally diffuſed, its parts may be at ſo great a diſtance as to loſe all power of mutual attraction. In this caſe cryſtallization cannot take place until the quantity of the menſtruum be diminiſhed. Now water is rendered volatile by a certain degree of heat. Evaporation,

tion, therefore, is the usual means of producing the crystallization of salts; and in order to obtain large and regular crystals, it is necessary that the vessel should be removed from the fire as soon as signs of incipient crystallization appear on the surface, and that the liquor should be very gradually cooled; otherwise the crystals will be small and irregular.

CRYSTALS *of Silver*, are silver dissolved in strong hot nitrous acid and crystallized by cold.

CRYSTALS *of Copper* are made by dissolving verdigrise in vinegar in a sand-bath, and crystallizing the solution. They are called distilled verdigrise, and are much used by painters.

CUCURBIT, the body of an alembic, a vessel for distillation almost totally out of use.

CUPEL is a kind of shallow basin, thick and square on the outside, made of calcined bones mixed with a small proportion of clay and water. It is used in assaying and refining gold and silver by melting them with lead. The process is called *cupellation*.

DECOMPOSITION, in its present chemical acceptation, means a separation of the constituent principles of compound bodies. The signs of the decomposition of bodies in solution, are turbidness and precipitation. This is effected by the addition of some other body which is more powerfully attracted by one of the principles of the compound in solution, than by that to which it was united. Epsom salt consists of vitriolic acid and magnesia. If to a solution of this salt I add a solution of salt of tartar, a decomposition will immediately take place. The vitriolic acid, preferring the vegetable alkali, will relinquish the magnesia, which will consequently fall to the bottom of the vessel.

DECREPITATION is the instantaneous decomposition of salts, attended with a crackling noise, when thrown into a red-hot crucible or into a naked fire.

DEFECATION. Purging, or separating a fluid from the fœces or lees.

DEFLAGRATION. Burning, as when nitre and tartar are burnt together in a red-hot crucible in making the black or white flux; or nitre with sulphur, in the silly operation of making *Salt of Prunella.*

DELIQUESCENCE of saline solid bodies, signifies their becoming fluid by means of the water which they imbibe from the atmosphere. This can only happen in consequence of their attraction to water. Why some neutral salts are deliquescent, and others not, is not easily accounted for. It seems to depend on the degree of saturation of their principles.

DEPHLEGMATION means the taking away phlegm, or water, by means of evaporation or distillation.

DETONATION, properly ſpeaking, means exploſion with noiſe. In chemiſtry it is particularly applied to the exploſion of nitre when thrown into a red-hot crucible with ſome phlogiſtic body.

DIAMOND, the moſt brilliant and hardeſt of all minerals, is of ſo ſingular a nature, that Mr. Kirwan thinks it cannot be arranged either with earths or inflammable ſubſtances. Vitriolic acid has ſome effect upon it. In a degree of heat not much exceeding that in which ſilver melts, it is entirely conſumed, and burns with a low flame. It is proof againſt all fluxes except borax and microcoſmic ſalt.

DIFFUSION, p. 170.

DIGESTION differs from maceration only in the application of heat, which muſt be moderate and continued. It is uſually performed in a matraſs placed in a ſand or water-bath.

DIGESTOR *Papin's*, is an inſtrument invented by the perſon whoſe name it bears, for the purpoſe of expeditiouſly reducing animal or vegetable ſubſtances to a pulp or jelly. It is a box of metal (iron I ſuppoſe) with a cover ſcrewed on ſo as to be perfectly air-tight. The matter to be digeſted being put into the box, we are inſtructed to fill it with water, and then to apply the flame of a lamp. In ſeven or eight minutes, fleſh meat will be diſſolved, and in a few minutes more, the hardeſt bones will become a jelly. So we are told.

DISTILLATION, p. 175.

DOCIMASTIC *art*. The art of aſſaying.

DOME. The round cover of a portable furnace.

DROP, *Ward's* is a ſolution of two ſalts, viz. nitrated mercury and nitrous ammoniac. It is made by diſſolving ſeven ounces of concrete volatile alkali with four ounces of quickſilver, in 16 ounces of ſpirit of nitre; then cryſtallizing and rediſſolving in water.

DUCTILITY is that quality in certain bodies in conſequence of which they may be drawn out to a certain length. Gold, ſilver, braſs, and iron poſſeſs this quality in a high degree.

DULCIFYING. At this word, in the *Cyclopædia*, we are referred to *edulcoration*, which in chemiſtry, has a very different meaning. By dulcification is underſtood the rendering corroſive acids mild by mixing them with ſpirit of wine, as in *ſpiritus nitri dulcis, ſpiritus vitrioli dulcis*. Corroſive ſublimate is dulcified by ſaturating the acid with crude mercury, as in *mercurius dulcis*.

DYING is a chemical operation, the theory of which, notwithſtanding the labours of ſeveral French chemiſts, remains hitherto unexplained. The dyers enumerate five primary colours, viz. blue, red, yellow, brown, and black. From a mixture of theſe, all other colours are produced.

The

The three firſt are the only real primary colours.

Blue is dyed with woad, indico, logwood, or with brazil-wood. The two firſt of theſe only are permanent.

Red is dyed with kermes, cochineal, gum-lac, madder, archil. This laſt does not give a permanent dye.

Yellow is dyed with weld, ſavory, green wood, yellow wood, fenugreek, fuſtic, roucow, grains of Avignon, turmeric. The laſt four are falſe dyes.

Brown is dyed with the thick rind of walnuts, the rind of alder, ſantal, ſumach, fovic, ſoot, &c.

Black is dyed with a mixture of copperas and logwood.

All other colours, and their various ſhades, are produced by a judicious mixture of the materials above mentioned.

EARTH, p. 11, 61.

—— *animal* is not a diſtinct ſpecies of earth.

—— *argillaceous*, p. 65.

—— *calcareous*, p. 63.

—— of *magneſia*, p. 67.

—— *ponderous*, p. 61.

—— *ſiliceous*, p. 66.

—— *vegetable* is not a diſtinct ſpecies of earth.

—— *vitrifiable*, p. 66.

EAU DE LUCE. A smelling-bottle, prepared by dissolving a dram of oil of amber in a solution of ten grains of white soap in four ounces of spirit of wine, and afterwards mixing this solution with strong spirit of sal-ammoniac.

EDULCORATION as a chemical term, means nothing more than washing with water.

EFFERVESCENCE. Macquer's explanation and illustration of this word in the *Chemical Dictionary*, ought to have been expunged and re-written by his translator, who could very easily have set him right. The cause of that commotion or ebolition, which we call effervescence, on the admixture of acids with alkalis or absorbent earths, is the expulsion of the aerial acid from the alkali or earth, by a stronger acid, in consequence of a more powerful attraction; and this expulsion of the aerial acid is, in all cases, the cause of effervescence.

ELEMENTS are the simple constituent parts of bodies: they are frequently called *principles*, by chemical writers, and are generally considered as constituent parts, simple in themselves, and incapable of decomposition. The physical elements of the ancient philosophers were fire, air, water, and earth; but modern chemistry hath so analized and confounded these elements, that nothing positively systematical can be determined. See p. 3.—For what I call *Chemical Elements*, see p. 12.

The modern sect of philosophers who deny the existence of phlogiston, and who are thence called *Anti-phlogistics*, adopt the following catalogue of elements: viz. pure air, inflammable air, phlogisticated air, sulphur, phosphorus, all metallic substances, ponderous earth, the acid principle of some acids, charcoal, &c. &c.

ELIQUATION is the separation of one metal from another by a degree of heat which will melt one of them without affecting the other.

ELUTRIATION is the operation of separating the metallic parts of ores, by first pounding and then mixing them with water, so that the lighter matters which are capable of suspension, may be poured off.

EMERALD. The softest of precious stones. It is of a pure green colour, 100 parts of it contains 60 of clay, 24 of flint, 8 of calcareous earth, and six of iron. It preserves its colour in a porcelain heat; but fuses with borax or microcosmic salt.

EMERY is an ore of iron, though never used as such. It appears to be a mixture of the red and white calces of iron, with some tripoli.

EMPYREAL *air*: so Dr. Higgins denominates that which Dr. Priestley calls *dephlogisticated* air, and other philosophers *vital* or *pure* air.

EMPYREUMA is a peculiar disagreeable smell proceeding from vegetable and animal matters

matters when burnt, particularly in close vessels.

EMULSION, or *milk*, whether natural from animals or plants; or produced by mixture and trituration, is a diffusion of oil in water by means of a mucilage.

ENAMEL is a composition of glass and some opake substance not vitrifiable in a degree of heat sufficient to melt glass. The substances generally used, are metallic calces. The glass, which is the foundation of all enamel, is made by melting together equal quantities of frit of calcined flints and calx of tin and lead, with a very small proportion of pure fixed alkali. Various colours are communicated to this glass by the addition of other calces with magnesia, &c.

ESSAY *of ores*, &c. See *Assay*.

ESSENCE. What are called essences in chemistry and pharmacy are essential oils.

EVAPORATION, p. 173.

EXTRACTS, in pharmacy, are the soluble parts of vegetable substances, first dissolved in water or spirit, and then reduced to the consistence of a thick syrup or paste, by evaporation.

FAT is an oily concrete animal substance, composed of oil acid, and charcoal. From two pounds of fat M. Crell obtained $14\frac{1}{8}$ ounces of oil, $10\frac{1}{2}\frac{9}{4}$ ounces of charcoal, and $7\frac{1}{4}$ ounces of acid, which with alkalis and earths forms neutral

salts

ſalts much reſembling thoſe formed by alkalis and earths with vegetable acids. The oil ſeems to differ very little from the oils obtained from vegetables, which are called *fat oils*.

FELT-SPAR, or, as the French naturaliſts write it, *Feld-ſpath*, is a ſiliceous ſtone containing a ſmall proportion of clay and magneſia, with a very little ponderous earth. It is of all colours, and generally opake. It is, in point of hardneſs, between quartz and fluors. It melts *per ſe* more readily than fluors, into a whitiſh glaſs, and diſſolves in borax or microcoſmic ſalt, without efferveſcence. See *Kirw. Min.* chap. 8. ſp. 11.

FLINT, or *vitrifiable*, or *ſiliceous* earth, p. 66.

This earth, the ſpecific gravity of which is 2,64, and which is inſoluble in any acid except the ſparry, is copiouſly diffuſed through the foſſil kingdom, being generally found, in different proportions, mixed with all other earths. *Flint* alſo conſtitutes a numerous *genus* of minerals, including precious ſtones and every other ſpecies that ſtrike fire with ſteel, and do not efferveſce with acids. They all contain other earths, and frequently iron. Common *flint* contains, beſides ſiliceous earth, about one fourth of clay, and one fortieth of calcareous earth. See *Kirwan*'s *Min.* chap. 8.—*Bergman*'s *Diſſert.* 13.—*Scheele*'s *Eſſay the* viii.

Monſ. Baumé found means to convince himſelf that this vitrifiable earth is the only earth exiſting in in nature; that calcareous earth is compoſed of this elementary earth, combined with water, phlogiſton, and air; that clay is a compoſition of this vitrifiable earth and vitriolic acid; and that the earth of alum is not *clay* (which it moſt certainly is) but *flint*. This celebrated French chemiſt formed this laſt concluſion, becauſe he produced alum by adding vitriolic acid to the earth precipitated from the *liquor of flints*: he had no conception that the argillaceous earth, which formed the alum, came from the crucible in which the flint and alkali, for the preparation of the *liquor of flints*, were fuſed.

FLOWERS are ſolid dry bodies reduced to a fine powder by *ſublimation*.

——— of *Arſenic*. Mere arſenic unaltered.

——— of *Benzoin* are an acid ſalt obtained, from this reſin, by ſublimation, with a gentle heat, in an earthen pot, covered with a cap or cone of doubled filtring paper; or by means of two pots, one inverted on the other; or by diſtillation in a common retort. This ſalt is not free from empyreumatic oil, which may be ſeparated by waſhing in hot water, evaporating and cryſtallizing. This acid ſalt may alſo be obtained by lixiviation only without previous ſublimation; but the quantity will be ſmall. The excellent Scheele invented a new method of producing the ſalt of Benzoin, by boiling a pound of this reſin, four times over, in a gallon of lime-water; mixing the ſeveral leys

and

and boiling the whole down to a quart, which he ſtrains into a glaſs veſſel, and precipitates the ſalt with marine acid. This precipitate muſt be ſeparated by filtration, and waſhed by repeated effuſions of cold water. It may be cryſtallized by boiling in ſix ounces of water, and ſtraining whilſt hot through a cloth into a glaſs veſſel previouſly heated; but it is more œconomical to let it remain in the form of a precipitate. The ſalt of benzoin thus obtained, is entirely free from oil, and will be equal in quantity to the flowers produced by ſublimation.

FLOWERS *martial*, is a yellow powder prepared by mixing iron filings with an equal quantity of ſal-ammoniac, and ſubliming in a retort. This medicine, if it were worth making, may be much more conveniently prepared, in the moiſt way, by mixing a ſolution of ſal-ammoniac in water, with a ſaturated ſolution of iron in weak marine acid, and evaporating to dryneſs; or, by ſimply diſſolving iron in a boiling ſolution of ſal-ammoniac, and evaporating. *Crell's Chem. Annal.* 1787, p. 239.

FLOWERS of *ſal-ammoniac*. Sal-ammoniac, and nothing more.

FLOWERS of *ſulphur*. Sulphur only, without the leaſt alteration.

FLOWERS of *zinc* is a white powder raiſed in light flocks by burning this ſemi-metal. It is uſually ſwept from the chimneys of furnaces in which

which the ores of zinc are ſmelted. It is obtained for medical purpoſes by ſublimation in an inclined crucible, to the upper internal ſurface of which it adheres in the form of a white woolly ſubſtance. This powder, or flower, cannot be a ſecond time ſublimed, nor *reduced*, but in a very ſtrong heat, with ſome ſubſtance containing phlogiſton, in a cloſe veſſel. It is, like zinc, ſoluble in acids.

FLOWERS of *plants* yield no durable colour either to water or ſpirit, except yellow flowers, the infuſions of which in water, communicate to ſilk or wool, previouſly boiled in a ſolution of alum and tartar, a permanent yellow dye.

FLUOR, as an adjective, applied to acids or alkalis, is uſed in oppoſition to *concrete*.

FLUOR is a kind of ſpar, called *fluor* from its fuſibility *per ſe*, and its property of promoting the fuſion of other bodies, particularly argillaceous earth. Its conſtituent parts are calcareous earth, water, and *fluor acid*; which acid poſſeſſes the ſingular property of diſſolving flint even in glaſs. It may be decompoſed by diſtilling it with concentrated vitriolic acid, which, uniting with the calcareous earth, ſuffers the fluor acid to paſs into the receiver. Fluor is of various colours and ſhapes. It is too ſoft to ſtrike fire with ſteel. It neither burns to lime, nor hardens, after burning, by the effuſion of water. When ſlowly heated, it becomes phoſphoreſcent.

FLUX is a ſaline ſubſtance uſed by chemiſts to promote the fuſion of ores and other minerals. Fixt alkali, vegetable or mineral, ſeems to be the chief fluxing principle. *White flux*, which is made by deflagrating together equal parts of nitre and tartar, is the vegetable alkali of theſe two ſubſtances, which remains in the crucible, the two acids of the nitre and tartar, together with the phlogiſton of the alkali, being diſſipated in the combuſtion.—*Black flux*, which is made by deflagrating two parts of tartar with one of nitre, is alſo vegetable alkali, partially dephlogiſticated, becauſe the quantity of nitrous acid was inſufficient to conſume the whole. It is black, becauſe the remaining phlogiſton is fixed as in charcoal or tinder.—*Borax*, which is a powerful flux, is compoſed of marine alkali, and a peculiar ſalt of an acid nature.—*Microcoſmic ſalt*, which is one of the moſt irreſiſtable fluxes, conſiſts of phoſphoric acid, ſaturated with mineral and volatile alkali. —*Fluor* is a flux to metallic ores.—*Lime* acts as a flux to other earths.—*Charcoal, oils*, &c. fuſe and *reduce* the calces of metals by reſtoring their phlogiſton.

FULMINATION. Thundering; exploſion with noiſe: thus, fulminating gold, fulminating powder.

FURNACE, p. 234.

FUSION is imperfectly defined,—" the ſtate of a body rendered fluid by fire." Mercury, water, and every other fluid, is rendered fluid by fire. It were more accurate to ſay, that fuſion is the ſtate of a body which was ſolid in the temperature of the atmoſphere, now rendered fluid by the artificial application of fire.

FUSTIC is a yellow wood, from the Weſt Indies, uſed by dyers. It communicates to wool a reddiſh yellow, which is by no means durable. Mixed with weld and a little cochineal, it dies a kind of orange ſcarlet, which is tolerably fixed. With weld and the rind of walnuts, it is uſed for dying coarſe woollens light or dark brown, according to the proportions of each.

GALENA, p. 194.

GALENA, *pſeudo. Blend*, or *Black Jack*, is an ore of zinc. It is called *pſeudo*, or *falſe* galena, becauſe it frequently reſembles the lead ore called *galena* in its teſſellated form, to which it is however inferior in ſpecific gravity. It loſes conſiderably of its weight when heated, and burns with a blue flame. It generally contains ſome lead ore, and, when vitriolic or marine acid is dropped on it, exhales a ſmell of ſulphur, p. 111, 201. *Kirw. Min.* chap. 9.

GALLS uſed in chemiſtry, dying, making ink, &c. are excreſcences found on oak trees: they are hardened exudations of an aſtringent juice iſſuing from wounds made by a peculiar inſect. All vegetable aſtringents ſtrike a purple, or black, colour with ſolutions of iron. Galls, poſſeſſing this aſtringency in a very high degree, are not only

only of univerſal utility in every art where *black* is required; but alſo in diſcovering the preſence of iron in water, or in any other liquid; for which purpoſe either an infuſion in water, or a ſpirituous tincture may be uſed.

The admirable Scheele obtained an acid ſalt from a ſolution, in water, of powdered galls, which, by diſtillation with nitrous acid, became an abſolute ſaccharine acid. Other chemiſts have ſince endeavoured to develop the conſtituent principles of the aſtringent matter in galls; but we are hitherto not much wiſer for their labours. Scheele's diſcovery of the ſaccharine acid in galls, is an additional confirmation of my conjecture, that the preſent rage for the diſcovery of new acids will terminate in a diminution, rather than an increaſe, of the number of acids eſſentially different.

GALLON, an Engliſh meaſure, containing four quarts, each of which contains two pints, which pints, wine meaſure, hold a pound of water: the wine gallon, therefore, holds eight pounds avoirdupoiſe; but the ale gallon holds ten pounds, three ounces, and a quarter, the pints being ſo much larger. This wine gallon is the *congius* of our diſpenſatories. The Roman *congius* contained only ſeven of our wine pints. This wine gallon contains four French *pintes*, which therefore are equal to our quarts.

GAMBOGE is ſoluble, almoſt entirely, either in water or ſpirit. It melts in a moderate heat, and is like other gum reſins inflammable. It is

 uſed

ufed as a hydragogue purge, and as a yellow pigment.

GARNET, a red precious ftone, in 100 parts of which there are about 48 of flint, 30 of clay, 12 of calcareous earth, and 10 of iron. It melts *per fe*, with difficulty; but eafily with borax. See *Kirw. Min.* chap. 8. fpec. 14.

GAS, p. 19. This word, to fignify aerial fluids, was, I think, firft ufed, in this kingdom, by the tranflator of Macquer's Dictionary, in his Appendix to the fecond edition of that work. Some French writers have adopted it; but moft of the German and Englifh philofophers continue to ufe the word *air*: thus, *fixed air*, *nitrous air*, &c.

GEMS. The abfolute meaning of this word feems not yet determined. Bergman confines the term to precious ftones whofe hardnefs much exceeds that of mountain cryftal, and in whofe compofition there is more clay than flint. Thefe are five in number. In 100 grains of each their feveral conftituent parts are proportioned as in the following table.

	Clay.	*Flint.*	*Lime.*	*Iron.*
Emerald,	60 —	24 —	8 —	6 grains.
Sapphire,	58 —	35 —	5 —	2
Topaz,	46 —	39 —	8 —	6
Hyacinth,	40 —	25 —	20 —	13
Ruby,	40 —	39 —	9 —	10

The

The diamond is excluded, becauſe, though it is confeſſedly the hardeſt and moſt brilliant, and conſequently the firſt of gems, its principles are very imperfectly known. It certainly contains ſome flint; but from its inflammability and volatility in a moderate degree of heat, it ſeems probable that phlogiſton is its principal conſtituent. How very wonderful it is, that Sir Iſaac Newton, who was no chemiſt, ſhould have conjectured, that the diamond was an inflammable ſubſtance!

Gems may be analized thus.—Reduce the gem to a very fine powder; mixed with twice its weight of calcined mineral alkali, put it in a poliſhed iron diſh, covered by an inverted crucible, and place it on a tile in a wind furnace, where it muſt remain, in a moderate heat, three or four hours. Then pound, and afterwards diſſolve it in marine acid in a digeſting heat. If to this ſolution Pruſſian alkali be added, Pruſſian blue will precipitate, which being properly waſhed and dried, the ſixth part of it indicates the proportion of iron. Fixed alkali will then precipitate the ſeveral kinds of earth, which being waſhed, dried, and afterwards kept red-hot for half an hour, and weighed, muſt be diſſolved in ſix times the weight of diſtilled vinegar, and then precipitated by mild fixed alkali. If the earth, thus precipitated, be again diſſolved in diluted vitriolic acid, the ſpecies of earth will be determined by the ſalt produced.

If it be ponderous earth, ponderous ſpar will be the reſult; if lime, gypſum; if magneſia, Epſom ſalt. The reſiduum, on examination with the blow-pipe, will be found to be either flint or particles of the gem not yet ſufficiently divided. See Bergman's excellent diſſertation on this ſubject, Vol. ii. *Diſſert.* 15.

GLACIES MARIÆ, *lapis ſpecularis*, or *gypſum ſpathoſum*, is of various colours and forms, but generally cubic. Its texture is ſcaly or fibrous, and its compoſition is calcareous earth combined with vitriolic acid.

GLASS *common*, is a mixture of flint and fixed alkali, combined by heat. Flint, called *vitrifiable* or *ſiliceous earth*, cannot be melted in the ſtrongeſt heat without ſome additional ſubſtance, which poſſeſſing the property of liquifying this earth, is called a *flux*. Alkaline ſalt, particularly mineral alkali, is commonly uſed in making glaſs; to which borax, arſenic, or calx of lead, are added in the manufacture of glaſs for particular uſes. The black-green colour of common bottles is aſcribed to phlogiſton, from the impure alkali employed. A fine blue is communicated to glaſs by calx of cobalt. Thoſe who are deſirous of particular information on the art of making glaſs may conſult *Neri, with Kunckel's Notes.*

GLASS *of antimony*, is antimony ſeparated from its ſulphur by calcination, and afterwards vitrified

in

in a crucible expoſed to a ſtrong heat in a melting furnace.

GLASS *of borax*, is borax fuſed by heat. When cold it has the appearance of glaſs; but it is ſoluble in water, and, when cryſtallized, is borax unaltered. It is in ſome caſes preferred to crude borax as a flux, becauſe, being freed from ſuperfluous water, it is leſs liable to ſwell.

GLASS *of lead* is the calx of lead vitrified by heat; but it is ſo powerful a flux, that it cannot be retained in any crucible except by the addition of a little ſand or powdered flint. Thus combined, it is uſed as a flux in aſſaying of ores.

GOLD, p. 71, 190. *Kirw. Min.* 230.—The calx of 100 grains of gold diſſolved in *aqua regia*, and precipitated by *mild* mineral alkali, will weigh 106 grains; by cauſtic 110.

GOLD *fulminating*, *aurum fulminans*, is a yellow powder precipitated from a ſolution of gold in *aqua regia*, by fixed or volatile alkali. This powder poſſeſſes the aſtoniſhing property of exploding with a ſmart, very loud noiſe, in a degree of heat much below that of boiling water, or by moderate triture, percuſſion, or friction. The cauſe of this phenomenon hath been variouſly explained by celebrated chemiſts of different nations. Some aſcribe it to the decrepitation of a neutral ſalt, formed in the precipitation and adhering to the calx. Some attribute the fulmination to nitre with phlogiſton. Others, with greater appearance of probability, tell us it is a *nitrum flammans*, compoſed of nitrous acid and volatile alkali. Dr. Black thought it to be the ſudden expanſion of fixed air accumulated in the calx. M. Baumé aſſures us, that this loud detonation is cauſed by the nitrous ſulphur, generated in the precipitation, by the union of nitrous acid with phlogiſton. Bergman finally explains the matter by ſuppoſing, that the precipitate, that is, the calx of gold, being united with the volatile alkali, attracts its phlogiſton, and thereby ſets at liberty the elaſtic fluid, its other conſtituent principle; which being ſuddenly releaſed, ſtrikes the atmoſpheric air with ſuch violence as to produce the fulmination. If Bergman had ſtopped here, we might, for the preſent, have remained ſatisfied with his explanation of the matter; but he afterwards bewilders himſelf in the decompoſition of the *matter of heat*, which *heat* I muſt ſtill beg leave to conſider as a mere quality of fire.

Towards the perfect comprehenſion of this ſubject, it is neceſſary to obſerve, that the precipitate of gold will not fulminate, unleſs the *aqua regia* be made with *ſal-ammoniac*, or volatile alkali be uſed in the precipitation. Volatile alkali, therefore, is a *ſine qua non* in the formation of this fulminating powder.

GRAIN. Colours in grain, in the language of dyers and drapers, are red and its various ſhades and tints, dyed with cochineal, which, as well as the

the inſect *kermes*, uſed for the ſame purpoſe, was formerly miſtaken for the ſeed or grain of a plant. In dying with kermes, the wool or yarn muſt be previouſly boiled with alum and tartar; but with cochineal, the preparative liquor is a ſolution of cream of tartar.

GRAIN is the ſmalleſt weight ſpecified in chemiſtry. It is the 20th part of a ſcruple. 3 ſcruples make a dram; 8 drams make an ounce; and 12 ounces make a pound. 24 Paris grains are nearly equal to our ſcruple.

GRANULATION is a ſimple operation by which certain metals are divided into ſmall particles for chemical purpoſes. It is performed by pouring a melted metal into water agitated by a broom. Lead may be granulated by pouring it, when melted, into a box rubbed with chalk on the inſide, and ſhaking it briſkly during the operation.

GRAVITY *abſolute*, is that property by which bodies move towards each other in proportion to their reſpective quantities of matter; it is that property by which bodies fall to the earth; it is that property in bodies uſually called their weight, which is directly as the quantity of matter they contain, regardleſs of their bulk or denſity.

GRAVITY *ſpecific*, is the comparative weight of a particular ſpecies of matter: it is the weight of a given meaſure of a fluid or ſolid body compared with the ſame meaſure of diſtilled water, which

which philosophers have agreed to constitute the standard. Bodies are specifically heavier as they are more dense; that is, as the parts of which they are composed are nearer together. Gold is specifically heavier than silver, because it is more dense, a cubic inch of gold being almost double the weight of a cubic inch of silver.

The specific gravity of fluids may be determined by first weighing any given measure of distilled water, noting the weight, and then weighing the same measure of the fluid in question: the difference determines the specific gravity. But this problem may be more accurately solved thus; suspend a solid ball of metal, by a horse-hair, to the arm of a balance; poize it accurately by weights in the scale at the opposite end of the beam. Now sink the ball in a cylinder of distilled water, and then take weights out of the scale, till the beam stands horizontally. Note the weights you have taken away. Wipe the ball perfectly dry; immerge it in the fluid you wish to examine, and deduct the weights as before. The difference of the weights deducted determines the specific gravity.

The specific gravity of a metal, or other fossil, is thus found. Suspend the piece to be examined in a horse-hair loop fixed to a hook at the bottom of a scale: poize it exactly by weights in the opposite scale: immerse it in the cylinder of distilled water, and restore the equilibrium by putting weights into the lighter ſcale: theſe weights indicate the weight of the quantity of water which is equal in bulk to the ſtone or metal under examination. Divide the ſum of the weight in air by the ſum of the weight required to reſtore the equilibrium in water, and the quotient gives the ſpecific gravity. If, for example, the piece of metal weighed in air 72 grains, and that, when weighed in water, 9 grains were wanting to reſtore the equilibrium; 72 divided by 9 gives 8; I ſay therefore its ſpecific gravity is 8: that is, it is 8 times heavier than water.

Chemical authors uſually ſignify ſpecific gravity in decimal numbers; it is therefore neceſſary that thoſe who ſtudy books of chemiſtry ſhould, at leaſt, be able to decypher theſe numbers. This knowledge is not difficult to acquire.—Firſt let it be obſerved, that the figures before the comma are whole numbers, as in common arithmetic; thoſe after the comma are numerators whoſe denominator is 10, or 100, or 1000. Theſe denominators are omitted, and the numerator only ſet down thus, five tenths is thus written ,5; forty-five hundred parts thus ,45; a hundred and twenty thouſandth parts, thus ,120. In theſe decimal fractions cyphers after the figure ſignify nothing: 500 means only five tenths; but before the figure they decreaſe its value, thus 05, means five hundredth parts.

The

The following table of ſpecific gravity is, I believe, the reſult of the lateſt experiments. *Jour. Phyſ.* Jan. 1787.

Platina -	24,000	Garnet -	4,188
Gold -	19,500	Topaz orient.	4,010
Mercury -	14,110	Saphir orient.	3,994
Lead -	11,450	Spar adamant.	3,873
Silver -	10,595	Ruby octaed.	3,760
Biſmuth -	9,650	Hyacinth	3,687
Copper -	8,925	Diamond	3,521
Arſenic -	8,308	*Peridot* -	3,354
Nickel -	8,200	Fluor -	3,155
Iron -	7,600	Chryſolite	3,098
Cobalt -	7,500	Mica -	2,934
Tin -	7,150	Emerald -	2,755
Zinc -	7,160	Spar calcareous	2,715
Antimony -	6,860	Zeolyte -	2,701
Manganeſe -	6,850	Rock cryſtal	2,650
Tungſten -	5,000	Shoerl white	2,511
Molybdena -	4,569	Feltſpar -	2,431
Ponderous ſpar	4,440	Selenites -	2,324
Jargon de Ceylon	4,416	Water -	1,000

For the ſpecific gravity of liquids and other fluids, ſee page 7 & 8.

GUMS are mucilaginous exudations from certain trees. They have no ſmell, very little taſte, are inſoluble in oils or ſpirit of wine, but diſſolve entirely in water. All ſubſtances that do not poſſeſs theſe properties, are improperly called gums.

The

The gums, properly ſo called, are gum-arabic, gum-tragacanth, and the gums of cherry-trees, plumb-trees, &c.

GUM *elaſtic*, *Indian rubber*, or *borachio*, is a very ſingular elaſtic ſubſtance, very improperly called a gum, as it is not in the leaſt degree ſoluble in water. It is probably the inſpiſſated juice of a plant, caſt into moulds whilſt fluid. I believe it is brought to Portugal from the Brazils. It may be diſſolved in æther, in ſpirit of turpentine, and by boiling in linſeed oil. By theſe means the aerial voyagers have produced a liquid with which they varniſh their balloons. See *Balloon*.

GUM-RESINS. The concrete juices properly ſo called, conſiſt chiefly of gum and reſin combined in various proportions. They are never tranſparent; whereas pure gum and pure reſins are always ſo in ſome degree. Since water will diſſolve the gum and ſpirit the reſin, the only method of diſſolving gum-reſins entirely, is by the alternate application of theſe menſtrua.

GUHR, a name, without meaning, given to a looſe calcareous earth, found in the clifts of rocks. It is generally white; but, from a mixture of clay or ochre, it is ſometimes red or yellow.

GYPSUM, or *ſelenites*, or *plaiſter of Paris*, is compoſed of about 30 per cent. vitriolic acid, the ſame proportion of calcareous earth, and 40 of water. Its colour, ſhape, and texture are various. It is difficultly ſoluble, in any acid, and will ef-

ferveſce

fervesce with none. Specific gravity about 2,[illegible] It falls to powder in a moderate heat, and, if then mixed with water, soon hardens. It is fusible *per se* in a strong heat long continued, and acts as a flux to clay. It is soluble in 500 times its weight of water: hence what are called hard waters. The celebrated Pott was so puzzled with this species of stone, that he at last considered its basis as one of his four simple primitive earths, and called it the *Gypseous earth*.

HÆMATITES. *Bloodstone*. A very hard stone, externally red, or yellow, or brown, but when scratched shews a red mark. It is a calx of iron, combined with a little clay, and sometimes manganese. It is used for burnishing and polishing metals. *Kirw. Min.* chap. 5. sp. 7.

HAMMITES. *Kitton stone*. A kind of limestone consisting chiefly of calcareous earth, with about a tenth part of clay, and a small proportion of the red calx of iron. *Kirw. Min.* chap. 4. sp. 2.

HARDNESS. Absolute hardness, that is, impenetrability, is believed, by philosophers, to be a general property of the ultimate indivisible particles of matter. That the ultimate particles of matter are indivisible, is very certain; but it does not follow from thence that they are absolutely hard: their indivisibility may be owing to our want of mechanical or chemical means to effect a farther division. The particles of fire and of of invifible fluids may be effentially elaftic, and confequently not hard.

Comparative Hardnefs.

Diamond	-	20	Rock cryftal	-	11
Ruby	-	17	Quartz	-	10
Saphire	-	16	Tourmaline	-	10
Topaz orient.		15	Chryfolite	-	10
Emerald	-	12	Zeolyte	-	8
Agate	-	12	Fluor	-	7
Spar adamant.		12	Calcareous fpar		6
Garnet	-	12	Gypfum	-	5
Onyx	-	12	Chalk	-	3

HARTSHORN (that is, the horn of the ftag, or of any kind of deer) was formerly believed to contain an oil, a falt, a fpirit, and an earth of fingular medical virtues; but we now know that the fame principles are obtained by diftillation from every other animal fubftance. Bones, hoofs, hair, urine, &c. produce the fame fpirit, &c. of hartfhorn, and moft of them in greater quantity. The fpirit of hartfhorn generally ufed, is diftilled from bones previoufly prepared by boiling in water. *Salt of hartfhorn* is concrete volatile alkali. *Spirit of hartfhorn* is falt of hartfhorn diffolved in water: it is obtained by continuing the diftillation after the falt has fublimed, till a quantity of water fufficient to diffolve all the falt fhall have paffed into the receiver. This is the way in which

it

it ought to be made; but many trading chemifts prepare their fpirit of hartfhorn in a lefs expenfive manner. The worft fophiftication of fpirit of hartfhorn (fays the author of the *Elaboratory laid open*) is that which is done by means of quicklime. He is kind enough, however, to reveal to us an infallible method of detecting this and every other fophiftication of fpirit of hartfhorn. The common method, he tells us, of precipitating the falt, by the addition of fpirit of wine, is infufficient, unlefs the precipitated cryftals be held in a fpoon over the flame of a candle. If they be genuine falt of hartfhorn, they will entirely evaporate; if fophiftications, they will remain. He begs to be excufed from explaining the principles on which this trial is founded, as that would teach the art it is intended to explode. Surely the poifon could do no great mifchief with the antidote along with it. I will therefore venture to reveal this mighty myftery.

Firft it is neceffary to know that volatile alkali, in no refpect different from fpirit of hartfhorn, may be obtained by diftillation from fal-ammoniac, which we know is a compofition of volatile alkali with marine acid. But, in order to fet the volatile alkali at liberty, fome fubftance muft be added, to which the marine acid has a fuperior attraction. In our firft table of chemical attractions, we fee that fixt alkali, calcareous earth, or lime,

lime, precede volatile alkali in the firſt column of acids; therefore ſome one of theſe is put into the retort with the ſal-ammoniac, but with very different effects: if mild fixed alkali, or mild calcareous earth, be employed, we obtain a concrete volatile alkali, equal in weight to the whole of the ſal-ammoniac: but, with lime, the produce will be a liquid volatile alkali, highly cauſtic. It is really amuſing to obſerve the embarraſſment of the celebrated Baumé, and even of Macquer himſelf, in their awkward attempts to account for theſe phenomena. It is the fire, *preſque pur*, ſays Baumé, attracted by the inflammable matter of the volatile alkali, from the lime, which is the cauſe both of the fluidity and cauſticity in queſtion; and as to the increaſe of weight in the concrete alkali, it is the water from the calcareous earth employed in the diſtillation.—If theſe great chemiſts had ſufficiently attended to Dr. Black's diſcovery, that the cauſe of cauſticity is the abſence of fixed air, their difficulties would have vaniſhed. M. Macquer, in the Appendix to the laſt edition of his Dictionary, appears convinced of the truth of Dr. Black's theory; but Baumé obſtinately ſhuts his eyes againſt demonſtration. —We now return to the ſophiſtication of ſpirit of hartſhorn, and the detection of the fraud. In this fraud the intention of the chemiſt is to produce a fluid that ſhall appear to contain a greater quantity of volatile alkali than it really does, and which ſhall, nevertheleſs, upon trial, with ſpirit of wine, produce a cryſtalline precipitate. For theſe purpoſes, he adds a certain proportion of cauſtic ſpirit of ſal-ammoniac, diſtilled with quicklime, and ſome neutral ſalt. The firſt of theſe gives poignancy to the ſpirit, and the latter exhibits cryſtals on the addition of ſpirit of wine, If the pretended mild ſpirit of hartſhorn conſiſt entirely of ſpirit of ſal-ammoniac, diſtilled with quicklime, no precipitation will take place on the addition of ſpirit of wine, becauſe cauſtic volatile alkali is always fluid. If on the contrary, the ſpirit under examination be a genuine ſolution of mild volatile alkali, the precipitate will entirely evaporate in the ſpoon, becauſe volatile alkaline ſalts ſublime in a very moderate heat. But if the precipitate remain fixed, it is evidently ſome other ſalt, diſſolved in the fluid, for the purpoſe of deception.

More than half the weight of mild volatile alkali is aerial acid, which, when diſtilled from ſal-ammoniac with chalk or fixed alkali, it takes from one of theſe, whilſt the alkaline baſis, or the lime, unites with the marine acid.

HARTSHORN, *calcined:* mere inert aſhes, neither abſorbent nor aſtringent, though conſtantly uſed as ſuch, particularly in Sydenham's *Decoctum Album.*

HEAT, p. 4. *ſpecific*, p. 5.

HEPATIC *air*, p. 34.

HOPS are uſed in brewing malt liquors, partly to render them grateful to the palate and ſto-

mach

mach, but principally to make the liquor *keep*: i. e. to prevent its running into the acetous fermentation. I do not believe they promote the vinous fermentation, or increase the spirituosity of the wort, as Newman supposed.

HORNBLEND, or *hornstone*, may be known by the following properties: when breathed upon, it emits an earthy smell; it seems greasy in the mortar; the powder it yields is greenish grey; specific gravity not less than 2,66.—100 parts of it consist of flint 37, clay 22, calcareous earth 2, magnesia 16, calx of iron 23. *Kirw. Min.* chap. 7. sp. 10.

HYACINTH, is a precious stone of the first order, of a reddish yellow, and generally of a prismatic form. Its composition is almost half clay, one fourth flint, one fifth calcareous earth, and about a tenth iron. It melts in a wind furnace in two hours. It differs but little in any respect from the topoz.

HYDROPHANES are opals and chalcedonies, which, being laid in water, from opake become transparent. This phenomenon is produced by their admitting water within their pores; for water being nearly of equal specific gravity with the stone, its power of refraction is nearly the same, which was not the case with the air that filled the pores before the water entered. See *Bergman's Dissert.* 14.

JAPONIC EARTH. Not an earth, but a gum-resin, soluble either in water or in spirit.

JASPER is a ſpecies of flint combined with about one third of its weight of clay and a little calx of iron. Its colour is generally reddiſh, or green, or ſtriped; but ſometimes blue, grey, or whitiſh. It melts with borax, and *per ſe* in a chalk crucible. *Kirw. Min.* chap. 8. ſp. 4.

JELLY is a kind of animal gum or mucilage, which conſtitutes the greateſt part of animal bodies. It may be obtained, by boiling in water, from all the ſolid and fluid parts of animals, except the excrementitious. It contains a large proportion of water, which will evaporate by heat, leaving a ſubſtance reſembling horn. Jelly, by ſtanding, ſoon grows ſour, and then runs rapidly into the putrifactive fermentation. Alkalis diſſolve it readily; ſpirit of wine not at all.

JET is a black, inflammable, bituminous foſſil, capable of a fine poliſh, conchoidal in its fracture, and highly electrical. It is inſoluble in ſpirit of wine. *Kirw. Min.* Part iii. ſp. 8.

INDIGO is the fecula of an American plant. It gives the moſt permanent blue dye to woolen cloth, &c. without any preparation except wetting them in warm water. It is uſually mixed with urine, alkaline ſalts, and other ingredients, ſome of which I believe to be entirely ſuperfluous.

INFLAMMATION, p. 15, 156. The inflammation of oils by mixing them with certain acids, is a very extraordinary chemical pheno-

menon.

menon. Essential oils in general may be inflammed by concentrated nitrous acid; but the experiment succeeds best with oil of turpentine, and a mixture of smoaking spirit of nitre with concentrated vitriolic acid. This experiment is more easily performed than accounted for. It is true, oil of turpentine and smoking spirit of nitre contain a quantity of phlogiston; but spirit of wine contains more than spirit of nitre, yet does not inflame oil of turpentine. M. Macquer ascribes the inflammation to the powerful action of the oil and acid upon each other, in consequence of both containing phlogiston: the heat, he says, resulting from their reaction, is equal to that of ignition. By reaction, I suppose he means, mutual friction of particles. I do not believe, the most violent friction of fluid particles capable of producing even the least degree of *heat*, much less *flame*. But if, as I have ventured to suppose, (p. 16, 160) phlogiston be a combination of fire with an acid; if inflammation be the actual decomposition of phlogiston, whatever will cause this decomposition will produce flame. Now, according to this theory, I would say, that the stronger acid of nitre expels the weaker acid of the phlogiston in the oil of turpentine, and that the fire is consequently at liberty to unite with pure air, as in other inflammations.

INFUSION. The liquid generally used in this most simple of chemical operations is water,

 which

which we know diſſolves ſalts, gums, and mucilagies; ſuch parts therefore of vegetables may be extracted by infuſion in water. Cold water extracts the flavour, &c. from aromatic herbs in a ſhort time. Some leaves of plants, as tea, require boiling water: but all infuſions are more elegant in proportion as the proceſs is ſhort.

INK *black*. Iron, combined with any acid, and diſſolved in water, ſtrikes a black colour with any vegetable aſtringent. This fact is the foundation of black dyes and of black ink. The combination of iron with the vitriolic acid, called green vitriol, and oak galls, are the ingredients generally uſed for theſe purpoſes. Dr. Lewis, after a great number of chemical experiments, found the following proceſs to produce the beſt black ink.

To three pints of vinegar, white wine, or water, add three ounces of galls; logwood and green vitriol, each one ounce; gum arabic an ounce and half, all reduced to a fine powder. Shake the veſſel three or four times a day, and in leſs than a fortnight your ink will be fit for uſe.

What is ink? What are the principles of the black matter which conſtitutes this liquid with which I am writing?

Dr. Lewis is of opinion that this black matter is the iron of the vitriol ſeparated from its acid,

and

and combined with the aſtringent matter of the galls.

M. Macquer, in his Dictionary, informs us, that all vegetable aſtringents have the property of ſeparating iron from any acid, and that the blackneſs of theſe precipitates is cauſed by an oily matter from the vegetable ſubſtance.

Dr. Percival concludes, from his experiments, that ink is a combination of vitriolic acid, iron, and a certain proportion of vegetable aſtringent matter.

Dr. Falconer believes that, by a double attraction, the acid quits the iron and unites with the aſtringent matter, whilſt the phlogiſton with which that was combined, unites with the iron.

The firſt queſtion among theſe philoſophers is, Whether the black matter of ink be *vitriol*, or only *iron*, combined with the vegetable aſtringent? This queſtion is eaſily determined by the following very ſimple experiment.—Five grains of green vitriol and fifteen of galls, both reduced to a fine powder, were put into a quart of warm water, that had boiled an hour, and ſhook. It immediately became a pale bluiſh ink. After ſtanding three days, the black matter had ſo entirely ſubſided as to leave three parts of the liquor above it perfectly clear and white, with a very ſlight bluiſh tinge. Part of this clear liquor was poured off and filtred, by which it became ſtill whiter. Into this fluid I dropped ſeveral tinctures of blue flowers, and no change of colour took place; but on the addition of a single drop of vitriolic acid, it became red. It might be urged, that the acid from the vitriol, in so large a quantity of water, was too much diluted to have any effect on blue syrups or tinctures: I therefore evaporated a pint of this fluid to a very small quantity, and repeated the experiment, and with the same result. If this be admitted as a proof that there is no acid in the fluid, the vitriolic acid, not being a volatile substance, must necessarily be fixed in the solid black precipitate; but, whether combined with iron, as Dr. Percival supposes, or with the vegetable astringent, according to Dr. Falconer, is not determined by this experiment: it seems to prove, however, that Dr. Lewis and M. Macquer were mistaken. The latter is also wrong in ascribing the blackness to an oily matter from the vegetable substance of the galls; because this black matter, laid upon hot iron, burns without flame, and because galls in distillation yield no oil.—The objections to Dr. Falconer's theory are, that the astringent matter is discovered to be an acid (*Crell's Annalen.* No. 1 & 2. 1787) and therefore probably does not combine with the vitriolic acid; and that the iron is not *reduced* by its union with the phlogiston of the galls, seems probable, because the black matter, Dr. Lewis tells us, is not attracted by the magnet.

That the black colour of ink is produced by phlogiſton combined with ſome other ſubſtance, is pretty certain. If it were combined with the iron, we ſhould diſcover this metal in the precipitate, in its metallic form, and conſequently magnetic: this not being the caſe, it muſt neceſſarily be united to the vitriolic acid, and the aſtringent principle, that is, the acid of galls, being thus ſeparated from its phlogiſton, and having nothing elſe to unite with, muſt neceſſarily combine with the iron. Probably this acid of galls poſſeſſes the power of ſeparating iron from every acid, in circumſtances where its phlogiſton is attracted by another acid. Mineral waters, in which iron is diſſolved in the aerial acid, become purple or black, with tincture of galls on the ſame principle: the aerial acid unites with the phlogiſton, and the acid of galls with the iron. Why this double decompoſition produces a black colour, I know not; but I know that vitriolic acid in proportion to its combination with phlogiſton, approaches gradually to a black colour.

INK, *Indian*, is a compoſition of glue and lamp-black. It is made by ſtirring the lamp-black in the glue made liquid by heat, in a ſmall quantity of water.

INK, *Printers*, is a mixture of lamp-black with what the printers call varniſh. This varniſh is made in the following manner. Take as much as you pleaſe of linſeed or nut-oil (the latter is beſt) put it into an iron pot that would hold double the quantity. When it grows hot, keep it ſtirring with an iron ladle, and, as ſoon as it boils, ſet it on fire with a piece of burning wood. Let it burn about half an hour, and then extinguiſh the flame by covering the pot. After this, continue the boiling, till, by dropping a little of it on a cold tile, you find it of a proper conſiſtence. It is common to add cruſts of bread, and a quantity of onions, in order to deſtroy the greaſineſs of the oil; but theſe additions are of no uſe. Turpentine, or litharge, anſwer the purpoſe much better; but theſe are alſo unneceſſary, if the oil be of a ſufficient age. When turpentine is uſed, it muſt be firſt boiled almoſt to a reſin, and poured into the varniſh whilſt hot. They muſt be then boiled together till they are ſufficiently mixed. To every pound of this varniſh add two ounces and a half of lamp-black; grind them together on a ſtone with a muller, and your ink is made. See *Lewis*'s *Comm. Phil. Techn.* p. 371.

INK, *Rolling-preſs*, differs not eſſentially from printers ink. The varniſh is prepared in the ſame manner, but the boiling is not continued ſo long, becauſe a greater degree of fluidity is requiſite; and the black uſed is vegetable charcoal, imported from Germany, called *Frankfort black*. See *Lewis*'s *Comm. Phil. Techn.* p. 376.

INK,

INK, *sympathetic.* Sympathetic inks are colourless fluids with which invisible characters may be traced with a pen; but which, by peculiar applications, become legible.

If we write with a solution of sugar of lead in water, or with a solution of bismuth in nitrous acid, the writing will become visible, either by moistening the paper with a pencil dipped in a solution of liver of sulphur, or by being exposed to the vapour of the liver of sulphur, which exhales on the addition of any acid. This hepatic air will take effect even through a quire of paper.

If we write with a solution of green vitriol in water, with the addition of a little acid, the writing may be rendered visible by a solution of galls.

If we write with diluted vitriolic acid, the writing will become legible by holding the paper to the fire.

If we write with zaffre digested in *aqua regia*, diluted with a little water, the letters will appear of a greenish blue colour if exposed to a moderate degree of heat.

IRON, p. 91, 195.—*Kirw. Min.* 269, 399. *Kirw. Ess. on Phlog.* 134.

ISINGLASS, *fish-glue*: soluble in water but not in spirit.

KALI. Glass-wort, is a maritime plant, from the ashes of which, mineral fixed alkali is obtained by lixiviation. See *Dr. Watson's Chem. Essays*, vol. i. p. 114.

KANNE,

KANNE, a Swedish measure frequently mentioned in the writings of the chemists of that nation, the contents of which, I think, are not perfectly understood in other countries. In Vol. I. of *Bergman*'s *Essays*, p. 119. the translator tells us, in a note, that the Swedish kanne contains eight quadrants, each containing twelve and a half Swedish inches: so that the Swedish kanne contains 100 Swedish cubic inches. Now the Swedish inch is to ours as 12 to 11,733: so that, as to inches, the difference is trifling. The English pint contains 28,875 cubic inches; therefore three English pints and a half contain 101,062 cubic inches, and consequently one inch and 62 thousandth part of an inch more than the Swedish Kanne. But in Crell's translation of Scheele's paper on the acid of galls (Ann. 1787, No. 1.) where the kanne is mentioned, the translator adds, in parenthesis, by way of explanation, 3 lb.— what the Brunswick pound is I know not; but I know, that the pound of Hamburg is to our avoirdupois pound as 1,0000 to 1,0865; a difference of little consequence. A pint of distilled water weighs an avoirdupois pound: therefore, if Dr. Crell be right, the Swedish kanne is equal to three English pints only. But in the French translation of Scheele's paper (*Journal de Physique*, *Jan.* 1787) we are told, by the translator, that a Swedish kanne is equal to *deux pintes trois quarts*, i. e. two pints and three quarters. Now the Paris

pint

pint is our quart; so that, according to this estimate, the Swedish kanne is equal to five English pints and a half.—The difference of weights and measures in different countries, is a lamentable evil as well in science as in commerce.

KAOLIN is a fine clay used in making porcelain in China, and now in many parts of Europe. Like other clays, it consists chiefly of flint, the particles of which are particularly fine in Kaolin. It abounds in talcose particles; but, containing no oily matter, does not change colour in any degree of heat. *Kirw. Min* chap. 7. sp. 2.

KARAT, or *Carat*, or *Caract*, a weight used in estimating the purity of gold. The karat contains four grains: these grains are, in the Mint, called 16ths, each of which is again divided into two 8ths, and each of these 8ths into two 16ths. Gold absolutlely pure is said to be of 24 karats. Standard gold is of 22; that is, gold of which two parts in 24 are alloy. The French divide the karat into 32 parts; the Germans into 12.—The jewellers karat, by which they weigh diamonds, &c. also contains 4 grains, equal to $3\frac{1}{5}$ grains troy.

KERMES are little gall-nuts produced by an insect on a species of oak in Spain and in France, particularly in Languedoc. It was formerly much used in dying scarlet. The colour it yields is not so vivid as that from cochineal; but it is more durable and less liable to spot. The wool for receiving

ceiving this colour muſt be firſt prepared by boiling in bran and water for half an hour, and afterwards, during two hours, in a ſolution of alum and red tartar. It is then put into a bag and left to ſoak for five or ſix days, and finally dipped in the ſcarlet vat when boiling. This vat is a ſolution of kermes in water, in the proportion of 12 ounces of kermes to every pound of wool to be dyed.

KERMES *mineral*, a fooliſh appellation given to an antimoniated liver of ſulphur, prepared by boiling in water crude antimony with vegetable fixed alkali. Crude antimony conſiſts of the ſemimetal called regulus of antimony, mineralized by ſulphur; which ſulphur, uniting with the alkali, forms the compound called *liver of ſulphur*; which liver, being a ſolvent for all metallic ſubſtances except zinc, ſaturates itſelf with the regulus: but this compoſition being ſoluble in water, but in a very ſmall proportion, falls to the bottom as the water cools, in the form of a powder, called in France, *poudre des Chartreux*, and highly celebrated for its medical virtues.

M. Macquer, in his Dictionary, favours us with a long diſſertation on kermes mineral, in which, I think, in point of theory, he is wrong. My reaſons for this opinion will appear as I proceed.

M. Macquer informs us, that the kermes, which precipitates as the water cools, being over-

charged

charged with regulus, and particularly with sulphur, contains but little alkali; but that there remains dissolved in the water, another part containing a much larger proportion. That the precipitate is overcharged with regulus and sulphur, he takes for granted, because Geoffroy boiled the same kermes 78 times with no other addition than water, and always, on cooling the liquor, obtained a fresh precipitate of kermes. This experiment, he says, proves that the alkali transforms the antimony into kermes by overcharging itself with regulus and sulphur, and that but a small proportion of alkali is carried down at each precipitation.—With submission to the opinion of so eminent a chemist, I humbly conceive, that the liver of sulphur is compleatly saturated with the regulus of antimony, in the first decoction; and, that in the 77 subsequent boilings, nothing was effected, except the solution of a small quantity of kermes in the fresh boiling water, part of which it deposites when cold. Liver of sulphur is soluble in water in a large proportion; kermes requires a considerable quantity of water to dissolve it.

M. Macquer, to prove that the menstruum after the precipitation of kermes, contains a kermes supersaturated with alkali, informs us, that M. Baumé, by adding an acid to this menstruum, obtained a precipitate of *golden sulphur of antimony*, which is a mixture of regulus of antimony with sulphur, and which he tells us, remained dissolved

in

in the menſtruum, becauſe it was combined with a larger proportion of alkali than the kermes which firſt precipitated.—That Mr. Baumé's precipitate is a golden ſulphur of antimony, I readily grant; but I am of opinion, that the kermes remaining in the menſtruum, after the firſt precipitation, was, in no reſpect, different from the precipitated kermes; that it was all the kermes which the water, when cold, could hold in ſolution, and that the acid cauſed the precipitation by uniting with the conſtituent alkali in the liver of ſulphur, and conſequently decompoſing it: therefore the ſulphur and the regulus fall to the bottom.

This famous kermes, the French chemiſts tell us, ſhould be well waſhed, ſo that it may not in any degree be ſoluble even in boiling water. If that were poſſible, it would then be a very precarious medicine, and ſo in fact it is, as its ſolubility in the primæ viæ, and conſequently its activity, muſt depend in a great meaſure on the acid in the ſtomach of the patient.

KUPFER NICKEL is an ore of the ſemimetal called nickel, of a bright orange colour: it is very heavy, and generally covered with a greeniſh efflorеſcence. It contains ſulphur, arſenic, cobalt, and iron. A regulus may be obtained by melting the ore, after long roaſting, with thrice its weight of black flux; but this regulus is ſtill combined with ſubſtances above mentioned, from which

which it may be finally ſeparated; but the proceſs is laborious. See *Bergman*'s *Eſſays*, vol. ii.

LABORATORY, p. 203.

LAC-AMMONIACI, according to the London Diſpenſatory, is made by triturating 2 drams of gum-ammoniac with half a pint of ſimple penny royal water, till it becomes an emulſion.

LACCA, improperly called *gum lac*, is a kind of red wax brought from the Eaſt Indies, ſuppoſed to be the fabrication of certain inſects. It is called *ſeed lac*, or *ſhell lac*, accordingly as it is differently prepared. It is ſometimes uſed for dying ſcarlet, and alſo as a pigment; for which laſt purpoſe nothing more is required than to boil the ſtick lac in water, and to reduce the colour to an extract by evaporation. Its principal uſe is for making ſealing wax. It is alſo uſed for lacquering tin or braſs. The varniſh for this purpoſe is prepared by diſſolving *ſeed lac* in highly rectified ſpirit of wine, and afterwards giving it the colour required, by diſſolving in this tincture a certain proportion of gamboge and annotto.

LAC LUNÆ, is a very white clay ſaturated with aerial acid; therefore it effervеſces with acids. It is commonly found in ſmall cakes, and has much the appearance of chalk. It has been generally confounded with a looſe calcareous earth found in the fiſſures of rocks, called *mineral agaric*. Its ſpecific gravity is, according to Shreber, 1,669. *Kirw. Min.* p. 1. chap. 7. ſp. 1.

LAMP *Argand's*, a very ingenious contrivance on the principle of a wind-furnace, and so constructed that the air, which rushes in through the circular grate at the bottom, passes through the middle of the burning wick, which is a thin circular cotton paper. Philosophers know that inflammable bodies, when kindled, burn only in the part which is in contact with the air, consequently at the surface; and that the smoke of a common candle or lamp, is part of the oil and wick issuing from the centre of the flame, volatilized but not burnt, because the combustion is complete at the surface only. Now the wick of Argand's lamp being all surface, there can be no smoke, and the heat and light must necessarily be considerably increased. These lamps are of great use in many chemical operations.

LAPIS LAZULI, an opake stone of a fine blue colour, frequently streaked with yellow. It is a flint combined with a blue martial fluor, and a small proportion of gypsum. In a strong fire it melts *per se* into a whitish glass. *Kirw. Min.* chap. 8. p. 1. sp. 9.

LAVA is a stone of volcanic origin. There are two distinct species of lava; one of which is a composition of calcareous earth, with about four times its weight of flint, and one third of iron. It is of various colours, of a glassy appearance, and easily melts *per se*. The other *species* consists of clay, flint, and iron, in different proportions,

portions, with, generally, a little lime. Of this latter ſpecies Bergman diſtinguiſhes three varieties, viz. *cellular*, *compact*, and *vitreous*. See *Bergm. on Volcanic Productions. Kirw. Min.* p. 1. chap. 7. ſp. 13. chap. 8. ſp. 20.

LAVENDER *ſpirit of*, is, according to the London Diſpenſatory, made by diſtilling a pound and a half of lavender flowers with a gallon of brandy, *in balneo mariæ:* but *lavender water* ſold by the perfumers, is uſually made by mixing one ounce of oil of lavender (which is imported cheaper than it can be made here) half an ounce of oil of roſemary, one or two drops of oil of cinnamon, with a gallon of proof ſpirit.

LEAD, p. 85, 194. *Kirw. Min.* p. 2. chap. 7.

LEATHER *mountain*, is conſidered by naturaliſts as a variety of aſbeſtos, from which it differs only in texture and colour, which is white, or yellow, or brown, or green, or black. It is compoſed of more than half flint, about one fifth of mild magneſia, a tenth of mild calcareous earth, with ſome clay and iron. It is ſo light as to ſwim upon water. *Kirw. Min.* p. 1. chap. 6. ſp. 3.

LEMON. The acid juice of this fruit poſſeſſes the general properties of vegetable acids; it differs, however, from vinegar, and from the acid of tartar, in being an immediate vegetable production without fermentation. The rind contains an eſſential oil obtained by diſtillation with

 water.

water. It is called *essence of lemons*, and is generally imported from the south of Europe.

LEY, or *soap-leys*, is prepared by boiling equal parts of fixed alkali and quicklime in water. It is caustic, because the alkali is deprived of its aerial acid by the quicklime. When M. Macquer wrote in his Dictionary the article under *Ley (caustic)* he was yet unacquainted with the cause of causticity. This seems very surprizing, when we recollect how long ago it is since every student of chemistry in this kingdom has been perfectly familiar with the properties of fixed air.

LIME, p. 63. also Dr. Watson's excellent Essay on Lime, vol. ii.

LIME-WATER is a solution of quicklime in water; for water will dissolve about one seven hundredth part of its weight of lime; that is, calcareous earth deprived of its aerial acid by calcination. Lime-water therefore cannot be made stronger by any additional quantity of lime after the water is saturated. The white scum which forms on the surface of lime-water exposed to the air, is mild calcareous earth; that is, lime which has recovered its fixed air from the atmosphere. This earth, not being soluble in water, falls to the bottom, and a fresh pellicle is formed on the surface, which also subsides in its turn, till all the lime is precipitated, and the water becomes perfectly insipid. Monsf. Baumé (whom I have several times had the honour to mention; who, being

being a chemiſt of conſiderable fame, merits particular attention, eſpecially when he is wrong) tells us, that the cream of lime is a ſaline ſubſtance, poſſeſſing the general properties of ſalts; conſequently it is ſoluble in water. He tells alſo, with equal truth, that on examining a portion of lime that had been kept in a bottle during 15 years, the cork of which having loſt its elaſticity, admitted the external air, he found, upon treating it with water, that indeed no heat was produced, becauſe its half-combined fire had been gradually diſſipated; but that it communicated to the water as much of its ſaline matter, as an equal quantity of freſh quicklime would have done. Now, from Dr. Watſon's experiments related in the Eſſay above quoted, it appears, that lime in contact with the atmoſphere ſaturates itſelf with fixed air in leſs than a month, it is therefore evident, either that the bottle was cloſe ſtopt, or that no ſaline matter was diſſolved in the water. What pity it is that men of ſcience ſhould ſo frequently ſuffer ambition to warp their experiments to a favorite theory!

LIQUOR *of flints*, is a ſolution of flint in water by means of an alkaline ſalt. Flint is inſoluble in any acid except that of fluor; but when fuſed with three or four times its weight of fixed alkali, it becomes perfectly ſoluble in water. In this proceſs it is neceſſary that the crucible ſhould be large, and that the mixed powder ſhould be dropped

dropped into it by little at a time. After being kept in fuſion a quarter of an hour, it muſt be poured upon a greaſed ſtone. If any acid be added to this ſolution, the flint will precipitate in conſequence of a ſuperior attraction between the acid and alkali. M. Baumé poſitively aſſerts, that by precipitating this ſiliceous earth, from liquor of flints, with vitriolic acid, he produced real cryſtals of alum; and that he repeated the experiment with a variety of vitrifiable earths, and always with the ſame reſult. Every ſmatterer in chemiſtry knows this to be impoſſible; but to complete the abſurdity, he tells us, in the next page, that alum is a ſelenites with a baſis of vitrifiable earth, compoſed of equal parts of argillaceous earth and vitriolic acid.

LIQUOR, *ſmoking, of Libavius,* is produced by diſtilling in cloſe veſſels, a mixture of corroſive ſublimate, and an amalgam of tin with crude mercury. The proportions preſcribed by M. Baumé, and by M. Macquer, are very different. The laſt of theſe chemiſts mixes four parts of tin with nine of ſublimate; the firſt, in the proportion of five to twenty. The crude mercury is of no other uſe than to ſave the trouble of pulverizing the tin. M. Baumé directs the retort to be placed in a ſand-bath; Mr. Macquer, in a reverberatory furnace. A ſmoking ſpirit paſſes into the receiver, and at the end of the diſtillation, a thick concrete, called *butter of tin.* Theſe gen-

tlemen

tlemen agree in the explanation of this process. They tell us that the marine acid in the sublimate, preferring tin to mercury, quits the latter, and, combined with the tin, rises in white fumes, which condensing in the receiver, constitute the smoking liquor of Libavius. This explanation is true as to the fact; but the cause, I think, they did not understand. That we may comprehend this matter right, we must remember, that corrosive sublimate consists of the calx of mercury and marine acid; tin, of a metallic calx and phlogiston. Now I conceive that, in this process, a double attraction takes place: the two compounds decompose each other: the acid unites with the calx of tin, and the phlogiston with the calx of mercury; for the tin carried over in the fuming liquor is not tin in its metallic form, but the calx of tin; and the mercury is actually revived. So far, I think, we stand upon firm ground. But this *smoking spirit* is found to possess the singular property of producing marine æther in distillation with spirit of wine; which æther cannot be obtained by means of marine acid, as is vitriolic and nitrous æthers by distillation with vinous spirit. This fact is much more difficult of explanation: however, *in arduis*, &c. In the generation of æther, probably the spirit of wine is deprived of a part of its phlogiston by vitriolic or nitrous acid, both which, when highly concentrated, attract that principle with great avidity.

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The marine acid cannot take phlogiston from spirit of wine, because it holds phlogiston as a constituent principle; therefore with this acid no æther is produced. But the liquor of Libavius with spirit of wine produces æther; and hence I presume that this smoking liquor, is dephlogisticated marine acid, and which was dephlogisticated in the process by the calx of mercury, which not finding a sufficient quantity in the small proportion of tin, took what was farther wanting to its saturation from the acid, the union of the acid with its constituent phlogiston being broken by the attraction of the calx of tin to its acid principle, and of the calx of mercury to its phlogiston. In refutation of this hypothesis, I shall be told, that marine æther has been actually produced without this smoking spirit. I do not deny the fact; but I am not convinced that the marine acid was not dephlogisticated in the process.

LIQUOR *(mineral anodyne) of Hoffman.* This German physician, not having left behind him his receipt for making this famous anodyne liquor, which is not in the smallest degree anodyne, we know nothing certain either of the ingredients or their proportion. Some writers tell us, it was made by distilling nitrous acid with spirit of wine, and adding to the liquor thus obtained, a small quantity of oil of cloves. If this be true, it was a kind of nitrous æther, or rather *sweet spirit of nitre.* But, in the chemical dictionary we are told,

told, that it is made by mixing an ounce of the ſpirit which riſes firſt in the diſtillation of vitriolic æther, with the ſame quantity of the æther which follows, and twelve drops of the oil which riſes after the æther has paſſed. If this be the proper receipt, this anodyne liquor is no more than the *ſpiritus vitrioli dulcis* of the ſhops.

LITHARGE, p. 85. This ſemi-vitrification of lead is uſed in various arts, and is generally purchaſed of the refiners. It is the calx of lead, mixed with parts of other ſcorified imperfect metals, that floats on the ſurface of ſilver in cupellation. The difference of colour is chiefly owing to the different degree of heat it has ſuſtained.

LIVER *of antimony*, is antimony deflagrated with an equal weight of nitre. It is the *crocus antimonii* of the London Diſpenſatory.

LIVER *of arſenic*, is a combination of fixed alkali with white arſenic. It is made by ſaturating a ſtrong ſolution of the alkali in water with powdered arſenic; to what purpoſe I know not.

LIVER *of ſulphur*, is a combination of ſulphur with fixed vegetable alkali. It may be made either by melting equal parts in a crucible, or by boiling ſulphur in a ſtrong ſolution of fixed alkali in water, filtring and evaporating to dryneſs. The firſt of theſe methods is moſt expeditious, and therefore generally uſed. This combination M. Macquer conſiders as an obvious example of his general rule, " that compounds partake of the

the properties of the ſubſtances of which they are compoſed." I ſhould rather have conſidered it as an example of the contrary. M. Macquer is alſo miſtaken in ſuppoſing that the hepatic gas which iſſues from the liver of ſulphur, when heated, or when decompoſed by an acid, is the phlogiſton of the ſulphur ſeparated from the vitriolic acid, in conſequence of their power of adheſion being weakened by their combination with the alkali. This gas appears from Mr. Kirwan's experiments, to be real ſulphur volatilized by heat. Another of M. Macquer's axioms is, that "the leſs ſimple any bodies are, the leſs ſtrongly they are capable of adhering to other bodies."—And he produces as an example of this truth, the ſeparation of the alkali in liver of ſulphur by a weaker acid, from the ſulphur which contains a ſtronger. Now this is certainly no example; for the weaker acid in this inſtance, ſeparates the alkali from the ſulphur, and not from the vitriolic acid, with which, as an acid, the alkali is not at all united.

LIXIVIAL *ſalts* are fixed alkalis obtained by lixiviation; *i. e.* by waſhing vegetable aſhes with water, and ſubſequent evaporation.

LIXIVIUM. *Ley.* It is a ſolution of fixed alkali in water, rendered cauſtic by quicklime. It has lately been much uſed as a medicine for the ſtone, conſiderably diluted in veal broth, or other vehicle. This ley is generally made with equal weights of potaſh and quicklime. Boiled with

about

about a third of its meaſure of oil, it coagulates into ſoap, which is pure or impure according to the oil employed.

LOGWOOD communicates to water, in ſeveral hours boiling, a dark blue colour. This decoction is uſed in dying woollens black; which colour, without logwood, has a diſagreeable brown tinge. The wool, or cloth, being firſt dyed blue with indigo or woad, is boiled in a ſolution of galls, and afterwards in the logwood-decoction, with a proper quantity of copperas. The proportions are for a hundred pounds of wool, 30 lb. of logwood, 5 lb. of copperas, and 5 lb. of galls.

Logwood is alſo a principle drug in dying hats. A hundred pounds of this wood, with 12 lb. of gum, and 6 lb. of galls, is boiled, in a ſufficient quantity of water, for ſix hours. Six pounds of verdigriſe and ten of green vitriol are now added, and the liquor kept ſimmering till theſe ingredients are diſſolved and properly diffuſed. Twelve dozen of hats, on their blocks, are then put in and kept down by croſs bars about an hour. They are now taken out, and the ſame quantity ſupply their place in the dye, whilſt the firſt parcel are airing; and thus they are alternately dipped and aired eight times: the liquor being each time refreſhed by a leſs quantity of the ſame ingredients.

LUMINARY, *pocket*. A ſmall tin box containing a few matches, an iron pin, a bit of wax candle, and a little bottle filled with phoſphorus. When you want to produce a light, you plunge the match into the bottle, ſo as to cauſe a ſlight friction againſt the phoſphorus. The uſe of the iron pin is to rub the phoſphorus a little harder in caſe it does not immediately light the match. The method of ſafely putting the phoſphorus into the bottle, and of giving it the property of burning as ſoon as it comes in contact with the external air, is as follows; take a cylindrical piece of phoſphorus, and, having wiped it dry with a bit of old linen, cut it longitudinally into four, ſix, or eight pieces, according to the ſize of the phoſphorus and the neck of the bottle; which bottle, being now filled with phoſphorus, muſt be left open for three or four hours, more or leſs, according to the temperature of the air. By degrees the phoſphorus will loſe its tranſparency, and aſſume a yellow or red colour. Now ſtop the bottle, and your pocket-luminary is fit for uſe. The proceſs may be ſomewhat accelerated by blowing into the bottle after the phoſphorus is in it.

There is another method of preparing this luminary, by putting the phoſphorus into the bottle moiſt, and expelling the water by heat: but this operation is attended with ſome danger. For the preparation of phoſphorus, ſee *Phoſphorus*.

LUNA

LUNA CORNEA, is a combination of marine acid and ſilver. It is called *luna*, becauſe in the fanciful days of alchemy, they give to ſilver the name of the moon, and *cornea*, becauſe this combination, expoſed to a hot fire, melts into a horn-like ſubſtance, as chemiſts report.

This *luna cornea* is produced by diſſolving ſilver in nitrous acid, and precipitating with the marine; for though this metal diſſolves much more readily in the former, yet it prefers the latter to every other menſtruum. Margraaf, Baumé, and other eminent chemiſts, have taken great pains to diſcover the beſt method of reducing this calx of ſilver. Some tell us, that diſtillation of an amalgam with mercury, will do the buſineſs: others ſay, the ſilver may be reduced by fuſion with fixed alkali. *Luna cornea* is, to the beſt of my knowledge, of no other uſe than to ſilver the dial-plates of clocks, which is done by mixing it with ſea-ſalt and tartar, and rubbing the mixture on the braſs plate previouſly heated.

LUTE. In various chemical operations it is neceſſary to cover the juncture of the two veſſels employed, ſo as to prevent the exit of the volatile matter produced in the proceſs. The plaſtic compoſitions uſed for this purpoſe, are properly called *lutes*. But this term is alſo applied to the ſubſtance with which glaſs retorts are covered, to enable them to ſuſtain a violent degree of heat; and not improperly, becauſe the ſame compoſi-

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tion is frequently applied to both uſes. Such a variety of compoſitions have been recommended by different chemiſts, that one would imagine any thing capable of forming a plaſtic body would anſwer the purpoſe.

For ſecuring the juncture of glaſs veſſels, when the vapour to be confined is mere water, ſlips of wet bladder, or of paper, or of linen dipped in a thin paſte of flour and water, is ſufficient.

A lute of greater ſecurity is compoſed of quicklime made into a paſte with whites of eggs.

A *fat lute*, for the retention of very corroſive vapours, is made by beating in a mortar dried clay finely powdered and ſifted, with drying linſeed oil, ſo as to form a paſte, which, when applied to the juncture, muſt be covered with ſlips of linen dipped in the lute laſt mentioned.

A lute for coating the outſide of glaſs retorts, may be made by mixing clay with horſe-dung, or with equal parts of brick-duſt and clay beat up with cow's hair.

In chemical operations where elaſtic fluids are to be confined, a lute compoſed of powdered lime mixed with liquid glue; or equal parts of clay and ſand, will anſwer the purpoſe.

The cracks in glaſs chemical veſſels may be effectually ſecured (if Doſſie is to be depended upon) by a mixture of grated Suffolk cheeſe, with an equal quantity of quicklime and ſkim-milk, ſpread on a ſlip of linen.

MACE

MACE is the membrane which immediately covers the ſhell of the nutmeg. Diſtilled with water, it yields an oil more volatile than that from nutmegs, and by expreſſion an oil more fluid. Spirit of wine, by infuſion, extracts all its flavour and virtues.

MACE, *oil of.* There are three ſorts of oily ſubſtances ſo called, but which are really obtained from nutmegs. That which comes in jars from the Eaſt Indies is the beſt. It is a thick oil of the colour and ſmell of mace. The ſecond ſort, which is in the form of flat cakes, comes from Holland, and is *conſequently* adulterated. The third ſort, Dr. Lewis ſays, is a compoſition of ſevum, palm oil, &c. flavoured with oil of nutmeg.

MACERATION. In chemiſtry, by maceration is properly meant the ſteeping of a ſolid body in a fluid, warm or cold, with an intention to ſoften it. M. Macquer confines maceration to *cold* water, that being the only difference, he ſays, between maceration and digeſtion. Now I conceive, that this is *not* the diſtinction between theſe two operations. Digeſtion, it is true, always ſuppoſes heat; but I can with equal propriety, order an herb to be macerated in *cold* or in *warm* water. The diſtinction between digeſtion and maceration is, that in the firſt there is an intention to impregnate the fluid; in the latter, nothing more is meant than to ſoften the ſolid, frequently

quently as a preparative to a ſubſequent proceſs. In the *Cyclopedia* we find three different ſignifications of *maceration*, all which are evidently wrong. Firſt, he tells us, it is the operation of *diſſolving* a ſolid body in water: ſecond, it is *infuſion* in order to a *ſolution* of the principles of the body infuſed: third, it is *digeſtion* in the heat of the ſun.

MADDER is a root uſed in dying. To wool, previouſly boiled with tartar and alum, it gives a permanent, but not a very bright, red. The proportion is half a pound of madder to each pound of wool. Mixed with a ſmall quantity of cochineal it produces what dyers call a half ſcarlet. Blue cloth, prepared as uſual with alum and tartar, and then dipped in the madder-vat, becomes black, with ſomewhat of a browniſh tinge. Linen or cotton firſt ſtained yellow by a ſolution of iron in ſour ſtrong beer, receives a purple, almoſt black, from a decoction of madder; or a light purple, if the yellow ſtain was light; or, if prepared with a ſolution of alum and ſugar of lead, a red colour.

M. Margraaf, of Berlin, produced a fine red lake for the uſe of painters, by boiling two ounces of madder with the ſame quantity of alum, in ſix quarts of diſtilled water, and precipitating with a clear ſolution of ſalt of tartar.

If fowls or pigs, &c. be fed with madder, their bones will in a little time be dyed red.

MAGISTERY. A word frequently uſed by ancient chemiſts, but without any determinate meaning. M. Boyle defines it, a body converted by ſome additament, into a body of a different kind; as iron into vitriol, &c. Some have called reſinous extracts, and calcareous earths, by this ridiculous name; but it is more generally applied to metallic precipitates. At preſent it ſeems confined to biſmuth, benzoin, and tin.

MAGISTERY *of Biſmuth*, is the calx of this ſemi-metal precipitated from its ſolution in nitrous acid by the addition of water; for nitrous acid diluted with water cannot hold biſmuth in ſolution. This calx may alſo be precipitated by alkaline ſalts; becauſe acids prefer alkalis to metals; but the precipitate obtained by means of fixed alkali, is not quite ſo white as that procured by precipitation with water: "The cauſe of this (ſays M. Macquer) is that the calx of biſmuth very eaſily recovers its phlogiſton: alkalis, however pure, always contain ſome ſuperabundant inflammable matter, and apply it to the metallic calces which are precipitated." *Chem. Dict.*—If it were not for the pun, I ſhould call this a *precipitate* concluſion: It ſeems very extraordinary, that fixed alkali, containing ſuperabundant inflammable matter, ſhould, when laid on a red-hot iron, exhibit neither flame nor ſmoke; nor, in any other experiment, ſhew the leaſt ſign of inflammability. The truth is, that in this preci-

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pitation of bismuth with alkalis, there is no phlogiston in the case. If caustic fixed alkali be used, the alkali unites with the acid, and the calx falls down, combined with water only: if mild alkali, a double attraction takes place; the acid combines with the alkali, and the fixable air with the calx. If an hundred grains of bismuth were dissolved, the calx precipitated by water will weigh 113; with caustic mineral alkali, 125; with mild mineral alkali, 130. But if, according to M. Macquer's hypothesis, the bismuth be precipitated by a substance superabundantly loaded with phlogiston, how comes it to pass that the precipitate is a calx, and not the metal revived?

The principal use of this *magistery* is to daub upon the necks and faces of fine ladies, to hide a brown skin.

MAGISTERY *of Benzoin*. See *Milk of Roses*.

MAGISTERY *of Tin*, is a white powder precipitated, from a solution of this metal in vitriolic acid, by volatile alkali. It is used only as a cosmetic.

MAGNESIA *alba*, p. 67, 253.—also Bergm. *Essays*, vol. i. p. 423. Magnesia (we are told by M. Macquer) is nothing else than a very much divided calcareous earth—" which by calcination acquires the properties of quicklime." — His translator sets him right in a note, and M. Macquer himself appears, in the last additions to his dic-

dictionary, to have discovered the truth and importance of Dr. Black's system, for want of which discovery he had been so frequently misled.

Magnesia alba obtained by art, for it is never an uncombined natural production, consists of about half earth, one quarter aerial acid, and the other quarter of water. Fossils containing this earth in a notable proportion, constitute the *muriatic genus* in Mr. Kirwan's admirable system; they are these: *spuma maris, steatites, soap-rock, asbestos, amianthus, serpentine, venetian talc.* From some late experiments, the earth of magnesia appears to be a constituent principle of mineral alkali.

MAGNET. An ore of iron, its attraction to which metal is well known. Its chemical properties have not been accurately examined.

MALT is grain, of any kind, in a state of beginning vegetation. Barley is the grain commonly used in this kingdom: it is made to vegetate, germinate, or sprout, by soaking it in water for two or three days, till the grain is considerably swelled: it is then spread to drain, and frequently turned: after which it is thrown up in heaps to heat, and finally dried on a kiln. By this process the grain acquires a considerable degree of sweetness; that is, a saccharine matter is generated, which, by fermentation, produces a vinous spirit. Ale and beer are, in fact, malt-wines, which, by distillation, yield the same ar-

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dent ſpirit as that which is obtained from wine made by fermenting the juice of the grape. Malt ſpirit differs from rum or brandy in flavour only; which flavour being loſt in farther rectification, the alkohal, or ſpirit of wine, obtained from any of theſe, is in compoſition and chemical properties preciſely the ſame.

MANGANESE, p. 112, 202. This mineral contains a very ſmall proportion of phlogiſton, and is therefore ſingularly uſeful in dephlogiſticating the marine acid, in which it is entirely ſoluble. A very complete eſſay on manganeſe the reader will find in *Scheele*'s *Eſſays*, tranſlated into Engliſh, p. 67. See alſo *Kirw. Min.* Part 4. chap. 15.

MARBLE. Marbles are calcareous ſtones capable of being poliſhed. They are of various colours, and are variouſly combined with other earths, and frequently with iron. The ſpecific gravity of marble is about 2,7. *Kirw. Min. calcar. gen.*

MARCASITE. Every glittering ore or pyrites, has been commonly called *marcaſite.* Wallerius includes under this demination, ſuch pyrites only as have a regular form. Mr. Kirwan confines it to a white, grey, or bluiſh-grey pyrites, in which iron is mineralized by ſulphur and arſenic. It may be analized by digeſtion in marine acid, to which ſome nitrous acid muſt be

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gradually added, to prevent the deſtruction of the ſulphur.

MARL is a mixture of chalk and clay; or, to ſpeak in the language of chemiſtry, of calcareous and argillaceous earth; which argillaceous earth, it muſt be remembered, conſiſts of at leaſt half flint. Marl, which contains 50 *per cent.* or more of chalk, is of the calcareous genus; if leſs, it is called *argillaceous marl.* The firſt of theſe effervеſces with acids, burns to lime, and vitrifies in a ſtrong heat. If marl be found to loſe 16 parts from 100 by ſolution in any acid, it belongs to the argillaceous genus: the matter loſt is aerial acid. *Kirw. Min.* chap. 6. & 7. All that has been formerly written on this ſubject, ſyſtematically, merits no attention.—The great Dr. Johnſon in his *wonderful* Dictionary of the Engliſh language, tells us, that "marl is a kind of clay which is become fatter, and of a more enriching quality, by a better fermentation." Poor Johnſon knew nothing of the matter: he copied this ſtuff from Quincy, who was as ignorant of natural hiſtory as himſelf. From this, and from many other examples in Johnſon, I ſhould conclude, if I were not myſelf now in the very act of writing a Lexicon, that no man ſhould dare to compile a dictionary, even of *words,* who does not poſſeſs a conſiderable degree of univerſal knowledge.

MARS, in chemiſtry, and in pharmacy, means iron: thus, *mars ſaccharatus* is iron filings covered with ſugar by boiling them together: *mars ſolubilis* is iron filings ground with tartar into a fine powder, &c.

MASTIC is a reſin ſoluble only in ſpirit of wine. It is uſed as a varniſh.

MATRASS is a globular bottle with a long neck, called alſo a *bolt-head*. It is uſed in various chemical operations, but particularly for digeſtion.

MATRIX applied to ores, is the ſtone or earth in which they are found enveloped: from theſe the ores are ſeparated either by mechanical or chemical means, appropriated to the nature of the matrix and of the ore.

MATT, in ſmelting of ores, is that maſs of metal which ſeparates from the ſcorea in what is called crude fuſion; that is, ſmelting without previous roaſting. This *matt* contains ſulphur combined with the regulus, from which ſulphur it muſt be freed by repeated roaſting, previous to the ſecond fuſion.

MATTER, p. 1.

MEASURES unfortunately vary, not only in every country, but often in different provinces of the ſame country. An Engliſh chemiſt ſhould know that

An Engliſh wine pint contains one pound of diſtilled water, and meaſures 28,875 cubic inches.

A French

A French pint is two English pints.

A Scotish pint contains 109 cubic inches.

The French *chopine* is the English pint.

The *demi-setier* is the English half-pint.

The *poiçon* is the English quarter of a pint, or four Paris ounces, which differ only in the proportion of 63 to 64 from our Troy ounce. See the word *Kanne*.

Air, or gas, of what kind soever, is measured by cubic inches; that is, the cylinder in which the air is confined, measured internally from the surface of the water or mercury, to the roof, contains so many cubic inches. Cylindrical vessels, which are generally used for this purpose, are very easily measured, by the following rule: multiply the area by the perpendicular height. Now the area is found by multiplying half the diameter by half the circumference, which is to the diameter as 22 to 7 nearly; or still nearer, as 100 to 314. But, by way of example, to use small numbers, and to avoid fractions, we will take the diameter to the circumference as 1 to 3. Our cylinder we will suppose is 18 inches deep, and its internal diameter is exactly 8 inches; its circumference therefore is 24 inches, half of which being multiplied by 4, which is half the diameter, gives 48 for the area, and 48 multiplied by 18, the depth of the vessel, gives the number of square inches of gas contained in the cylinder, viz. 864.

MENSTRUUM is the fluid in which a solid body is dissolved: thus water is a menstruum for salts and gums; spirit of wine for resins, &c.

MERCURY. *Quicksilver*, p. 81, 193.

MERCURY, *philosophical*, or rather *alchemical*. The ancient chemists, or *adepts*, make frequent use of the word mercury in their writings, evidently without knowing what they meant.

MERCURIFICATION is an operation by which the alchemists pretended to extract from other metals the mercurial principle, or to transmute them into mercury. This nonsense is quite out of date.

METALS, p. 69. *Kirw. Min.* P. 4. chap. 1.

MICA. Authors have almost universally confounded *mica* with *talc*, from which however it differs essentially. Talk is a composition of magnesia, flint, and clay, and is soapy to the touch. Mica is not soapy to the touch, and, besides containing a less proportion of magnesia, has in its composition about 14 parts in 100 of calx of iron. It is of various colours; its texture is always scaly; it does not effervesce with acids because the magnesia is pure; but after calcination with four times its weight of fixed alkali, it effervesces violently, the magnesia being now saturated with aerial acid from the alkali. The colourless mica is fusible with borax, and the coloured melts *per se* in a very strong heat.

In

In the *Chemical Dictionary*, there is a note to *mica* (a word omitted by the author) in which we are told, that it is neither a calcareous, ſiliceous, argillaceous, nor gypſeous earth. Very true: but it is a mixture of the three firſt with a little iron. As to gypſeous earth, the writer of the note knew very well that it is calcareous earth, and nothing elſe.

MILK. Authors tell us, that milk is an animal emulſion: that is, milk is milk. I ſuppoſe they meant to ſay, that emulſions are artificial milks. Emulſions, we know, are made by mixing, in a mortar, oil, mucilage, and water; or, by grinding, with water, ſeeds that contain the other two ingredients. But the conſtituent parts of milk are, butter, cheeſe, ſugar of milk, ſome extractive matter, common ſalt, and water. Theſe conſtituents may be farther analized.

It is well known that any acid added to milk, with the aſſiſtance of heat, will produce a perfect ſeparation of the curd or cheeſe.—Why?—Becauſe a part of the acid combines with the curd, and this compound requires more water for its ſolution than is contained in the milk.

About a tenth part of this cheeſe is an inſoluble earth, which is the univerſal animal earth, conſiſting of phoſphoric acid ſuperſaturated with lime.

The whey of milk contains an eſſential ſalt, animal earth, ſugar of milk, marine acid combined

bined with vegetable alkali, some mucilage, and the acid of milk. Two of these constituents of whey may be obtained separate in sufficient quantity, viz. the sugar and the acid of milk. To separate the sugar, nothing more is required than to evaporate the whey, previously clarified and filtered, to about one fourth, and then to set it in a cool place to crystallize. This is sugar of milk, which may be refined by two or three times redissolving and crystallizing. To obtain the acid, a much more troublesome process is necessary. First, the milk must stand a fortnight, and the sour whey be then separated by filtration. This whey must be evaporated to about an eighth, and again filtered. To separate the animal earth, the sour whey must be saturated with lime, then filtered, and the lime precipitated by the acid of sugar. Now, in order to get rid of the sugar of milk, with the other heterogeneous matter, the fluid must be evaporated to the consistence of honey, and then dissolved in highly rectified spirit of wine, which, being separated, by distillation from the acid of milk, leaves it in the retort perfectly pure. See p. 52.

Besides this acid thus obtained from sour whey, another acid may be extracted from the sugar above mentioned, by the following process.— Take any quantity of sugar of milk; put it into a large retort, and add five times its weight of diluted nitrous acid: adapt it to a receiver, not closely luted, and place it in a sand-bath. Continue

tinue the diſtillation till the fluid in the retort becomes yellowiſh. Now remove it from the fire, and when it is cool, pour into the retort a quantity of water ſufficient to diſſolve the maſs, and paſs the ſolution through a filter. The powder which remains on the filter is the acid ſalt required. It may be purified by repeated ſolution and cryſtallization. The properties of this acid are theſe—It effervesces with abſorbent earths; it reddens the tincture of turnſol; with alkalis it forms neutral ſalts; with earths it forms ſalts inſoluble in water; it takes *barytes* and lime from marine or nitrous acid, but not gypſum; with metallic earths it forms ſalts inſoluble in water; it precipitates ſilver, mercury, and lead from nitrous acid: the neutral ſalts, formed by this acid with alkalis, decompoſe all metallic ſolutions.

Milk of different animals differs in the proportions of its contents. Cows milk contains moſt curd and leaſt ſugar; goats milk, a little leſs curd, and a little more ſugar; women and aſſes milk contain a little more than half the quantity of curd which is in cows milk, and five times the quantity of ſugar.

MILK *of Lime*. Lime ſuſpended in water.

MILK *of Roſes*, is Benzoin diſſolved in ſpirit of wine, and afterwards diluted with a large quantity of roſe-water.

MILK *of Sulphur*. Sulphur precipitated, from a ſolution of liver of ſulphur in water, by vitriolic acid. It differs from common brimſtone only in being white.

MINIUM. *Red Lead*, is a calx of this metal prepared by burning in a reverberatory furnace. It is used in common as a coarse paint, and for other purposes; but it has lately risen into distinction, in consequence of its property of yielding pure air in distillation, *per se*, or with vitriolic or nitrous acid.

MOLYBDÆNA appears, from Scheele's Experiments, to be a peculiar acid mineralized by sulphur. It has been generally confounded with *plumbago* (black-lead) but its laminæ are larger, brighter, and slightly flexible; besides, in chemical properties they are essentially different. The specific gravity of molybdæna is 4,569. It is somewhat more than half sulphur. These constituents are separated by repeated distillation with nitrous acid: the remaining white calx is the molybdænous acid, the specific gravity of which is 3,460. It possesses the general properties of acids, but requires near 600 times its weight of water to dissolve it. Distilled with sulphur it reproduces molybdæna. Notwithstanding all this, it is certainly a metallic earth, if it be true, as we are informed, that it has lately been reduced to a regulus.

MORTAR. The best mortars for philosophical chemistry are those made by Mr. Wedgewood.

MORTAR, a cement used in building. From the stony hardness of the mortar found in ancient build-

buildings, it is ſuppoſed that our forefathers poſſeſſed ſome ſecret in the compoſition, with which we are unacquainted. "The lime (ſays our Cyclopædia) uſed in the ancient mortar, is ſaid to have been burnt from the hardeſt ſtones, or often from fragments of marble."—Did not the editor know, that the hardeſt ſtones will not burn to lime, and that marble is ſo common a lime-ſtone, that it is conſtantly brought from Ireland to Wales, by the coal-ſhips, as ballaſt, and there burnt for lime?

Common mortar, we all know, is a mixture of lime, ſand, and water. Various attempts have been made to improve this compoſition. Patents have been obtained for making mortar to cover walls, that ſhould laſt for ever, and in two or three years it has all tumbled down. Some writers lay great ſtreſs on the kind of ſand. Mortar made with ſea-ſand, I have been told, never dries. Authors differ as to the proportions of ſand and lime: common mortar is generally made with two parts lime to three of ſand.

Doſſie, in his *Memoirs of Agriculture*, vol. 2. reveals a ſecret for making a mortar, cement, or plaſter, as durable as that of the ancients. It is this: to one part lime add three parts fine ſand; ſlake it gradually, and uſe it whilſt hot. The lime, he tells us, muſt be made of limeſtone, ſhells, or marble.—What elſe would he make it of? Lime is calcareous earth deprived of its aerial acid,

acid, and is the ſame ſubſtance, make it of what you will. Lime cannot be made of any ſtone, or other matter, that is not compoſed of mild calcareous earth.

In the year 1774, was announced at Paris, by order of the King, M. Loriot's ſecret for making mortar, thus.—Mix together eight parts of fine river-ſand, four parts of fine brick-duſt, with three parts of powdered quicklime. Blend this powder with as much old flaked lime and water as will make the whole of a proper conſiſtence, and you will have a *very bad mortar*. The proportion of new lime is inſufficient to correct the bad quality of the old.

Dr. Higgins, in 1779, obtained a patent for a ſtucco of his own invention, which, he ſays, exceeds Portland ſtone in hardneſs. It conſiſts of one part lime, one part powder of calcined bones, with ſeven parts of clean ſand, made into a cement with lime-water.

The Doctor is of opinion, that the binding quality of lime is owing to its deprivation of fixable air in burning, and that it hardens not in conſequence of evaporation, but of the reabſorption of fixable air from the atmoſphere. This ſeems a rational theory: lime falls to powder becauſe it has loſt its vinculum, fixable air; which vinculum it recovers from the atmoſphere, and becomes again a hard ſtone. We will put this theory to the teſt of experiment.

I ſtruck

I ſtruck off ſome mortar from old brickbats, which probably was made at leaſt fifty or ſixty years ago. Four ounces (1920 grains) of this mortar, reduced to a powder, I threw into a tea-kettle of water that had previouſly boiled an hour or more. The boiling was continued two hours longer. There remained now about a pint of liquor, which I poured off into a baſon, and repeatedly putting freſh water into the kettle and pouring it out, till it came off perfectly clear, the ſand, &c. which remained, was freed from every kind of matter that water will ſuſpend or diſſolve. This reſiduum appeared to conſiſt of ſand of very different degrees of fineneſs, mixt with hard bits of lime: it weighed, when quite dry, 1375 grains; ſo that I had loſt either by evaporation, ſolution, or ſuſpenſion, 545 grains of the original weight. Now, in order to ſeparate the ſand from the mild calcareous earth, and to determine their reſpective quantities, I poured vitriolic acid upon it, till there was no longer any effervеſcence. Thus the calcareous earth was converted into gypſum, which I waſhed away by repeated effuſions of hot water, and having made the remaining ſand perfectly dry, I found that it weighed 1070 grains; ſo that there was among this ſand, 305 grains of calcareous earth, which either had recovered its aerial acid, or had never loſt it in burning.

The water in which the lime was boiled, added to the waſhings of the reſiduum, was immediately ly filtered. What remained upon the filter, being well dried, weighed 280 grains. Half a dram, (30 grains) of this ſubſtance, I put into ſome diluted nitrous acid. A violent effervеſcence enſued. As ſoon as it was over, I threw the ſolution into a quart of water, which, next morning, I paſſed through filtring paper, on which paper there remained an earth that, when perfectly dry, weighed 10 grains. Now, as 10 is to 30, ſo is 93 to 280, the whole quantity that remained on the filtre. One third, therefore, of the matter ſuſpended in the water in which the lime was boiled, I concluded was not calcareous earth, becauſe it did not diſſolve in the nitrous acid; and hence there remains only two thirds (187 grains,) of mild calcareous earth, which added to the 105 grains before diſſolved by the vitriolic acid, makes 292 grains.

Now we are to recollect that the original weight of the old lime was 1920 grains, and that the ſand which it contained weighed 1375 grains: the deficiency, therefore, is 545 grains, which, according to Dr. Higgins, ſhould be all mild calcareous earth. But if my experiments be juſt, all that we can diſcover of that earth amounts to no more than 292 grains; ſo that there remains 253 grains not accounted for: and if from the above 292 grains, we ſubtract the quantity of mild calcareous earth probably mixed with the lime, which is ſeldom ſufficiently burnt, or uſed

im-

immediately, we may, I think, fairly conclude, that not more than half the lime has, by regaining fixed air, returned to its original ſtate, and that the deficient 253 grains were lime unchanged, which diſſolved in the boiling.

On the ſuppoſition that mortar regains its fixed air from the atmoſphere, we are told that it ſhould be uſed as ſoon as poſſible after it is made. To try the truth of this opinion, I took 30 grains of mortar that had remained in a heap four years, and threw it into a quart of cold water. I filtred the whole, and there remained on the filter 22 grains; conſequently eight grains were diſſolved, which eight grains muſt have been pure lime. On the remaining 22 grains I poured vitriolic acid to ſaturation. I then mixed the ſolution with a quantity of water more than ſufficient to diſſolve the ſelenites; filtered again, and obtained nine grains of fine dry ſand; ſo that the matter which the vitriolic acid had diſſolved weighed 13 grains.

Still farther to illuſtrate this matter, I took 120 grains of freſh mortar, made with one third lime and two thirds road ſand, which are the common ingredients and proportions for mortar in this neighbourhood. Theſe 120 grains, when perfectly dry, weighed exactly 90: ſo that mortar, moiſtened for immediate uſe, contains about one fourth of its weight of water.

 Thirty

Thirty grains of this fresh mortar well dried, were treated exactly as the old mortar in the last experiment. I threw it into a quart of cold water; filtered, dried what remained on the filter, and to my very great surprise found that it weighed *thirty grains*: so that in this fresh mortar, which was sent to me by a neighbouring builder, there was not an atom of lime. Probably the lime, or rather lime-stone, of which this mortar was made, had been so long from the kiln as to have recovered all the fixable air which it lost in the burning. But to determine the quantity of sand in this composition, I poured on to these 30 grains a sufficient quantity of vitriolic acid, washed away the soluble and suspensible matter, and obtained of real sand 15 grains: so that the deficient 15 grains were mild calcareous earth, and other earth in the road-sand used in making the mortar.

I was so much surprized at the result of the last experiment, that I began to think I had made some mistake in weighing the mortar which I had examined. I determined, therefore, to repeat the process with strict attention, and somewhat more circumstantially.

1. Having carefully dried, pulverized, and then weighed 30 grains of the same fresh mortar, I put it into a quart decanter full of pure water, shook it well, and let it rest an hour. The design of this part of the process was to dissolve the lime, which

which is the only ingredient in mortar that water will diſſolve, and of which I know that water will diſſolve about a ſeven-hundredth part of its own weight. Now as the mortar in queſtion was made with two-thirds road-ſand, our 30 grains could not poſſibly contain more than ten grains of lime, which ten grains would diſſolve in 7000 grains of water, equal to 14 ounces and a half nearly: the quart of water therefore would have diſſolved more than double the quantity. I now filtered this *no* ſolution of lime; dried what remained on the filter, and found that it weighed very nearly 30 grains as before.

2. Theſe 30 grains, conſiſting of matter not ſoluble in water, were ſubmitted to the teſt of ſtrong ſpirit of nitre, which, when the efferveſcence ceaſed, I diluted with water and paſſed the ſolution through filtering paper. Nitrous acid diſſolves all earths except the ſiliceous, that is, flint or ſand; for the particles of ſand are ſmall flints. This ſand, thus ſeparated from all other matter, and well dried, weighed exactly 15 grains; ſo that 15 grains were diſſolved by the ſpirit of nitre, which 15 grains were probably mild calcareous earth and clay.

What do we learn from this inveſtigation? — 1. That half of this mortar is ſand. — 2. That one ſixth is clay, ſuppoſing that two thirds of road-ſand were uſed. — 3. That one third is mild calcareous earth. — And, laſtly, that it contains no lime at all. Now if lime be the principle in mortar which gives it the quality of binding bricks or ſtones together, what wonder that the bridges built over rivulets, in a part of the kingdom to which the lime, after being burnt, is brought from a conſiderable diſtance, ſhould be frequently carried away by torrents of water? —For lime is every moment imbibing fixed air, and thereby ſpeedily returning to its original ſtate of lime-ſtone.

There is yet another obſervation of ſeeming importance, which cannot have eſcaped the reader in the courſe of theſe experiments on old and freſh mortar: viz. that ſand is not at all acted upon, changed, or affected, either by lime or time. Of what ſervice, therefore, is ſand in the compoſition of mortar?

This article, to chemiſts, will have appeared too prolix, circumſtantial, and repetitious; but the ſubject is important, and therefore cannot be too well underſtood.

MOTHER-WATER, is that which remains, in the manufacture of common ſalt or nitre, after the cryſtallization of theſe ſalts. It contains ſalts compoſed of the ſame acids, but combined with an earthy baſis. By the addition of fixed alkali the earth is precipitated.

MOUNTAIN BLUE, or *chryſocolla*, is a blue calx of copper, frequently found in a looſe form, but ſometimes indurated. It contains a large proportion of copper. It may be analized by solution in acids, and precipitation with mineral alkali; or, in the dry way, by melting with borax and pitch. *Kirw. Min.* P. 4. chap. 4. sp. 2.

MOUNTAIN GREEN, is a calciform ore of copper, generally found in a loose and friable state, often mixed with calcareous earth and iron. A hundred parts of it contain about 72 of copper, 22 of aerial acid, and six of water. *Kirw. Min.* P. 4. chap. 4. sp. 2.

MUCILAGE, is a glutinous matter obtained from vegetables, either in the form of gum, or of a visced white transparent fluid, soluble in water, but not in spirit of wine. In distillation it yields a very large proportion of water, a little oil, resembling the expressed oils of vegetables, a little acid of sugar, phlogiston, and earth.

MUFFLE, is a semi-cylindrical utensil, resembling the tilt of a boat, made of baked clay: its use is to cover cupels or tests in the assay furnace, to prevent the charcoal from falling into the metal. Those used in London are generally made of Windsor-loam, and are of different dimensions, according to the purposes for which they are intended.

MUM, is a strong sweetish liquor, brewed chiefly of wheaten malt, with the addition of a small quantity of malt made of oats, and a little flour of beans. According to the old receipt, said to be preserved in the town-house at Brunswick

wick (when Brunſwick was a free city, I ſuppoſe: at preſent there is a ducal palace, and no town-houſe) a farago of herbs were put into the caſk whilſt in a ſtate of fermentation. Probably they loſt the old receipt with their liberty; for the mum now made at Brunſwick has not the leaſt flavour of herbs of any kind.

MUSK is, in part, ſoluble both in ſpirit of wine and in water.

MUSTARD imparts its peculiar taſte and pungency to water only. Muſtard-ſeed yields, by expreſſion, a conſiderable quantity of an oil without either taſte or ſmell.

MYRRH is a gum reſin, and conſequently ſoluble both in water and in ſpirit: water will diſſolve about three fourths; ſpirit, about one third only. It yields a ſmall quantity of eſſential oil in diſtillation.

NAPTHA is a fragrant foſſil oil which iſſues from certain clays in Perſia. It is *petrolium*, and what is called *Barbadoes tar*, in their firſt limped ſtate. It is extremely inflammable, and, like æther, takes gold from *aqua regia.* If long expoſed to the air, it changes colour, thickens, and becomes *petrolium.* It diſſolves ſome eſſential oils; but is inſoluble in ſpirit of wine. Its ſpecific gravity is 0,708.

NATRON, or *natrum:* foſſil alkali, and nothing elſe. It is found native in China, Egypt, and many other parts of the world; alſo upon

damp

damp walls in every part of Europe. The article under this word, in our great national Dictionary of Arts and Sciences, reprinted so late as the year 1786, is a very complete example of complicated ignorance. Chambers transcribed from Dr. Leigh (the most uninformed chemico-naturalist of his time) and such other books as were then in credit; but that is no reason why, in a book of reputation, those articles which can answer no other purpose than to misinform the reader, should be now reprinted.

This natron or marine alkali, when pure and recently crystallized, contains, in 100 parts, 20 of mere alkali, 16 of aerial acid, and 64 of water. When found native, it is commonly mixed with magnesia, sea salt, or other marine salts, with an earthy basis. See *Kirw. Min.* P. 2. chap. 2.

NICKEL, p. 101, 199.

NITRE, p. 49. This neutral salt, commonly called *saltpetre*, is a combination of nitrous acid and vegetable alkali, in the proportion of about two parts of alkali to one of acid. Its crystals are prisms, which require about seven times their weight of water to dissolve them. Its specific gravity is 1,92. It deflagrates on burning coals, and, mixed with sulphur and charcoal, forms gunpowder. The acid of nitre may be driven off from the alkali by deflagration with any phlogistic substance.

Nitre is generally an artificial production. It is formed by pouring water on a mixture of rubbiſh from the ruins of old buildings (particularly ſtables) with wood aſhes. This lixiviation is ſeveral times repeated: the liquor is then boiled and cryſtallized by cold. M. Becker, of Magdeburg, in a pamphlet publiſhed in 1783, aſſures us, that he can extract nitre at pleaſure, in the courſe of three days, from the earth of ſtables and cow-houſes, by uſing, for ſaturation, well purified potaſh. The uſe of the potaſh is to give the proper baſis to the nitrous acid, which in the rubbiſh is combined with calcareous earth. The acid, prefering the alkali to the earth, unites with it and forms nitre.

From nitre alone, by the application of a ſufficient degree of heat, a large quantity of pure air may be produced. Two ounces of this ſalt will give 800 ounce meaſures of pure air.

NITRE, *alkalized*, or *fixed nitre*, is vegetable fixed alkali, in no reſpect different from ſalt of tartar, ſalt of wormwood, or any other vegetable alkaline ſalt. It is obtained by deflagrating nitre with charcoal or any other phlogiſtic matter.

NITRE, *ammoniacal*. Nitrous acid and volatile alkali.

NITRE, *with an earthy baſis*. Nitrous acid ſaturated with lime or magneſia.

NITRE, *cubic*. Nitrous acid combined with mineral alkali. If to a ſolution of ſilver in nit-

rous

rous acid, a ſolution of common ſalt be added, the metal will combine with the marine acid, and the nitrous acid with the marine alkali, forming cubic nitre: or if foſſil alkali be added to a ſolution of any earth or metal in nitrous acid, the earth or metal will precipitate, and cubic nitre will remain diſſolved in the fluid, becauſe acids prefer alkalis to metals or earths.

NITRE, *fixed by arſenic.* This is a very improper appellation of a neutral ſalt compoſed of vegetable fixed alkali and the acid of arſenic. It is produced by projecting white arſenic upon nitre in fuſion until the ebulition ceaſes. In this operation the acid of the nitre is volatilized by the phlogiſton of the arſenic, the acid of which, being therefore diſengaged, unites with alkaline baſis of the nitre. The alkali is not ſaturated, and therefore the ſalt does not cryſtallize, becauſe the alkali is ſuperabundant, owing to the great heat employed in the proceſs. With leſs heat and more arſenic, a cryſtalline ſalt may be obtained.

NITRE, *fixed by charcoal—fixed by tartar—fixed by metals.* All theſe fixed nitres are very improperly ſo called: they are not nitres, but vegetable fixed alkali, produced by deflagration with matter containing phlogiſton; which phlogiſton, being ſet at liberty, deflagrates with the nitrous acid, and leaves the alkaline baſis. With metallic ſubſtances the alkali is cauſtic, becauſe the fixable

able air quits the alkali to unite with the metallic calx.

OCHRE is a yellow, red, or brown calx of iron, in a looſe form. Some ochres contain a large proportion of clay, and frequently manganeſe, or calcareous earth, or magneſia. They generally become red by calcination. They are uſed chiefly by painters.

OFFA *Helmontii*. Offa is a word of Van Helmont's coining. Add a little ſpirit of wine to your bottle of hartſhorn drops, and this *offa* will fall to the bottom, provided your ſpirit of hartſhorn be made without quicklime. It is nothing more than the concrete *ſal volatile* uſed in ſmelling-bottles. If you want to know whether your ſpirit of hartſhorn be made with quicklime or not, this experiment will tell you.

OIL, p. 115. *Animal* 118—*eſſential* 116—*expreſſed* 118—*foſſil* 119.

OILS, *empyreumatic*, are oils of any kind obtained by diſtillation with a heat greater than that of boiling water. They have a diſagreeable ſmell.

OIL *of tartar*, is a ſolution of vegetable alkali in a ſmall quantity of water. Whether made in the cellar or above ſtairs, is, notwithſtanding the preſcription of the college, of no conſequence.

OIL *of vitriol*. Concentrated vitriolic acid.

OLEOSACHARUM. A mixture of oil and ſugar.

OLIBANUM, or *Frankincenſe.* A gum-reſin, of which ſpirit of wine diſſolves more than water.

ONYX is ranked among precious ſtones of the ſecond order: it conſiſts of flint mixed with other earths and iron. It is very hard. Its colour is that of the human nail, with zones of another colour. Like other flints it is fuſible with fixed alkali. *Kirw. Min.* chap. 1. ſp. 5.

OPAL. Of the ſame ſpecies with the laſt. It is white, or yellowiſh, or greeniſh brown, and reflects different colours according to the poſition of the eye. *Ibid.*

OPINIONS, *philoſophical*, p. 37.

OPIUM. A gum-reſin, almoſt totally ſoluble either in water or ſpirit.

OPOPONAX. A gum-reſin, more ſoluble in water than in ſpirit of wine.

ORANGE. The rind contains an eſſential oil. From juice, diluted with water and clarified with white of eggs, a cryſtallized ſalt, like that from lemons, may be obtained by evaporation.

ORES, p. 184. Ores are mineral ſubſtances containing metals, or rather metallic earths, combined with ſulphur, or arſenic, or both, or with aerial acid. When with the latter, they are called calciform. Metals thus mineralized are always more or leſs dephlogiſticated.

OSTEOCOLLA. A calcareous incruſtation on the roots of trees.

OX-

OXYGENOUS, derived, I suppoſe, from ’οξυς *acutus*, is a term lately introduced by the French antiphlogiſtic ſect of philoſophers. The oxygenous principle, according to theſe gentlemen, is pure air deprived of a part of its ſpecific heat; conſequently condenſed, and in a concrete ſtate. This oxygenous, or acidifying principle, they tell us, joined to a peculiar baſis, conſtitutes all acids; that, in the calcination of metals, this principle combines with the calx; and that metals diſſolved by acids, deprive the acids of the oxygenous principle, with which principle the calx unites.

Theſe Antiphlogiſtians have not yet proved the exiſtence of this concrete, this pure ſour air. I believe it exiſts only in their own imagination.

PANACEA, *mercureal*. This mercureal preparation was formerly in great repute, particularly in France. It is made by ſubliming calomel nine times, and then digeſting it during 20 days, with ſpirit of wine: after all which trouble it remains calomel, and nothing elſe.

PARTING, p. 186.

PELICAN. A glaſs alembic formerly much uſed for circulatory diſtillation, when chemiſts had more patience than knowledge.

PENNY-WEIGHT. The twentieth part of an ounce Troy. Uſed only by goldſmiths.

PERUVIAN BARK, contains about an eighth part of its weight of a gum-reſin, in which its

its virtues probably reſide. Water and ſpirit extract both the gum and the reſin.

PHLOGISTON, p. 15.

PHOSPHORUS, is a chemical compoſition capable of inflammation by mere contact with the open air, without communication with any other burning body. It is a kind of ſulphur compoſed of phlogiſton and a peculiar acid: an acid which pervades the three kingdoms of nature, but abounds particularly in human urine. A great variety of preſcriptions for making phoſphorus have been publiſhed, moſt of which impoſe unneceſſary trouble: the proceſs is, in fact, nothing more than a diſtillation of urine, firſt boiled to the conſiſtence of ſyrup, continued till the retort acquires a white heat. The phoſphorus will then fall in drops into the water in the receiver. A ſecond diſtillation, by a very moderate heat, will render it white and pure.

Homberg produced a phoſphorus of the ſame kind by a different operation; but his proceſs is too naſty even for deſcription. Phoſphorus, when expoſed to the air, burns with a cold flame, incapable of ſetting fire to any combuſtable matter; but, by the leaſt friction, it acquires heat ſufficient to inflame a match, as in the *pocket luminaries* ſold in London.

PHOSPHORUS, *Bononian*, is ponderous ſpar, which, after calcination, is luminous in the dark. This property is much improved by reducing the ſtone

ſtone to powder, forming it into a paſte with gum, and calcining this paſte (flattened into a thin cake) in an open fire.

PHOSPHORUS *of Baldwin*, which is alſo luminous in the dark, is made by ſaturating common chalk with nitrous acid, waſhing it with water, and evaporating to dryneſs: therefore it is nitre with a calcareous baſis.

PHOSPHORUS, *ammoniacal of Homberg*, is made by melting equal parts of ſal-ammoniac and quicklime in a crucible: it is therefore marine ſalt with a calcareous-baſis.

PINCHBECK. A compound metal, ſo called from a watch-maker who firſt made it in any degree of perfection in this kingdom. It is compoſed of copper and zinc melted together, in different proportions, according to the intention of the artiſt. Some make the copper firſt into braſs, and then fuſe it with zinc; others uſe tin inſtead of zinc. This gold-coloured compound is alſo called *Prince's metal*; in Germany, *tonbach.*

PINT. See *Meaſure.*

PITCH. Tar from which a part of its water has been evaporated by boiling.

PLASTER. That which is uſed for lining brick walls, is common mortar mixed with cows hair. That which is uſed for cielings and other fine plaſter-work, is called *plaſter of Paris*, becauſe the ſtone of which it is made abounds in the neighbourhood of that city. This ſtone reſembles

lime-

limeſtone, marble, &c. in having lime for its baſis; but they are combined with different acids. All the ſtones, ſpars, and earths that will burn to lime, conſiſt of pure calcareous earth and aerial acid: but plaſter of Paris, or gypſum, is pure calcareous earth combined with vitriolic acid. Plaſter is eaſily reduced to a powder by a moderate degree of heat, and, being then mixed with water, forms a mortar which very ſoon becomes hard. Theſe properties ſufficiently diſtinguiſh it from lime. See *Gypſum*.

PLATINA, p. 79. This metal is ſo called from the Spaniſh word *plata*, ſilver; of which word it is a diminutive. Hence our word *plate*. See Lewis's *Phil. Com. of Arts*, p. 443.

PLUMBAGO. Black-lead, uſed for pencils. This mineral, after ſuffering all the various tortures of chemiſtry, is at laſt determined to be a ſpecies of ſulphur, compoſed of phlogiſton and aerial acid, in the proportion of about ſeven parts of the former to three of acid. But the reader, not much acquainted with the modern diſcoveries in chemiſtry, will be ſurprized to learn that this plumbago is found in iron; that ſteel contains more of it than the malleable iron of which it is made, and that conſequently plumbago is a factitious ſubſtance, formed during cementation by the ſuperfluous phlogiſton of the iron and the fixed air of the charcoal. It is inſoluble in the mineral acids, infuſible by the common fluxes, totally

tally volatile in a ſtrong heat, but may be decompoſed by deflagration with ten times its weight of nitre. See *Scheele*'s *Eſſays*, No. 13. *Kirw. Min. Append.* 1. and *Eſſay on Phlogiſton*, ſect. 12. In the *Cyclopædia* plumbago is improperly confounded with *galena* and *blind*, the firſt of which is known to be lead-ore, and the latter, we are told, in the ſame book, is a ſpecies of lead-marcaſite.

In the *Additions* printed at the end of the laſt Engliſh edition of *Macquer*'s *Chemical Dictionary*, we find a diſſertation under the word *Black-lead*; which diſſertation the author begins by confounding *plumbago* with *molybdæna*; the firſt of which is a combination of fixed air and phlogiſton; the latter, of an acid earth mineralized by ſulphur: therefore we can learn nothing from this diſſertation. M. Macquer, after relating the experiments of M. Pott and M. de Liſle on black-lead, is of opinion, that theſe chemiſts have proved the greateſt part of this mineral to be a micaceous talky matter, the earth of which, being of an argillaceous nature, forms alum with vitriolic acid; and that this talky matter is intimately combined with iron, and a volatile acid. Unfortunately for this concluſion, plumbago contains neither mica, nor talk, nor clay, nor vitriolic acid, nor iron (eſſentially) nor volatile acid: it is a ſimple combination of aerial acid and phlogiſton.

PONDEROUS EARTH, p. 61.

POR-

PORCELAIN. If the reader will give himſelf the trouble to turn to this word in our great *Cyclopædia*, he will find a moſt unintereſting jumble of miſinformation. If, thus diſſatisfied, he has recourſe to the *Chemical Dictionary*, he may read a prolix diſſertation on porcelain, and finally learn, that the beſt kind of porcelain and common ſtone-ware are the ſame thing, and that they are made of ſands and ſtones mixed with earths or clays. If this hiſtorical diſſertation was intended to convey inſtructions worth reading, the author would certainly have ſpecified the particular kinds of earth and ſtones, and their reſpective proportions. The beſt kind of porcelain, he tells us, is that which is made of vitrifiable mixed with unvitrifiable matter. We know that ſand or powdered flints are vitrifiable in a certain degree of heat; but not without a flux: mixed with clay alone they will never fuze: what then is the flux uſed in the manufacture of this beſt kind of China or porcelain?—This neceſſary piece of information M. Macquer forgot; or, having conceived that porcelain and ſtone-ware are the ſame thing, he totally loſt the idea of a flux.

Firſt let us obſerve, that porcelain and ſtoneware differ as eſſentially from each other as a piece of flint glaſs from a common red tile. Porcelain is a ſemi-vitrified ſubſtance; ſtone-ware is nothing more than baked clay mixed with ſand, unvitrified, and conſequently differs, only in being glazed, from a common brick.——"If, says M. Macquer, we except whiteneſs, *on which alone the ſemi-tranſparency depends*, and compare all the properties of Japaneſe porcelain with thoſe of our ſtone-ware, no difference can be found."——Is it not very extraordinary that this great chemiſt ſhould aſcribe the ſemi-tranſparency to the whiteneſs of the earths uſed in the manufacture of porcelain? Could he poſſibly be ignorant that the ſemi-tranſparency is owing to the ſemi-vitrification; that ſtone-ware is opake, becauſe it is in no degree vitrified; and that it is not vitrified, becauſe it is made of flint and clay only, which, without the addition of ſome other matter, are incapable of vitrification?

Porcelain, whether manufactured in China, at Dreſden, at Sevrés, or at Worceſter, is, like ſtone-ware or Staffordſhire-ware, a compoſition of flint and clay; but with this very eſſential diſtinction: porcelain is a half-glaſs; ſtone-ware is a glazed tile.—In the different manufactories of porcelain, different fluxes, and in different proportions, are added to the paſte formed of clay and powdered flint, for the purpoſe of producing the eſſential ſemi-tranſparency. What this flux muſt be, is not difficult to diſcover, when we recollect the chemical properties of flint and of clay. The firſt of theſe will melt either with fixed alkali or with calx of lead: the latter melts with calx of lead, but is not affected by fixed alkali; but calcareous earth will fuſe both flint and clay, in a moderate heat, eſpecially if they be mixed with each other: therefore, to produce the ſemi-vitrification of porcelain, nothing more is required than a proper proportion of powdered lime-ſtone, or of quicklime, in the paſte of which the ware is formed.—When the porcelain has been properly baked, it is covered with a kind of cream made of white glaſs, ground to a very fine powder, mixed up with water. It is then put again into the furnace, which melts the glaſs and covers the porcelain with a white tranſparent enamel. After this operation, the porcelain is painted with colours compoſed of calces of metals ground with glaſs and mixed up with gum-water. It is then again expoſed to a degree of heat ſufficient to fuſe the glaſs in the pigment, and there the operation ends.

M. Reaumur, and after him Dr. Lewis, made a kind of porcelain, by cementing common glaſs with ſand, gypſum, and various other matters; but the produce ſeems of no great importance.

PORI, or *Tophi*, are a kind of ſpar compoſed of calcareous earth and aerial acid, generally of a browniſh colour, but differing from ſtalactites (which are found ſuſpended from vaults) in being formed under water.

PORPHYRY, is a compound ſtone whoſe baſis is a flint, containing other ſtones in a cryſtal-

 line

line form. It is red, purple, grey, green, or black. *Kirw. Min.* P. 1. chap. 8. ſp. 5.

POTASH is vegetable fixed alkali obtained by pouring water on the aſhes of burnt vegetables, and afterwards evaporating that water to dryneſs.

POT-STONE, *ſoap-rock*, or *Spaniſh chalk*, is compoſed of magneſia, with a large proportion of flint and a little clay. It is generally of a yellow colour. *Kirw. Min.* P. 1. chap. 6. ſp. 2.

POTTERY differs from porcelain in being abſolutely opake. The ſtone-ware made in this kingdom, is a compoſition of pipe-clay and ground flint, which, without the addition of ſome other matter to act as a flux, are not vitrifiable, and conſequently the ſtone-ware formed by this combination, cannot poſſeſs any degree of tranſparency.

POUND. See *Weights*.

POWDER, *of Algaroth*, called alſo, very abſurdly, *mercurius vitæ*, for it contains not an atom of mercury, is a white precipitate obtained by pouring water upon *butter of antimony*. This powder, too violently emetic to be uſed with ſafety, M. Macquer prefers to the glaſs of antimony in the preparation of emetic tartar: by diſſolving it with cream of tartar, he obtained a neutral cryſtallizable ſalt.—The illuſtrious Scheele deviſed a method of preparing this *pulvis Algarothi*, in the moiſt way, by which he avoided the

very

very dangerous and expenſive proceſs of diſtilling regulus of antimony, with corroſive ſublimate for the purpoſe of making *butter of antimony* He firſt deflagrates, in an iron mortar, one pound of crude antimony with a pound and a half of nitre. To one pound of the *hepar* thus obtained, he pours three pounds of water and fifteen ounces of vitriolic acid, and afterwards fifteen ounces of powdered common ſalt. This maſs is then to be digeſted in a ſand bath, and conſtantly ſtirred during twelve hours. When cool it muſt be ſtrained through linen. On the reſiduum he pours one third of the quantity above mentioned of the ſame menſtruum; digeſts and ſtrains the mixture. From this ſolution, when diluted with boiling water, the *pulvis algarothi* will precipitate, which muſt afterwards be well waſhed and dried. From this powder *emetic tartar* ſhould always be prepared.

POWDER, *Carthuſian*. See *Kermes mineral*.

POWDER, *fulminating*, is compoſed of two parts vegetable alkali, three parts nitre, and one part ſulphur. This powder gradually heated in an iron ladle or ſpoon, explodes with a violent noiſe.

POWDER, *Gun*, is a compoſition of nitre, ſulphur, and charcoal, the beſt proportions of which are ſaid to be 75 parts of nitre, $15\frac{1}{2}$ of charcoal, and $9\frac{1}{2}$ of ſulphur.

POWDER, *Hair*, ſhould be made of ſtarch without any mixture whatſoever, except by way of perfume.—I took half an ounce of common white powder, mixed it with two quarts of water, which, after it had ſtood ſome hours, I paſſed through the filter: this fluid turned ſyrup of violets green, and became cloudy on the addition of a ſingle drop of ſaccharine acid.—The reſiduum on the filter being dried, weighed three drams and a half, ſo that I had loſt thirty grains in the ſolution. To this reſiduum I poured half a pint of diluted vitriolic acid: no effervefcence enſued. I then added three half pints of water, and ſaturated the mixture with vegetable alkali. A precipitation followed. I filtered again, and having dried the reſiduum, found that it weighed thirty-three grains. This reſiduum is inſoluble in vitriolic, or nitrous, or marine acids, or *aqua regia.* It is alſo inſoluble, and not miſcible, nor at all coagulable with boiling water. Query—What was this powder made of?

POWDER, *Dr. James's.* A celebrated febrifuge medicine, thus prepared, if we may believe the patentee on his oath—"Take crude antimony and calcine it with animal oil for two hours. Then put it into nitre, melted in a crucible; and let it continue there for ſome time; and afterwards take out the matter, and waſh the ſalts from it, and dry it. Take alſo quickſilver. Diſtil it three times from crude antimony. Then diſſolve it in ſpirit of nitre; and having evaporated the fluid, calcine the dry maſs in a crucible till

till it turn yellow."—This *recipe* ſeems to be in the very language of the old woman who was probably the inventer, and to whom it properly belonged. It is beneath all chemical criticiſm.

POWDER, *ink*. A powder for making black ink more expeditiouſly than in the old way, has of late years been made by particular people, and is generally ſold by ſtationers. Not being in the ſecret of theſe adepts, I took one dram of galls, and of green vitriol and gum-arabic each one ſcruple: after pounding them in a mortar, I put this ink-powder into two ounces of vinegar, and ſhook the bottle. I then placed it on the hob of the bath-ſtove in my ſtudy, in which there was a ſmall fire, and, in half an hour, it was as good ink as I ever wrote with.

POWDER, *Mareſhal*. Cloves pounded and ſifted.

POWDER, *Purple of Caſſius*, is ſaid to be gold precipitated from *aqua regia* by tin. It is indeed a precipitate from *aqua regia*, but not of pure gold. It may be produced either by putting a piece of tin in a ſolution of gold in *aqua regia*, much diluted with water; or by mixing a diluted ſolution of tin in *aqua regia* with a ſolution of gold in the ſame menſtruum. M. Macquer, in his Dictionary, finds no difficulty in accounting for the production of this purple powder. The tin, he ſays, precipitates the gold, becauſe it has than gold a ſtronger affinity to *aqua regia*; "and though it be already united with the ſame acids, it yet ſeizes thoſe ſuperabundantly that keep the gold diſſolved, which it therefore precipitates. This propoſition, he adds, is proved by obſerving that nothing elſe is added to the ſolution of gold but tin, *aqua regia*, and water."

Now that tin ſhould ſeize ſuperabundantly that particular portion of acid which was combined with the calx of gold, in preference to that which floated in the water, is improbable: beſides, a ſuperfluous quantity of *aqua regia* does not prevent the precipitation; therefore M. Macquer's theory is inſufficient. The following explanation ſeems more ſatisfactory.—The gold diſſolved in the *aqua regia* is calcined, and conſequently has loſt much of its phlogiſton. The tin has loſt ſo much, and no more, of its phlogiſton as to render it juſt ſoluble in the diluted menſtruum. Now, when theſe two ſolutions are mixed, the remaining phlogiſton of the tin, preferring gold to that metal, changes its poſition. The gold having thus recovered a ſufficient quantity of phlogiſton to render it inſoluble, falls to the bottom, not perfectly *reduced*. The tin, on the contrary, having loſt the portion of phlogiſton neceſſary to its ſolution, alſo precipitates in combination with the gold, and this combination is neceſſary to the production of the purple powder of Caſſius. That it is not pure gold, is evident from its ſpecific gravity. The uſe of this precipitate

pitate is to communicate a crimſon or purple colour to glaſs, enamel, or to porcelain. See *Bergman*'s *admirable Diſſertation on Metallic Precipitates*, Vol. ii. D. 23.

PRECIPITATES, *metallic*, are powders of different colours, which fall to the bottom of a veſſel containing the ſolution of a metallic ſubſtance, on the addition of ſome other matter capable of producing a decompoſition, in conſequence of its attraction either to the menſtruum or to the metal in ſolution: for example, metals diſſolved in any acid may be precipitated by alkalis or earths, becauſe the attraction of theſe to acids is ſtronger than that by which acids and metals are held together. Metals are alſo precipitated by other metals, when the power of attraction between phlogiſton and the calx of the metal in ſolution, is ſuperior to that between phlogiſton and the calx of the added metal to which it was united.

Metallic precipitates are the earths or calces of metals, deprived, by ſolution, of that Proteus, called *phlogiſton*, which gave them their former metallic appearance. But the moſt extraordinary phenomenon in theſe precipitates, is their increaſe of weight. This increaſe differs in different metals and precipitants. Many of them double their weight, and ſome precipitates weigh five or ſix times heavier than the metal before it was diſſolved. This problem is more difficult of *ſolution* than

than the metals themſelves. That there is an increaſe of matter is incontrovertable: for immaterial things, if any ſuch things exiſt, have no weight. Some philoſophers tell us it is fixed air; ſome ſay it is the oxyginous principle; ſome are of opinion that it is water, and others take it to be *matter of heat.*

PRECIPITATION, p. 171.

PRINCIPLES, in chemiſtry, are primary or ſecundary. Primary principles are elements; ſecundary principles are conſtituent parts compoſed of elements.

PUMICE-STONE is a volcanic ejection, of various colours, and ſo light as to ſwim upon water; nevertheleſs, it conſiſts chiefly of flint, with ſome magneſia, and a very ſmall proportion of calcareous earth. See *Kirw. Min.* P. 1. chap. 8. ſp. 21.

PURIFICATION, p. 188.

PUTREFACTION is the third and laſt fermentative chemical proceſs of nature, by which ſhe decompoſes organized bodies, ſo as to ſeparate their principles, for the purpoſe of re-uniting them, by future attractions, in the compoſition of new creations. But though, in ſome inſtances, the vinous, the acetous, and the putrefactive fermentations may regularly ſucceed each other, yet, in general, they operate independently. The vinous fermentation ſtops ſpontaneouſly without proceeding to the acetous: the acetous commences

mences without any previous perceptible vinous fermentation, and ſtops without running into the putrefactive; and, in animal ſubſtances, putrefaction begins without being introduced by either of the other two: on the contrary, vinous ſpirit and vinegar moſt powerfully reſiſt putrefaction. Hence the received opinion, that theſe three fermentations naturally ſucceed each other, ſeems to be ill founded. I rather believe that the ſuppoſed ſucceſſion never happens but when the previous fermentation is imperfect.

Animal or vegetable matter, in a ſtate of putrefaction, yields in diſtillation volatile alkali and a fœtid oil. Putrefactive matter expoſed to the air, gradually parts with its water, its aerial acid, its oil, and its phlogiſton, ſo combined as to produce an offenſive ſmell, and the earth which remains, if it be an animal putrefaction, is phoſphoric acid ſuperſaturated with lime.

PYRITES are improperly diſtinguiſhed from ores. They were called *pyrites* from πυρ, *fire*, becauſe they are generally ſo hard as to ſtrike fire with ſteel. Henckel talks of an unmetallic earth in pyrites, the nature of which, M. Macquer ſays, has not been well examined; but he ſuſpects it to be of an argillaceous nature. The nature of this unmetallic earth is at preſent very well underſtood. Martial pyrites is a hard concretion of ſulphur, clay, or calcareous earth, with flint and calx of iron: it is pale yellow, or brown.

Yel-

Yellow pyrites, or variegated with red or green, is a copper ore, containing ſulphur, clay, flint, a little copper, and a large proportion of iron. White pyrites is an ore in which iron is mineralized by ſulphur and arſenic. See *Kirw. Min.*

PYROPHORUS is a chemical preparation that burns ſpontaneouſly when expoſed to the air. It is uſually made by expoſing a mixture of three parts alum and one part ſugar (previouſly dried on an iron ſhovel till it is almoſt black) in a matraſs, to the red heat of a furnace, until a ſulphurious flame iſſues from the mouth of the veſſel. The matraſs muſt ſtand in a crucible filled up with ſand. Before the pyrophorus is quite cold, it muſt be poured into a dry bottle and kept cloſe ſtopped.—M. Macquer is of opinion, that the circumſtances attending the ſpontaneous inflammation of pyrophorus, clearly prove, that it is produced by the extreme heat exited in its parts by the activity with which the vitriolic acid ſeizes the water in the atmoſphere. This theory is by no means ſatisfactory. It is true, vitriolic acid ſuddenly mixed with a quantity of water, produces heat; but the moſt concentrated vitriolic acid, in attracting the moiſture of the atmoſphere produces no heat. Phlogiſton, I believe, is fire fixed by a peculiar acid. I am alſo of opinion, that whenever theſe two principles are ſeparated by any ſuperior attraction to either of

them,

them, inflammation is the confequence. In pyrophorus the vitriolic acid, as in phofphorus the phofphoric, may weaken the union between the principles of phlogifton, fo as to difpofe them to an eafy feparation as foon as they come in contact with pure air, which probably unites with the acid of the phlogifton.

QUADRUM. A name given by fome naturalifts to a fpecies of fand-ftone confifting of flints in a calcareous cement, in the proportion of almoft two parts flint to one of calcareous earth. *Kirw. Min.* P. 1. chap. 8. fp. 25.

QUARTATION. When gold and filver are to be feparated by the operation called *parting by aqua fortis*, it is neceffary that the mafs fhould contain at leaft three parts filver to one of gold, otherwife fome of the filver will be fo covered by the gold, that the nitrous acid cannot diffolve the whole of it. This operation of adding the neceffary proportion of filver, is called *quartation.*

QUARTZ, is commonly applied, as a generic term, to a great variety of flints, without any pofsitive fignification. Mr. Kirwan judicioufly confines it to the purer kind of filiceous ftones, fuch as cryftal, Briftol ftones, certain coloured falfe gems, fine fand, and fome opake pebbles. See *Kirw. Min.* P. 1. chap. 8.——If we liften to M. Macquer, quarts is a ftone intermediate between rock-cryftals and flints, of a milky colour, cracked

cracked throughout, a little waved, and of a greafy appearance.

QUICKLIME, p. 63. See *Cauſticity and Mortar*. M. Macquer, by the time he arrived at the letter Q in writing his dictionary, had acquired a ſufficient comprehenſion and conviction of Doctor Black's theory relative to quicklime; but he very unjuſtly attempts to conſider the experiments of that celebrated chemiſt as a mere illuſtration and completion of Stahl's doctrine; which doctrine, according to his own account of it, has no more ſimilitude to Dr. Black's theory, than the Carteſian vortices to Sir Iſaac Newton's gravitation: which gravitation, by the bye, M. Macquer continues to confound with chemical attraction.

RADICAL is a term in chemiſtry particularly applied to vinegar concentrated by combining it with ſome metal or earth, and then ſeparating it by diſtillation, or by means of vitriolic acid.

REALGAR is an ore of arſenic, in which the regulus is mineralized by a ſmall proportion of ſulphur. It may be analized by digeſtion in marine acid, adding nitrous acid by degrees. The ſulphur will remain on the filter, and the arſenic may be precipitated from the ſolution by zinc, with the addition of a little ſpirit of wine.

RECEIVER is a glaſs veſſel adapted to a retort or alembic, for the purpoſe of receiving and condenſing the volatile matter raiſed in diſtillation.

REC-

RECTIFICATION means nothing more than repeated diftillation or fublimation, p. 178.

REDUCTION, p. 182.

REFINING, p. 186.

REFRACTORY is applied to earths or metals that are either abfolutely infufible, or that cannot be melted without an extraordinary degree of heat.

REFREGERATORY is a contrivance of any kind, which, by containing cold water, anfwers the purpofe of condenfing the vapour that arifes in diftillation.

REGULUS. This word, in its chemical acceptation, fignifies a metallic fubftance freed from the fulphur or arfenic by which it was mineralized.

RESINS are vegetable juices concreted by evaporation, either fpontaneoufly, or by the application of fire: they are diftinguifhed from wax and gums by being foluble in fpirit of wine, and not in water; alfo by yielding effential oils in diftillation.

RETORT is a bottle, with the neck bent downwards, ufed in diftillation, the extremity of which neck fits into that of another bottle called a *receiver*. Retorts are generally made of glafs; but, where extream heat is required, thofe made by Wedgewood, of baked earth, are preferable.

REVERBERATORY is a furnace in which the flame is confined by a dome, ſo as to return upon the metal under operation.

ROASTING *of ores* is a preparative operation, which conſiſts in burning them with ſome combuſtible ſubſtance, with an intention to diſſipate the inflammable matter with which the metal is combined.

RUBY is a precious ſtone of the firſt order. It is the hardeſt of all ſtones except diamond, and is infuſible *per ſe*, unleſs by the flame directed by the blow-pipe, and excited by pure air. Its conſtituent parts are flint, clay, calcareous earth, and iron. See *Kirw. Min.* P. 1. chap. 8. ſp. 6.

SAFFRON. This term has been abſurdly applied by chemiſts to every yellow calx or precipitate of metals.

SALTS. M. Macquer, in his chemical dictionary, has favoured us with a very long and elaborate definition of ſalts; from which we learn at laſt, that ſalts are ſapid bodies, ſoluble in water, and that they are acid, alkaline, or neutral.

SALTS, *Ammoniacal*, p. 60.

SALT, *Common*, p. 43.

SALT, *Epſom*, p. 40.

SALT, *Digeſtive of Sylvius*, p. 43.

SALT, *Glauber's*, p. 40.

SALT *of Rochelle*, p. 47.

SALTPETRE. Nitre.

SALTS, *neutral*, are combinations of an acid with an alkali, an earth, or a metal.

SALTS, *urinous*. Alkaline ſalts, both volatile and fixed, have been frequently ſo called—"the former, ſays the *Chemical Dictionary*, becauſe they all have the taſte of putrified or diſtilled urine; and the fixed, becauſe, although they have not themſelves this taſte, they however occaſion it, when applied to the tongue, by diſengaging the volatile alkali contained in animal ſubſtances."—What can this mean? How are we to know that fixed alkalis have not an urinous taſte, but by taſting them? Have fixed alkalis the power of extracting volatile alkali, or that matter which, in volatile alkali, gives the urinous taſte, from the tongue or the ſaliva?

SAND. Small flints.

SATURATION. Any fluid, or menſtruum, is ſaid to be ſaturated with a ſoluble ſubſtance, when, on adding more, that ſubſtance would now fall to the bottom of the veſſel. An acid is ſaturated with chalk or with ſalt of tartar, when, on adding more, there is no efferveſcence.

SELENITES. *Gypſum*, or *Plaſter of Paris*, is a combination of vitriolic acid with calcareous earth. It requires about 500 times its weight of water to diſſolve it. It is this ſalt which makes our pump waters hard: they curdle ſoap, becauſe its alkali quits the oil to unite with the vitriolic acid.

SEMI-METAL, p. 99.

SERPENTINE is a ſtone reſembling marble, of various colours, compoſed of pure magneſia, flint, clay, and a little iron. See *Kirw. Min.* P. 1. chap. 6. ſp. 5.

SHOERL. A very hard ſtone, tranſparent or opake, brown, or greeniſh, or violet, or white, or black, or red; compoſed of flint, clay, calcareous earth, calx of iron, and magneſia. *Kirw. Min.* P. 1. chap. 8. ſp. 15.

SIDERITE. Suppoſed to be a new ſemimetal; but it now appears to have been a miſtake.

SILVER, p. 74, 192.

SMELTING, p. 184.

SOAP, is a combination of oil with cauſtic alkali; *i. e.* of alkali deprived of its aerial acid by means of quicklime: for this purpoſe, equal parts of freſh lime and potaſh are ſlaked and diſſolved in about 12 times their weight of water. Of this ley, three parts are mixed with one of oil of olives, or of almonds, or any other expreſſed oil, and in a few hours, with or without heat, this mixture will coagulate into ſoap.—M. Macquer chuſes to call every thing ſoap which, having oil in its compoſition, is miſcible with water, and under this definition he includes all vegetable acids, eſſential ſalts, ſaccharine juices, and the ex-

extractive matter of plants: all these he assures us are acid soaps: but gums and mucilages also come under this definition; so that milk, artificial emulsions, and every thing miscible or soluble in water, is a soap. With M. Macquer's leave, I would rather confine the word soap to a combination of oil with an alkaline salt, miscible but not soluble in water.

SOAP-ROCK is a variety of steatites, generally of a greenish or yellowish colour. It is also called French or Spanish chalk. It consists principally of flint, a little mild magnesia, still less of clay, and a very small proportion of calx of iron. *Kirw. Min.* P. 1. chap. 6. sp. 2.

SODA. Mineral alkali obtained by lixiviating the ashes of the plant *kali*.

SOLUTION, p. 167.

SOOT is smoke condensed by coming in contact with the internal surface of chimnies, which are sufficiently cold for fixing the matter volatilized by heat. Its composition differs according to the constituent parts of the fuel. In general it contains water, volatile alkali, an empyreumatic oil, and some fixed alkali.

SPAR, in mineralogy, is a word without any determinate meaning. Spars are crystallized stones of various colours, transparent or opake, generally of a lamellar rhomboidal texture. Most spars are a combination of calcareous earth, aerial or vitriolic acid. Some contain other earths mixed with the calcareous.

SPERMA-CETI. An absurd appellation given to an oily concrete, said to be taken from some part of the head of a whale. Dr. Lewis says, it is prepared by boiling and purifying it with alkaline lixivia. It is soluble in oils; but is incapable of forming soap with alkaline salts. It is miscible with water by means of the yolk of an egg.

SPIRIT *ardent*, or *spirit of wine*, is obtained by distillation from any vegetable substance that has undergone the first, or vinous, fermentation. It is easily inflamed, and burns without smoke, or leaving any residuum. It is miscible with water in any proportion. Mixed with acids, it forms what are called dulcified acids. Distilled with acids, it forms *æther*. It dissolves resins and essential oils.

SPIRIT *of nitre*. *Nitrous acid*, which see p. 49.

SPIRITOUS RECTOR. A silly appellation given to the essential oil of aromatic plants.

SPIRIT *of Salt*. *Marine acid*, p. 42.

SPIRIT *of Sulphur*. *Vitriolic acid*, p. 39.

SPIRIT *of Venus*. Concentrated vinegar, distilled from verdegrise.

SPIRIT *af Sal-ammoniac*. *Volatile alkali*. Sal-ammoniac is a neutral salt composed of marine acid and volatile alkali. Now if this salt be di-

stilled

ſtilled with fixed alkali, or calcareous earth, which have a ſtronger attraction to the marine acid than the volatile alkali to which it is united, this volatile alkali will neceſſarily quit its baſis and riſe in diſtillation—" This volatile alkali, ſays the author of the *Chemical Dictionary*, has been diſengaged by means of ſome intermediate ſubſtance, which alſo has taken from it ſome of its oily principle, by means of which it was capable of a ſolid or concrete ſtate; hence the ſpirit is always fluid. The intermediate ſubſtances which have the property of producing this alteration upon volatile alkali, are ſtony and metallic calces."—By ſtony calces, I ſuppoſe he means quicklime. Could M. Macquer poſſibly be ignorant that, in this proceſs, the alkali is fluid becauſe it is rendered cauſtic; that is, deprived of its aerial acid by the lime? Had he forgotten that cauſtic volatile alkali is always fluid?

STEATITES. See *Soap-rock*.

STEEL is generally known to be iron rendered more hard, more elaſtic, and more ſonorous and heavier, by art. It may be prepared either from crude iron, called *caſt-iron*, or from bar iron, that is, iron rendered malliable by being repeatedly heated and hammered. Crude iron is converted into ſteel by melting only; malliable iron, by cementation with charcoal. But what is the cauſe of this converſion of iron into ſteel? M. Macquer finds no difficulty in accounting for it.

it. Iron, in cementation, he tells us, imbibes phlogiston from the charcoal, and thence becomes steel: so that steel is iron super-phlogisticated. But M. Macquer, as usual, forgets to support his theory by proof, probability, or experiment of any kind.—The French *Antiphlogistians* assure us on the contrary, that, in the act of cementation, the iron imbibes not a part only of the charcoal, but swallows the charcoal entire.—— Bergman is of opinion, that, in cementation, the superfluous phlogiston of the malleable iron uniting with the aerial acid of the charcoal, generates plumbago, which combined with iron, constitutes steel. This theory is well sustained by facts; for which I refer the reader to Mr. Kirwan's decisive *Essay on Phlogiston*, p. 137.

SUBLIMATION, p. 176.

SUGAR is an essential salt contained abundantly in the juice of the sugar-cane; and, being a salt, it necessarily contains an acid, which acid possesses the peculiar property of separating lime from every other substance. Hence the use of lime-water in refining sugar. Sugar contains a superfluous quantity of acid, which prevents its concretion; which acid, combining with the lime dissolved in the lime-water, forms an insoluble salt that either falls to the bottom or floats in the froth. The apprehension, therefore, that there is lime in refined sugar is groundless. The nature and properties of the saccharine acid are very amply investigated in Bergman's dissertation on this subject, vol. i.

SUGAR *of Lead*, is a metallic ſalt compoſed of the calx of lead and the acetous acid: it is made by boiling, or digeſting, white-lead with diſtilled vinegar; evaporating to the conſiſtence of a ſyrup, and then ſetting it to cryſtallize.

SUGAR *of Milk*. See *Milk*.

SULPHUR. *Brimſtone*. This inflammable ſubſtance is vitriolic acid ſaturated with phlogiſton. It is entirely inflammable; for it conſumes without leaving any reſiduum: it is unalterable by heat; for it ſublimes without the leaſt alteration: it is equally inſoluble in acids and in water; therefore the fooliſh medicine called *brimſtone water*, is water and nothing more: deflagrated with nitre, its acid combining with the baſis of the nitre, it forms vitriolated tartar: mixed with nitre and charcoal, it forms gunpowder: melted with alkaline ſalts, or abſorbent earths, it forms liver of ſulphur: it diſſolves readily in oils, in a degree of heat ſufficient to melt it: it is the common mineralizer of metallic ſubſtances.

TALK. See *Mica*, ſays the *Chemical Dictionary*: but *talk* and *mica* are eſſentially different. See *Mica* in this Lexicon.

TAR is the juice of pines and firs which exudes in burning.

TARTAR is an acid concrete which is found adhering to the internal ſurface of caſks in which wine has been kept. It is purified by boiling in water with a little clay; being then cryſtallized it is called *cryſtals*, or *cream of tartar*. This cream of tartar poſſeſſes the general properties of an acid: nevertheleſs tartar is in reality a neutral ſalt, compoſed of vegetable alkali ſuper-ſaturated with vegetable acid. See *Bergman's Elective Attractions* ix.

TARTAR *emetic*, when properly prepared, is doubtleſs the only ſafe and certain antimonial medicine; but no medicine is more various than tartar-emetic, as prepared according to the formulæ of all the diſpenſatories extant. It is generally made by boiling either the *crocus metallorum*, the *liver* or the *glaſs* of antimony, with a ſolution of cream of tartar; ſubſequent filtration and evaporation. The powder thus obtained muſt neceſſarily vary in its properties, becauſe the quantity of phlogiſton in theſe antimonials varies according to circumſtances in their preparation, which it is impoſſible to regulate; and they are ſoluble in the acid menſtruum, in proportion to the quantity of phlogiſton they contain. M. Macquer was, I believe, the firſt chemiſt who propoſed the ſubſtitution of the powder of Algaroth (of Algarotti it ſhould be called) for glaſs of antimony. On this ſubject the reader will find, in the *Chemical Dictionary*, a diſſertation, of ſix pages, from which he will finally learn, that the powder of Algarotti is preferable to other preparations

ations of antimony, becauſe, being regulus of antimony calcined by a determined proportion of marine acid taken from corroſive ſublimate, it muſt be always equally dephlogiſticated, and conſequently, in ſaturating the acid of tartar, it composes a neutral metallic ſalt, which muſt neceſſarily always poſſeſs the ſame degree of emetic power.

Emetic Tartar ſhould be made thus: boil in a quart of water, in a glaſs veſſel, for half an hour, five ounces of cream of tartar, with two and a half drams of the powder precipitated, by water, from butter of antimony. Evaporate the filtered ſolution in an open veſſel (not of metal) till a pellicle appears on the ſurface: then keep it in a digeſting heat, and as the cryſtals form, take them away and dry them on moiſt filtering-paper: they will weigh five ounces. Half an ounce of water will diſſolve about three grains of theſe cryſtals, which are, if the cryſtallization has been properly managed, octaedral pyramids. This ſalt may be precipitated from its ſolution in water by any alkaline ſalt. For Scheele's method of making Algarotti's powder, ſee *Powder of Algaroth*. Vide alſo Bergman's *Diſſertation on antimoniated Tartar*, vol. 1.

TARTAR *regenerated*, is one of the improper names given to a neutral ſalt formed by ſaturating vegetable alkali with vinegar. It ſhould be called *tartarized vinegar*.

TAR-

TARTAR, *foluble*. The acid of tartar faturated with the alkali of tartar, by dropping what is abfurdly called *oleum tartari*, into a boiling folution of cryftals of tartar. This falt fhould be called *tartarized tartar*.

TARTAR, *vitriolated*. Vitriolic acid faturated with vegetable alkali: it is made by pouring the acid into a folution of falt of tartar, or any other vegetable alkali, till the effervefcence ceafes; filtration and evaporation.

It is an axium in chemiftry univerfally acknowledged, that alkalis have a ftronger attraction to the vitriolic than to any other acid: therefore no other acid can decompofe vitriolated tartar. But M. Baumé difcovered, many years ago, that this falt may be actually decompofed; for that, if to a folution of vitriolated tartar, we add nitrous acid, a real nitre will precipitate; which nitre could not be otherwife formed than by taking the alkaline bafis from the vitriolated tartar. He does not, however, admit this extraordinary phenomenon as an exception to the general axiom, nor yet as an example of reciprocal affinity: but he afcribes it to the fuperior attraction of the nitrous acid to the phlogifton in the vitriolated tartar. M. Macquer adopts this opinion. Was it not neceffary that one of thefe philofophers fhould have proved the exiftence of phlogifton in vitriolated tartar? It is, however, of no confequence, fince phlogifton has nothing to do in the pro-

procefs. The phenomenon in queftion may be rationally explained thus: vegetable alkali, like a drunkard, will drink after its natural thirft is fatisfied: in the language of chemiftry, it is capable of fuper-faturation with acids; if therefore I pour nitrous acid into a folution of vitriolated tartar, a part of the vitriolated tartar will relinquifh its bafis to the nitrous acid, in order to fuper-faturate itfelf with the vitriolic acid, which will thereby be difengaged; in this experiment, therefore, only a part of the vitriolated tartar is decompofed. If the vitriolated tartar, which is ufed in the experiment, were cryftallized in a fuperfluous quantity of vitriolic acid, no nitre would precipitate, becaufe the tartar was already fuperfaturated. See Bergman's *Elective attractions.*

TERRA *foliata tartari.* A ridiculous appellation given to *tartarized vinegar.* The *Chemical Dictionary* informs us, that during the effervefcence occafioned by the mixture of the vegetable acid with the vinegar, a large quantity of *air*, which he calls *aerial water*, is produced, as fuffocating as volatile alkali, or volatile fulphurious acid. What ftrange nonfenfe!

TERRA *Japonica* is not an earth, but the infpiffated juice of a vegetable, foluble in water or in fpirit.

TEST, is a kind of oval difh made of woodafhes, or powder of calcined bones, mixed with

a little

a little clay; it is uſed by refiners, and for aſſaying, teſting, or trying gold or ſilver by melting it with lead.

TEST-LIQUOR. A ſolution of green vitriol in water, uſed formerly by brandy-merchants for the purpoſe of diſtinguiſhing genuine French brandy from malt ſpirits. A few drops of this liquor would turn a glaſs of brandy purple; but had no effect on malt ſpirits: becauſe the latter was coloured with burnt ſugar; the former by the oak caſk in which it was kept. The cauſe of this effect is eaſily underſtood, when we recollect that the oak caſk communicates to the brandy not only colour but aſtringency, and that a ſolution of iron ſtrikes a purple or black colour with any vegetable aſtringent. But this teſt-liquor is at preſent of no uſe; for the diſtillers have learnt the art of colouring their ſpirit with an extract of oak. We are told in the *Cyclopædia*, that this teſt-liquor is made by diſſolving a little green, or *white*, vitriol in water; but that the very beſt way of making it, is with a calcined vitriol of iron diſſolved in a dilute or aqueous mineral acid. Whether this was originally in old Chambers, or added by the laſt editor, I know not; but it was certainly written by ſome *chemiſt* who did not know that *white* vitriol is a vitriol of zinc and not of iron; and that calcined vitriol is inſoluble in any acid.

TIN,

TIN, p. 97, 198.

TINCTURES, in pharmacy, are ſolutions in ſpirituous menſtrua.

TURPENTINE is a reſinous juice extracted from certain trees by wounding the trunk with a knife. It poſſeſſes the chemical properties of other reſins.

VERDEGRISE is a metallic ſalt, conſiſting of vinegar ſaturated with copper.

VERDETER. A blue pigment, compoſed of copper diſſolved in *aqua fortis*, and whiting.

VINEGAR, by chemiſts called the *acetous acid*. It is the produce of that fermentation which is generally ſuppoſed to ſucceed the vinous. The ſtrongeſt wines are ſaid to produce the beſt vinegar. Vinegar may be concentrated, that is, made ſtronger, or rendered more acid, by freezing, or by combining it with earths, alkaline ſalts or metals, and afterwards ſeparating it by means of vitriolic acid; or by diſtilling it from verdegriſe, which is vinegar combined with copper.

VITRIFICATION. See *Glaſs*.

VITRIOLS are ſalts compoſed of vitriolic acid ſaturated with a metallic earth. Vitriols are eaſily known by diſſolving them in water, and mixing the ſolution with that of Epſom ſalt or of vitriolated tartar. If it be a vitriol that you have diſſolved, the mixture will continue limpid.

VITRIOL *of Cobalt* is red, and produces a red ſolution in water.

VI-

VITRIOL *of Copper. Blue vitriol.* If we add volatile alkali to a ſolution of this ſalt in water, a deep blue will be produced. If into a ſolution of this ſalt in water, we immerſe a poliſhed plate of iron, it will immediately be covered with copper.

VITRIOL *of Iron,* is eaſily diſcovered by its ſolution ſtriking a purple or black colour with a ſolution of galls, or of any other vegetable aſtringent.

VITRIOL *of Lead.* We are aſſured by Dr. Withering, that it is found in large quantities in the Iſle of Angleſea.

VITRIOL *of Zinc. White vitriol.* It is ſoluble in twice its weight of water, and may be precipitated by alkalis, but not by iron.

UMBER. Till lately ſuppoſed to be a clay; but now believed to be decayed wood mixed with bitumen. It is uſed as a pigment.

URINE is a ſolution of different ſalts in water: the ſalts are microcoſmic, marine, and ammoniacal. The compoſition of theſe ſalts hath been already explained: they vary according to the health and conſtitution of the individual; but are conſiderably influenced by the quality and quantity of aliment. The illiterate quacks, who pretend to judge of diſeaſes from a bare inſpection of the urine of the patient, are arrant knaves, and their patients pitiable fools. In an age diſtinguiſhed by ſcientifical improvements; in a na-

tion

tion diſtinguiſhed particularly by the progreſs of medical knowledge, is it not aſtoniſhing that there ſhould yet be found, among the higher ranks of people, a ſingle individual ſo weak as to conſult an ignorant urinemonger?

WATER, p. 10, 122.

WATER, *diſtilled.* Diſtilled water is required in all chemical experiments, becauſe water in general contains heterogeneous matter. It is of no conſequence whether it be rain-water, ſnow-water, river-water, or ſpring-water, provided it be diſtilled in a glaſs retort, and the diſtillation be diſcontinued when about two thirds of the quantity has paſſed into the receiver.

WATER, *Mineral,* is water impregnated with ſome ſoluble mineral ſubſtance, particularly metallic: this metal is generally iron, ſometimes copper; they are held in ſolution either by the aerial or the vitriolic acid.

WATER *of Rabel.* Sweet ſpirit of vitriol.

WEIGHTS uſed in Chemiſtry, in this kingdom, are

Apothecaries' Weights, viz.

20 grains	make	1 ſcruple.		
3 ſcruples	—	1 dram	=	60 grains.
8 drams	—	1 ounce	=	480 do.
12 ounces	—	1 pound	=	5760 do.

Gold-

Goldsmiths Weights.

24 Grains make	1 penny-weight.	
20 Penny-weights —	1 ounce =	480 grains
12 Ounces —	1 pound =	5760 do.

Thus we see that the apothecaries' and the Goldsmiths' weights are the same Troy pound differently divided. But in all weights above two drams, the Apothecaries generally use Avoirdupois weights, which are the weights used by druggists, grocers, &c.

Avoirdupois Weights.

16 Drams make	1 ounce =	$437\frac{1}{2}$ grains.
16 Ounces —	1 pound =	7000 do.
28 Pounds —	1 quarter	
4 Quarters —	1 hundred.	
20 Hundred —	1 ton.	

French Weights.

24 Grains make	1 denier =	$19\frac{33}{48}$	Troy grains.
3 Deniers	1 gross =	$59\frac{1}{2}$	do.
8 Gros	1 ounce =	$472\frac{1}{2}$	do.
16 Ounces	1 pound =	7560	do.

The Paris grain is to the Troy grain as 7560 to 9216.

In a note to Bergman's *Analysis of Waters*, sect. 7. we are told that the Swedish apothecary's pound consists of 12 ounces, and each ounce of 480 grains; so that it is the same as our own.

WEIGHT

WEIGHT of different kinds of air according to Mr. Kirwan. *Essay on Phlogiston*, p. 18.

100 *Cubic Inches.*	*Grains.*	*Proportion to Common Air.*
Common air -	31 -	1000
Pure air -	34 -	1103
Phlogisticated air	30,535 -	985
Nitrous air -	37 -	1194
Vitriolic air -	70,215 -	2265
Fixed air -	46,5 -	1500
Hepatic air -	34,286 -	1106
Alkaline air -	18,16 -	600
Inflammable air -	2,613 -	84,3.

WELDING *Heat*, is that degree of heat in which two pieces of iron may be united by hammering.

WINE. See *Fermentation*, p. 161.

WOAD is a plant cultivated in France for the use of dyers of woollen cloth. The leaves are ground and made into balls. It gives a permanent blue colour, and is generally mixed with indigo.

WOLFRAM is a very heavy ore of iron, frequently found in tin mines. When scratched it shews a red trace, which distinguishes it from tungsten. It is very refractory and insoluble. It consists of flint, calx of iron, and a little tin. *Kirw. Min.* P. 4. ch. 5. sp. 24.

YELLOW. The drugs used by dyers for this colour, in what is called the *good dye*, are weld,

 savory,

ſavory, green wood, yellow wood, and fenugreek. The wool or ſtuff is previouſly prepared by boiling in a ſolution of alum and tartar, in the proportion of four ounces of alum and one ounce of tartar to each pound of wool. Silk or wool may alſo be dyed yellow, by indigo mixed with diluted nitrous acid.

ZAFFRE is the calx of cobalt mixed with vitrifiable earth. It is uſed for giving a blue colour to glaſs and enamels, alſo for painting on porcelain.

ZEOLYTE is a ſtone compoſed of flint, clay, and lime. It is tranſparent, or opake; colourleſs, or reddiſh, or greeniſh, or yellowiſh. It is various as to ſhape and texture. It does not ſtrike fire with ſteel. It does not efferveſce with acids, though they partly diſſolve it. It ſwells and dilates in a ſtrong heat, and melts *per ſe* into a frothy ſlag. *Kirw. Min.* P. 1. ch. 7. ſp. 12.

ZINC, p. 108, 201.

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